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Working together: the positive effects of introducing formal teams in a first year Engineering degree

Thomas Joyce and Clare Hopkins

Abstract

Students enrolled in engineering courses in the UK have a higher than average rate of non-progression from Stage 1 to Stage 2. In the academic year 2009/10, in response to these concerns, the School of Mechanical and Systems Engineering at Newcastle University introduced a model of team working based on a scheme which had previously proved effective in increasing retention at another institution. Qualitative and quantitative evaluation of students' perceptions of the introduction of team working revealed both their appreciation of this way of working together with identification of aspects of the model requiring further refinement. Analysis of statistical data relating to progression from Stage 1 to Stage 2 for this cohort of students revealed an increased number of students continuing into Stage 2, from an average of 82.0% over the academic years 2005/06 to 2008/09, to 92.5% for the academic year 2009/10. This paper discusses the impact of the introduction of this team working through feedback provided by the students themselves.

Introduction

In engineering courses in the UK, the level of non-continuation from first to second year has remained above 20% for the past five years (Higher Education Statistics Agency). Student retention can be viewed on many

levels. The Higher Education Funding Council for England (HEFCE) collects retention data in order to measure the success of higher education institutions in ensuring that students who start courses progress to graduation (the 'completion rate'). The Higher Education Statistics Agency (HESA) measures the 'continuation rate', a calculation of the proportion of an institution's intake which is enrolled in higher education in the year following their first entry to higher education (NAO, 2007). It is recognised that these blunt statistical definitions fail to acknowledge the experience gained by the individual student when they leave their course, be it voluntarily or involuntarily (Quinn et al., 2005; Jones, 2008). Non-completion of a course of study involves potential losses for everyone involved: the university has lost a student and revenue which cannot be replaced, the School has lost a potentially successful graduate, and the individual student may have lost a career opportunity. If that student is the first in their family to take part in higher education and subsequently does not continue into the second year of their course they may construe this as having 'failed', despite having made gains in confidence and having acquired valuable future study skills (Quinn et al., 2005).

The continuation rate from Stage 1 to Stage 2 in the School of Mechanical and Systems Engineering at Newcastle University over several academic years is shown in Table 1.

Table 1. Continuation rates over four academic years from Stage 1 to Stage 2 in the School of Mechanical and Systems Engineering at Newcastle University

Academic year	Students registered	% of students registered able to progress
2005/06	93	82.8
2006/07	75	82.7
2007/08	90	80.0
2008/09	114	82.5

These rates, despite being lower than the national average for engineering and technology (HESA), were still considered a cause for concern and action. For comparison, the progression rates for Newcastle University as a whole were 96.3% for full-time first degree entrants 2007/08 (HESA). Recognised factors related to retention in Engineering include appropriate mathematical skills, student attendance and a tutorial system (Pulko and Cutler, 2003) and the School already employed a number of schemes to aid progression, providing additional mathematical instruction to students based on an induction week diagnostic test. Attendance was monitored and all students were assigned a personal tutor with whom they met weekly during a one-hour timetabled slot throughout their first year.

Prompted by these continuation rates, and having become aware of the successfully implemented changes to the organisation of student learning and pedagogical practice in the School of Mechanical Engineering at Strathclyde University known as the NATALIE project (New Approaches to Teaching and Learning in Engineering) (Boyle, 2004), a decision was made to adapt this approach to make it compatible with the environment and facilities at Newcastle University. The hypothesis central to this change was that, by formally placing students into pre-selected Engineering Teams and giving them tasks to complete together throughout their first year, peer-to-peer support and peer-to-peer learning would take place, enhancing the student learning experience and potentially increasing the number of students continuing onto Stage 2 of their degree programme.

Introducing Engineering Teams during Stage 1 seemed most appropriate because, as Tinto (2006) writes of efforts to increase students' sense of integration, 'at no point does it matter more than during the first year of college when student attachments are so tenuous and the pull of the institution so weak' (p.3). Moreover (and pragmatically) the continuation rates were lowest between Stage 1 and Stage 2.

It was not possible to import the NATALIE approach in totality. At Strathclyde University changes were made to both the pedagogical approach (using group work and interactive approaches) and the building (where classrooms were redesigned to incorporate a communication system enabling active

collaborative learning) (Nicol and Boyle, 2003). The building in which the School of Mechanical and Systems Engineering at Newcastle is housed does not have the classroom communication systems used in Strathclyde University and it was not possible to redesign lecture theatres and tutorial rooms specifically to accommodate group working. The substantial financial costs of the investment at Strathclyde were not available to Mechanical Engineering at Newcastle so instead a low cost solution was sought and it was hoped that embracing the key principles of the NATALIE model – students purposively organised into 'Engineering Teams', team tutorial sessions, team project work and assignment submission – would bring significant learning and retention benefits. Other modifications to the first year curriculum at Newcastle included: changing the personal tutor system to team based tutorials; the introduction of an additional assignment on ethics and a change of Stage 1 Manager. In the period during which these changes were implemented there were no changes in academic staffing within the School.

The aim of this paper is to provide an account of these changes in learning and teaching and to highlight which aspects were successful and which, after reflection, needed further refinement. It will hopefully contribute to the sum of understanding about the effect of the team process on student learning and demonstrate the benefits and difficulties of introducing this way of working into a traditional university where structural adaptations to the environment to facilitate small group working may not be possible and where the traditional academic and learning ethos demands that students arrive with an already developed sense of academic independence and autonomy in their learning.

The introduction of Engineering Teams

The overall student cohort for Stage 1 of Mechanical Engineering during the academic year 2009/10 consisted of 107 students of whom 8% were female and 23% were overseas students. These students were allocated into Engineering Teams of five, comprised so that there was a range of previous academic performances (i.e. there were no teams consisting only of academically high achieving students and none whose members had relatively low entry grades). In addition, and as far as possible, ex-foundation year and

overseas students were distributed throughout the Engineering Teams. Great care was taken to ensure that females, who represented a minority group within the cohort (8%), were in a Team which contained another female.

In preparation for working as Engineering Teams all students took part in a team building exercise during Induction Week which was aimed at encouraging team participation and communication. This exercise required them to build a Lego construction. Only part of the Team was allowed to see the model, the test of their team skills being their ability to communicate and follow instructions accurately. It also aimed to facilitate the growth of trust in each other. These aims were greatly enhanced by the fun and enjoyment to be gained from this exercise.

A tutor was allocated to each Engineering Team with the remit of meeting with them on an approximately fortnightly basis. The Teams were encouraged to sit together during lectures and to work together on any exercises given by the lecturer. Formal project work, assigned within two Stage 1 modules, was to be completed as a team and students were encouraged to be independent in scheduling meetings and allocating the necessary work between Team members. Officially this was for the two modules previously mentioned, but there was nothing to stop the students meeting in support of their learning in other modules.

Evaluation methods

Evaluation of the implementation of these changes ran parallel with them, continued throughout the academic year and was undertaken both qualitatively (through student feedback) and through analysis of data relating to continuation onto Stage 2 of the course. Student feedback was obtained through a brief online survey at the mid-point in the course about their experience of being part of an Engineering Team (see Appendix 1). This elicited a 64% completion rate. Survey methods allow the collection of feedback data from a large group of anonymous participants in a non-intrusive way and are frequently employed in evaluations of educational change (Suter, 2005). Analysis of the quantitative and qualitative responses to the questionnaire generated a set of questions which were then used to provide a loose structure and set of interview prompts for three student focus groups. A total of 22 students attended the

focus groups, twenty of whom were male, two female and four self-identified as international students. These focus groups were facilitated by a researcher not connected to the School, who transcribed and analysed the transcripts for themes. The involvement of the independent researcher allowed the students to give anonymous responses and be reassured about their contributions remaining confidential. Students were asked not to refer to themselves or each other by name during the focus groups. This also permitted the principal author to work with the anonymised data without it influencing his relationship with the students.

The choice of focus group interviews as a means of collecting in-depth qualitative feedback aimed at the development of a 'synergy' between focus group members. When this is developed 'a momentum is generated which allows underlying opinions, meanings, feelings, attitudes and beliefs to emerge alongside descriptions of individual experiences' (Parker and Tritter, 2006, p.26). It was hoped (and indeed proved to be the case) that facilitating discussion between participating students in this way would generate rich data.

Accessing the statistical data relating to the rate of continuation of this cohort was helpful in examining the hypothesised connection between improved peer group interaction and communication, the students' sense of belonging to their Team and their School, their ability to remain resilient in the face of difficulties and, consequently, to continue with their course.

Feedback from the Engineering Teams

Results from the questionnaires included the following:

- 84% said that they enjoyed being part of a Team either very much/somewhat
- 90% said that they had gained new skills through being part of a Team
- 72% said that they had gained confidence in their interactions with lecturers
- 72% said that being in a Team increased their sense of being part of the School.

Analysis of the questionnaires together with the scrutiny of the transcribed focus group interviews showed five themes which ran parallel with the students' journey through the

first year of their degree programme. These themes were:

1. becoming a team member
2. working and learning together as a team
3. dealing with team problems
4. dealing with practical difficulties
5. finding the support needed to be an effective team.

The existing research literature on the influence of team working on effective learning and students' sense of integration has been employed to explore the meaning of this student feedback.

Theme 1: Becoming a team member

The respondents said that they largely enjoyed working in Teams. Most of all, students valued the opportunities being in a Team provided for getting to know a small number of other students very quickly, and being formally allocated to a Team provided opportunities to get to know students with whom they might not otherwise have formed a relationship. As one student put it, *'It's quite a good ice breaker because obviously none of us knew each other when we got here. We get to know four people pretty much straight away [...] so that is good.'*

The induction week Lego team building exercise provided an informal, good-humoured occasion which provided a basis for confirming team relationships. It seems that exercises which focus upon building group understanding of teams, foster a sense of commitment to the team as well as helping the team to develop an understanding of task management and problem solving can help provide students with the necessary secure grounding for productive functioning (Lizzio and Wilson, 2005; Klein et al., 2009).

For international students who took part in this evaluation the process of formation into Engineering Teams appears to have been more complex. They talked of their struggle with the process of cultural and academic acclimatisation. Although being part of a Team provided them with immediate opportunities for interaction, some international students found that it took time to become acquainted with this different way of working, a different educational system and sometimes also a second language. This could lead to a sense of dislocation as this student's words show: *'I*

think that they should use more simple projects at first. Because most international students [...] they contributed less to the first project. Because in the first project they didn't know [...] they were assigned some work and they didn't understand.'

However, working as part of a Team also offered opportunities for international students to overcome these difficulties, as another student commented:

For international students – it's a good thing because when you come here we have to learn lots of other things also and in the group you can actually depend on your group mates. If you can't do something, you won't miss anything out. If you learn only twenty percent of a project then you at least learn something and later on, when you move on, you get the other things then [...] you get to understand it properly.

Bringing students together in Engineering Teams at a very early stage in their university career through purposive allocation to groups provides an opportunity for the development of peer interaction and collaborative learning relationships. In their review of the literature on student engagement, Zepke and Leach (2010) found these two factors to have the highest significance.

Theme 2: Working and learning together

Ninety percent of our questionnaire respondents said that they had gained new skills from working with others in their Engineering Team. Even when none of the Team members had any specific skills which were required for a project, focus group participants commented on the usefulness of learning as a group: *'we didn't have anyone in our group who was very good at computer aided design, none of us had done much of it before but we just had to work through it [...] teach each other while we were doing it.'*

Although less formal than the concept of reciprocal peer coaching, it seems that working as part of an Engineering Team provides an environment in which students are encouraged to teach each other and to share skills and knowledge (Hammond et al., 2010). Feedback received suggested that this was especially significant where there was a shared commitment to the success of team endeavours.

One participant described other members of his team as being *'an extremely proficient source of knowledge'*. This supports the initial hypothesis underlying the introduction of the Engineering Teams: that team learning and team support would occur. Academically related peer interaction was found by Moran and Gonyea (2003) to be the factor which most influenced students' estimates of their development and this appeared to be the case with the Engineering Teams.

The issue of leadership was mentioned by participants in the questionnaire survey and repeatedly in the focus groups. There was a general agreement that a leader/manager for the team was necessary, but the emergence of this leader was seen largely as an organic process; that someone with the skills to be a leader would adopt the role naturally. This participant described such a leader in their team: *'He doesn't put any pressure on you but, the way he does things, you feel like [...] well, you should follow his example naturally.'*

On the other hand, a bid for leadership could effectively be a take-over of the team: *'There are some people who just take control of it completely, without asking or anything [...] they just take control'*. This concern rarely arose, but on those few occasions seemed to evoke unease amongst the focus group and they also seemed to be at a loss to know how to change this situation.

Theme 3: Dealing with team problems

Where Engineering Teams encountered difficulties this was mainly said to be because one or more of their Team was not participating equally. This Team member sums up a situation reported by many when one or more of the Team absented themselves from Team activities or failed to add any value to the work of the Team: *'Some people just have a tendency to be a bit rubbish really – they are not bothered about the group. I don't know [...] they just kind of don't do a great deal of work and leave most of the group work to other people.'*

This opting out by Team members brings a variety of challenges to the Team. Initially, the participating members of the Team may not be aware that this member cannot be relied upon and may allocate work or roles to them. When these are not completed the progress of projects is held up. However, focus group

members felt that this situation became obvious quite quickly:

Sometimes after lectures we would meet up to do stuff and there are the people who would be there or there are some who would turn up late or wouldn't be there at all. It was the same people who were doing the same things each time so after a few weeks of this you would know who you could rely on to get a certain thing done and who you could ask about certain things.

Whilst absences and lack of commitment to the Team were described as frustrations for other Team members, many also differentiated between absences over which the absentee had no control and those for which there was no apparent reason. When it was established that the absence or lack of contribution was as a result of illness, distressing personal circumstances, shyness or multiple calls upon the absent person's time there appeared to be considerable willingness to cover for that person and to ensure that they were not penalised. This focus group participant expressed a largely accepted view:

If someone is just being plain lazy then I think [...] it's affecting you so you have to say something but if there is a reason, and someone is having a hard time on the course or anything like that [...] I wouldn't mention it [...] I don't think there should be disciplinary procedures or anything like that.

Several focus group participants also talked about how they responded if a member of their Team suffered from extreme shyness. In this respect working as a team seems to have fostered a strong sense of personal responsibility for others:

As the year goes on, you keep seeing him and you keep working with him so he becomes open with you [...] and it is good that he gets to know you because he may need your help. Because he is very shy he cannot ask any other person apart from you.

However, when the absence and lack of contribution was perceived as laziness by the Team this was regarded very differently. Those students who talked about absent Team members who were, as one person put it, *'being dragged through the course on the coat tails of the rest of the team'* had developed

various strategies for trying to ameliorate the situation. One participant described the way this was dealt with in their Team. *'And we literally – when we set up the work – we allocate him only a bit of work because we know he is not going to get it done [...] he does not even turn up.'*

Another group said that they would give the absentee *'a bit of grief'* but this did not happen immediately on recognition of the problem. The Engineering Teams seemed to have to wait until they knew the person well enough to allow them to, as another participant put it, *'have a bit of banter'*. None of the students who mentioned these techniques felt that they had a great deal of effect.

Despite the strong feelings voiced by both questionnaire respondents and focus group interviewees on the subject of non-contribution by Team members and subsequent unequal reward for effort, there was a paradoxical feeling expressed that, whatever the misdemeanour of the absent Team member, it would be wrong of the Team to 'backstab' or 'snitch' on her/him. The reasons given for not directly addressing the issue or asking for help from an authority figure such as a tutor was given as concern that this might cause even further conflict within the Team and perhaps aggravate an already tense situation. In addition, several focus group interviewees said that they did not feel that making the situation known should be their responsibility, as is shown in the words of this international student who believed that it was the university's responsibility to monitor the Team's progress: *'I think that instead of the student being involved in this kind of stuff I think that the university should monitor the team work [...] see who turned up or who has put in more work.'*

The Higher Education Academy's briefing paper on self, peer and group assessment (Race, 2001) acknowledges the difficulty of ensuring a fair distribution of marks as reward for effort in shared projects, particularly when faced with students' unwillingness to disclose the identity of non-contributing team members. Despite this difficulty, Race suggests that involving students in decisions about marks facilitates their deep learning and understanding, not only in their current situation but also in terms of transferable skills that could be invaluable in their later professional lives. The use of web-based tools such as

Web-PA (<http://webpaproject.lboro.ac.uk/>), a means of analysing anonymously input student data about their own and other students' contributions towards project work, can assist tutors in the allocation of marks and has been reported to have a high level of student satisfaction (Wilmot and Crawford, 2007). Plans are afoot to use this in future.

Theme 4: Dealing with the practical difficulties

Focus group participants talked of the practical difficulties they had encountered, mostly related to project work. The 'right kind of project' was one which allowed all team members the opportunity to play a meaningful role. Focus group participants also commented on the key role of lecturers in providing clear and consistent information about the requirements of the task to help the Engineering Teams avoid the frustration of repeated attempts to complete the work. This is consistent with the findings of Parsons and Drew (1996) who note the influence of assessment on the student team operation and their learning processes.

Theme 5: Getting the support needed to be an effective team

The issue of support from an academic tutor was seen by participants as having a key significance in enabling each Team to function effectively, and they demonstrated a sense of vulnerability if they did not perceive this to be available to them. In addition, the ability of lecturers to remain mindful of the need of the Engineering Teams to sit together in lectures was important as this reinforced the Teams' sense of identity. Despite there being some inconsistency in the amount of support lecturers gave to the Engineering Teams in working in this way, being in a team was said by 72% of questionnaire respondents to increase their confidence in interacting with the lecturer/tutor. This seems to demonstrate the phenomenon outlined by Lizzio and Wilson (2005) that perceived support of people in authority roles not only improves productivity of a team but also has psychological implications in terms of students' commitments to tasks.

Learning from the introduction of the Engineering Team approach

Gathering data from multiple sources as part of this evaluation has provided evidence that the introduction of Engineering Teams has been

largely successful in encouraging peer to peer support and increasing continuation rates, but has also revealed certain aspects which need to be refined in response to feedback. In addition to the quantitative and qualitative data obtained through the brief online questionnaire (Appendix 1) and the three focus groups, the data for continuation from Stage 1 to Stage 2 for this cohort showed a significant improvement in the number continuing (see Table 2). For the first time in five years the progression rate has increased to above 92%. Prior to the introduction of these initiatives, the progression rate had averaged 82%. It is important to acknowledge, however, that the reasons for this increase are not linear and may be affected by a complex interaction of other factors.

Evaluating how students have experienced working as part of an Engineering Team has shown that, despite being unable to make structural changes to their environment and not being able to introduce an interactive communication system as in the original model (Nicol and Boyle, 2003), the positive effects of academic interaction between students leading to informal reciprocal peer coaching and learning have led to a greater sense of satisfaction and, it is hypothesised, has been the key factor contributing to a higher number of students continuing to the second stage of their degree. This is borne out by the responses to the questionnaire statement 'Being part of the team has helped me to feel that I belong in this School' with 72% of those who responded agreeing that this was the case. The findings from this evaluation of a small-scale initiative reflect the wider literature on the subject. (Kuh et al., 2006; Moran and Gonyea, 2003; Zepke and Leach, 2010; Zhao and Kuh, 2004). In a large scale study in the USA, Zhao and

Kuh (2004) found that 'learning communities are associated with enhanced academic performance, integration of academic and social experiences, gains in multiple areas of skill, competence and knowledge, and overall satisfaction with the college experience' (p.13). Comments from the questionnaires showed how helpful team collaboration had been in enhancing students' learning:

- *'Working in a set group has helped me no end. I struggle a lot with some of the things we have to learn but I can get past this because I ask my team mates. I just am gutted we are not in teams in stage 2.'*
- *'It has been the only way to get through the vast amount of work in the first term. The members have helped me to understand elements I just couldn't get my head round.'*

This evaluation has also highlighted those factors that might further develop the effectiveness of the Engineering Team system. Additional refinements or sensitivities could improve the experience for students who are shy or who have language difficulties. The problems experienced by the Engineering Teams when one or more of their members becomes unproductive requires the development of specific team working skills and support for their use by the next cohort of students.

Refining and extending team building to enable students to develop an early team bond and sense of joint academic responsibility, coupled with imparting a clear understanding of the rationale underpinning their allocation into Engineering Teams will, it is hoped, put them in a better position to jointly capitalise on the resources within Engineering Teams, get to grips with the role of leadership and

Table 2. Continuation rates from Stage 1 to Stage 2 over five academic years in the School of Mechanical and Systems Engineering at Newcastle University

Academic year	Students registered	% of registered able to progress
2005-06	93	82.8
2006-07	75	82.7
2007-08	90	80.0
2008-09	114	82.5
2009-10	107	92.5

learn from each other. Expanding the Team's consciousness of the potential pitfalls of team working should one of their members become inactive and ways of dealing with this in a non-conflictual way would, it is suggested, provide knowledge useful not only to their experience of being part of an Engineering Team but also to future practice.

Conclusion

Evaluation of the adoption of a team working model in Stage 1 of an Engineering degree using a modification of an approach previously found to be successful at another university showed that this could be introduced effectively into a different university in a modified form and at no additional cost. The aim of this innovation was the development of peer interaction and learning and ultimately an enrichment of the sense of integration experienced by the student group. It was hypothesised that working as part of a Team would bring a greater sense of integration and that this sense of integration

within the School and the university would lead to an increase in the number of students able to progress from Stage 1 to Stage 2. This has proved to be the case with continuation rates above 90% for the first time in five years.

The findings from this evaluation are offered as a contribution to the understanding of the use of team work in engineering, of those factors which impede the implementation of team working and the benefits to be gained through working in this way.

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Appendix 1.

Questions and responses used in an online questionnaire used to gain feedback from students on their experience of being part of an Engineering Team at the School of Mechanical and Systems Engineering, Newcastle University

Please tell us about your experience of being part of an Engineering Team

I enjoy working as part of an 'engineering team'

Enjoy very much
Enjoy somewhat
Neither enjoy/not enjoy
I have some doubts about the system
Do not enjoy at all

I have gained new skills from working with others in the team

Yes
No

We are encouraged to sit together as a team in lectures/seminars

Always
Sometimes
Never

We are encouraged to work together as a team during lectures/seminars

Always
Sometimes
Never

As part of a team I feel more confident in interacting with the Lecturer/Tutor

Yes
No

Our team meet up outside of the university

Yes
No

Being part of the team has helped me to feel that I belong in this School

Yes
No

Please add any other comments about your experience of being part of a team

.....
.....
.....

Thank you very much for taking the time to fill in this questionnaire. Your effort is very much appreciated.

Summary of answers to the questions (based on 64% completion rate):

- 84% said that they enjoyed being part of a team either very much/somewhat
- 90% said that they had gained new skills through being part of a team
- 100% said that they were encouraged to sit together all or sometimes during lectures
- 98% said that they were encouraged to work together all or sometimes during lectures
- 72% said that they had gained confidence in their interactions with lecturers
- 56% said that they met up outside of the university as a Team
- 72% said that being in a team increased their sense of being part of the School.