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Evaluation of initiatives related to engagement and retention of first year mechanical engineering students at two Russell Group Universities

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***Abstract**: The retention of engineering students is a concern at many UK universities, especially at the level of progression from first to second year. Although Russell Group universities are recognised as having fewer retention problems than other universities, the challenge remains a significant issue for most engineering Schools and Departments. Two Mechanical Engineering departments at two different Russell Group universities were compared in terms of their initiatives related to engagement and retention of first year students. There were several similarities between the two departments in terms of their student cohorts and comparable initiatives such as a focus on mathematical ability and the use of tutor groups. Differences included the Department of Mechanical Engineering at The University of Sheffield increasing the required 'A' level grades, alongside an emphasis on managing student expectations and a focus on induction week activities. Based on best practice from Strathclyde University, the School of Mechanical and Systems Engineering at Newcastle University has recently introduced 'engineering teams'. Here, students are placed in pre-selected groups of five and encouraged to work in these groups. This encouragement is reinforced by group assignments given to the engineering teams. Initial student feedback on the engineering teams is positive but there remains the opportunity of increased interactivity during most lectures. Retention rates at the Department of Mechanical Engineering at The University of Sheffield are higher than those at the School of Mechanical and Systems Engineering at Newcastle University. It remains to be seen how recent initiatives at the latter School will influence retention rates in future.*

Introduction

Retention of engineering students, especially at first year, is an acknowledged problem at most UK universities. The latest data from the Higher Education Statistics Agency (HESA) shows that, across HE in the UK, 23.2% of engineering and technology students who entered first year did not proceed to second year (Higher_Education_Statistics_Agency, 2009). This single figure masks a range of values, with retention said to be less of an issue at the more established universities. Government data from 2008 suggested that retention of students at Russell Group Universities tends to be higher than in non-Russell group establishments (House_of_Commons, 2008).

A combination of factors including difficulty of the subject and mismatching of student and academic expectations, have resulted in higher drop out from engineering than for most other subjects (Pulko & Cutler, 2003, Willis, 2007). Previous work has identified a range of factors considered to have an influence on the retention of engineering students. These include, but are not limited to, mathematical ability, support from tutors, and attendance monitoring (Pulko & Cutler, 2003). It is also recognised that engineering students tend to react positively towards teaching which engages them and is interactive (Willis, 2007).

This paper sets out to compare and contrast the changes made to first year at two Mechanical Engineering departments at two Russell Group Universities which have the aim of increasing engagement and therefore, retention rates. In this article, retention will be defined as the percentage of first year students who progress to second year. Reasons for not progressing may include failing first year exams and deciding to leave or changing courses from Mechanical Engineering.

Background

In the School of Mechanical and Systems Engineering at Newcastle University retention has been an issue for a number of years. Ongoing efforts have been made to improve this situation. For example, inputs have been taken from staff-student committee meetings. Specific cases include refurbishment and updating of classrooms, an emphasis on rapid student feedback and attempts to balance out assessment loads to avoid peaks of hand-ins. The retention issue has also been discussed at School Teaching and Learning Committee, Board of Studies, Teaching "away days" and Industrial Advisory Panel meetings.

The School already had in place a number of schemes to aid retention. The lack of appropriate mathematical skills is recognised as contributing to retention levels (Pulko & Cutler, 2003). Therefore, during Induction week, students undergo a diagnostic mathematics test and are then streamed on the basis of these results. Essentially this results in the less academically strong group receiving three hours of mathematics instruction per week, rather than two hours for the 'stronger' group. Another important issue linked to retention is student attendance (Pulko & Cutler, 2003). In all first year modules, attendance registers are taken, though at the discretion of the lecturer. A tutorial system is recognised as positively contributing to student retention (Pulko & Cutler, 2003). Until the 2009/2010 academic year, the School operated a tutorial system in which each member of teaching staff was allocated 5 or 6 tutees. During their first year, tutees met with their tutor once a week in a one-hour timetabled slot. Here, work set from a range of first year lectures was formally discussed, although it was also recognised that this format usefully offered opportunities for pastoral support. The views of students are clearly vital. Early in the 2008/2009 and 2009/2010 academic years, feedback on the Stage 1 experience was obtained from focus groups of second year students, those who had successfully progressed from first year. This data also informed issues related to retention.

In addition to these developments a number of further initiatives were pursued. One entailed a visit to Professor Jim Boyle of the Department of Mechanical Engineering at Strathclyde University, an acknowledged expert in this field (Boyle, 2004; Nicol & Boyle, 2003). Professor Boyle described the changes made at Strathclyde, including the NATALIE (New Approaches to Teaching and Learning in Engineering) system. Changes were extensive and included allocating students into pre-assigned 'buddy groups' of four members, redesign of lecture theatres to allow for 'buddy groups' to work together during lectures, the introduction of a set first year text, and the widespread employment of a personal response system ('clickers') to further encourage interactivity. Perhaps presciently it was noted that the changes necessitated a significant financial investment by Strathclyde University as well as a core of determined academic staff who wanted to see positive changes to the student learning experience and therefore retention rates. Professor Boyle stated that these changes had resulted in progression rates from entry to graduation in the high ninety per cents.

Based on the Strathclyde model, a number of changes were introduced to the School of Mechanical and Systems Engineering at Newcastle University in the 2009/2010 academic year. These developments included: placing first year students into pre-selected 'engineering teams' of five. Pre-selection followed the Strathclyde model in that: there were no lone female students; students were grouped into those living in Halls, and those not; and each group had a team member considered to be strong in terms in mathematics, one strong in terms of physics and another in terms of computing. These engineering teams also formed tutorial groups. Due to lower numbers of staff at Newcastle, teams had to be of five rather than of four at Strathclyde; also two members of staff in the School of Mechanical and Systems Engineering were assigned two engineering teams, so each had ten tutees. An overall aim was to allow engineering teams to work together during lectures, though this was left at the discretion of the first year lecturer. After these changes were introduced the first author of this paper (T Joyce) was asked to attend a lecture of each of the first year lecturers to assess levels of student interaction during classes and to then disseminate best practice among this group of lecturers. It has previously been recognised that interaction positively contributed to learning experiences of engineering students (Willis, 2007).

A consensus had been reached in the School of Mechanical and Systems Engineering that the tutorial system had not been working well. Therefore, it too was overhauled for the 2009/2010 academic year. New features included a series of guest lectures for the first year cohort, including speakers from industry. These lectures were assessed and were intended to be 'inspirational' and to show the relevance of modern engineering. Group assignments related to ethics were also introduced. The number of sessions with tutors was therefore reduced by approximately half, freeing up staff time, though tutorial sessions remained to preserve the connection between tutees and tutors.

Independent of these School changes, the first author (T Joyce) became involved in work with colleagues from Newcastle University's Quality in Learning and Teaching (QuILT) unit as part of a HEFCE/Paul Hamlyn Foundation funded project on retention of students with an emphasis on student inclusion. This involvement by the first author took the form of contributing to a review of strategies by several engineering schools at Newcastle University to accentuate inclusion of students. It also included encouraging Stage 1 students to contribute to the QuILT project via an on-line questionnaire.

As background data the School of Mechanical and Systems Engineering at Newcastle University offers a BEng and a suite of MEng degrees. All students follow a core first two years. Entry requirements (in terms of 'A' level grades used in the UK) to the course are ABB for MEng and BBB for BEng. Table 1 summarises additional data on the student cohort for the School of Mechanical and System Engineering. As can be seen it is largely a male dominated, European cohort, in line with many UK engineering Schools. It can also be seen that in the last two academic years the number of students registered has been significantly higher than in previous years. However retention rates (the percentage of registered students progressing to Stage 2) have remained similar over the four years at an average of 80%.

Table 1: Data for the School of Mechanical and Systems Engineering, Newcastle University

Year of entry	2005	2006	2007	2008	2009
No. of students registered	99	91	98	123	122
% female	6	12	7	10	8
% overseas	16	8	16	14	23
No. of students assessed	99	90	96	115	Not available
% of assessed progressing to Stage 2	83	78	82	86	Not available
% of registered progressing to Stage 2	83	77	81	81	Not available

In the early 2000s, the Department of Mechanical Engineering at The University of Sheffield experienced a period in which the drop-out rates reached about 10%. Due to this significant drop and pressures to increase recruitment, retention and progression, several strategic measures were taken during the following few years.

In 2002, under the headship of Professor Eann Patterson, Mrs Samantha Drobinski, Assistant Registrar of the Department explained that it was decided to increase the entry requirements to AAB for MEng and ABB for BEng (previously they had been ABB and BBB respectively). It was expected that by attracting students of higher academic abilities, both retention and progression levels would improve. While there were initial concerns that fewer students would be recruited, this latter reservation proved to be unfounded.

Also, several new degrees were created giving prospective students more choice before and after entering Higher Education. Students now have the option of being a pure mechanical engineer or to specialise in industrial management, language, motorsports, sports engineering and with a year in industry. In making these new degrees a few new modules were created. However the majority were existing modules which were given different 'flavours' to suit the new degrees. Therefore the workload to bring about these changes was not considered to be excessive.

In 2004, under the leadership of Professor John Yates, Dr Stephen Beck the now Faculty Director of Learning and Teaching, led a working group to restructure the 1st year learning provision. These changes were aimed at ensuring a better integration of the learning material, greater interactivity amongst students and staff, and clearer assessment and feedback.

Induction has proved to be another important factor in terms of retention; in helping students' expectations when entering higher education, institutions enhance the probabilities of positive end-of-year outcomes (Laing et al., 2005). In 2005, one of the authors of this article (Elena Rodriguez-Falcon) led a working group to revamp Induction Week. All staff in the Department agreed that the main objectives of induction were to ensure that new students were clear in their expectations of HE, were clearly and effectively inducted to the Department's learning and teaching philosophy, that students had the opportunity to create bonds with their peers and personal/academic tutors and last, but by no means least, that mathematical abilities were established so appropriate measures could be taken in good time if required. On the last point, students have for many years been given a maths diagnostic test. Based on this test and their maths 'A' level result, students are assigned to a 20 credit

maths module if their performance is lower than required or a 10 credit module if they meet the requirements. Central support from the University's MASH unit (Maths And Statistics Hub) for the past 3 years has also helped to increase students' maths attainment. This has been shown by a reduced number of students undertaking the 20-credit module, plus their average marks have increased. Moreover, student feedback on the MASH hub is very positive and the service is widely used.

The Department of Mechanical Engineering at The University of Sheffield has an academic tutorial system, where 4-5 students are allocated to a member of academic staff. The students meet their tutor twice a week for the first year, where they work on their first year tutorial questions, discuss academic and pastoral problems and develop a sense of community. This system has been around for more than 20 years and it is perhaps one of the most important features of the Department that enhances recruitment and retention according to feedback from parents and students. It is considered to be one of the Department's unique selling points.

Finally, student feedback is a very important issue in the Department. Working groups, which are small groups of staff and students working towards a common goal, have been put in place to increase students' awareness of feedback provided to them and to ensure that students' feedback is acted upon and actions communicated to them. The student and staff committee has put in place several measures which include the use of students' representatives actively engaging in conversations with students and University initiatives, staff responding to feedback from students and actions being communicated to the whole cohort as promptly as possible.

Table 2 summarises background data on the student cohort for the Department of Mechanical Engineering at The University of Sheffield. As with Mechanical Engineering at Newcastle University, it is largely a male dominated, European cohort. It can also be seen that there is a trend in the increasing number of students registered, with 2009 being significantly higher than in previous years. Retention and progression rates have been good over the past 5 years, aside from a 'blip' in 2006. Although, the data available is not conclusive, it appears that a possible contributing factor to this 'blip' could have been the loss of several members of staff during that year.

Table 2: Data for the Department of Mechanical Engineering, the University of Sheffield

Year of entry	2005	2006	2007	2008	2009
No. of students registered	118	123	124	131	164
% female	9	8	8	9	7
% overseas	17	26	21	23	28
No. of students assessed	112	113	118	126	Not available
% of assessed progressing to Stage 2	91	85	95	92	Not available
% of registered progressing to Stage 2	86	78	90	88	Not available

Results

Regarding the changes in the School of Mechanical and Systems Engineering at Newcastle University, assessment of retention issues has been informed by a number of sources. The use of (recently introduced) engineering teams by lecturers is variable, and the majority of lecturers have not used them to a great extent during their modules. However they are widely used in the tutorial-based 10-credit module, and also in a 25-credit Design and Manufacturing module. Initial assessment (by T Joyce) of interactivity in first year lectures has shown that there is still much room for interaction. For the majority of lecturers, lecturing currently equals data transference.

Responses from current Stage 1 students are summarised in table 3, alongside the questions concerning engineering teams that were posed. At the time of writing, there were 25 responses from Stage 1 students to the on-line questionnaires which were offered. As can be seen, comments were generally positive. The majority of respondents enjoyed working as part of an engineering team and felt they had gained new skills from working in this way.

Table 3: Responses to questions regarding engineering teams

Question	Answers
I enjoy working as part of an engineering team.	Enjoy very much, 10 Enjoy somewhat, 12 Neither enjoy or dislike, 3 Some doubts about the system, 0 Do not enjoy at all, 0
I have gained new skills from working with others in the team.	Yes, 22 No 3
We are encouraged to sit together as a team in lectures/seminars.	Always, 4 Sometimes, 21 Never, 0
We are encouraged to work together as a team during lectures/seminars	Always, 5 Sometimes, 20 Never, 0
As part of a team I feel more confident in interacting with the Lecturer/Tutor	Yes, 16 No, 9
Our team meet up outside of the university	Yes, 12 No, 13
Being part of the team has helped me to feel that I belong in this School	Yes, 17 No, 8

There were 11 individual replies to an opportunity for additional comments. In general comments were positive about the engineering teams. For example: 'working in a set group has helped me no end'; 'good for spreading the work between you so more gets done'; 'it is very good to be able to learn being a part of the team from early on in our professional life'; and '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'. Less positively, one student commented 'I haven't experienced working with other groups and so I do not know many other people on the course as I have little opportunity to interact with them'. However, another response was 'I've actually found I tend to work with friends from other teams more than my actual team'. Therefore the opportunity to work with students outside of allocated teams was clearly taken by some. The main negative comment was related to assessment, when marks were given to a team and took no account of individual effort. However, in at least one Stage 1 module, peer-moderated marking has been introduced. Perhaps such a scheme should be introduced more widely.

From the focus groups of second year students the same three key findings were found in each year of undertaking the focus groups: make lectures relevant, increase interactivity and have enthusiastic lecturers. It was noted that there were issues with some modules and lecturers. Similarly the (old) tutorial system had mixed reviews. Here, the consensus from students appeared to be that if you had an 'interested' tutor then the system worked well. The tutorial system has been changed for the 2009/10 academic year so it remains to be seen what impact this will have.

From the Department of Mechanical Engineering at Sheffield University, it is not clear which individual measure has had the greatest impact in increasing recruitment, retention and progression levels. Of course, it may be that measures in combination have given an overall positive result. It is arguable that higher entry requirements ensured that cohorts of students with better abilities, especially in maths, were recruited. Dr Stephen Beck said: "we are better at teaching more skilled students, therefore, we as lecturers are more able to meet students' expectations in terms of teaching".

Mrs Samantha Drobinksi explained that drop-out numbers are so small in recent years that reasons for their leaving the Department are much easier to account for and tend to be very individual so trends for dropping out are not easily identifiable. When analysing the numbers in more detail, however, it shows that although students stay in the Department a few tend to change from one degree to another for example from the main stream in Mechanical Engineering to one of the specialist courses such as Industrial management, or vice versa. Therefore, choice of degree after entering HE is also an important factor in retention. Arguably, some of these students would have left the Department if this choice was not available.

The list of measures HEIs could take to enhance retention and progression include the review of assessment and feedback, an inclusive curriculum, managing expectations, staff attitudes and relationships with students and others (Thomas, 2002). Therefore, it can be argued that the restructuring of the first year together with a more effective induction week, a better feedback system and small group tutorials might have also positively contributed to retention and progression. This conclusion, based both in the literature and student feedback, does have some weaknesses. For example, student response rates tend to be limited and another limitation is that the evidence collected and used relies on the students' own impressions of their learning experience and learning outcomes. Conversely, this does not limit this paper's value as an investigation, though it could be that an independent test of student learning and retention would strengthen these conclusions.

Discussion

In the School of Mechanical and Systems Engineering at Newcastle University, a raft of measures has recently been introduced to improve the learning experience and therefore, hopefully, increase retention rates. These changes have been on the back of more gradual changes and accepted 'best practice'. Based on all of these results amendments will likely be made to teaching practice so that year on year improvements are made and embedded into the curriculum. Although the feedback from Stage 2 focus groups can be seen as data from a select cohort of retained students, their comments have still been of interest, if only for reinforcing the three key elements, in the view of students, of making lectures relevant, increasing interactivity during lectures and having enthusiastic lecturers.

It can be seen that retention rates at the Department of Mechanical Engineering at The University of Sheffield have been superior to those at the School of Mechanical and Systems Engineering at Newcastle University. Given the differences reported in this paper, for Newcastle's rates to improve could they simply copy Sheffield's lead? For example, is it as straightforward as increasing entry grades, with a corollary that more academically gifted students are recruited and retention rates are subsequently increased? Separate to this, or perhaps in parallel, could Newcastle increase the number of tutorial sessions (applied twice a week at Sheffield) or try and ensure that their tutorial system works more effectively?

At both mechanical engineering departments at Newcastle and Sheffield University, retention statistics are analysed to discern trends. However, as already noted in comments from Sheffield, given the small number of students involved and their individual circumstances, any such trends, if indeed any exist, have not been identified. For example, while retention data for female and non-European students exists, any differences are not significant when compared with the larger student cohort.

For Mechanical Engineering at The University of Sheffield, managing expectations from the moment the student engages with the Department, whether it is through an ad, a contact in the department, a visit to the University, etc has been part of its mission in order to ensure that retention levels are stable or increase (Laing et al., 2005). Keeping promises is also very important. The learning and teaching philosophy of the Department has to be exactly or better than it is 'advertised' to the students. It has to be clear to them how they will be taught, how they are expected to learn, what facilities there will be available to them and what type of support.

In these times when numbers of students are increasing it is also very important to ensure that support schemes such as personal and academic tutorials are in place. Ensuring that students continue to be individuals and not just numbers in our systems will also help keep retention levels up.

Finally, it still remains to be seen what the impact on retention will be of external factors such as the introduction of fees.

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