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Progression of Engineering Students who attended a Pre-sessional Residential Summer School

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Abstract: 'Flying Start', a pre-sessional residential summer school was first held in September 2003 for incoming undergraduates, in the Department of Electronic and Electrical Engineering, with a weak or non-traditional mathematical background. In addition to mathematics sessions, the programme included an emphasis on key skills workshops, group work, evening social activities and an introduction to the Mathematics Learning Support Centre (MLSC) and its facilities. The MLSC, open to everyone at Loughborough University, has a wealth of mathematics support material and offers one-to-one mathematics support, which is available on a drop-in basis.

Due to the success of the first 'Flying Start', the pre-sessional school ran annually for four years and intake was widened to include students, who met the criteria, from engineering or engineering related disciplines. Following the first three summer schools, attendees who scored less than 50% on a mathematics diagnostic test, were also offered additional individual support with their mathematics modules during their first year of study. This paper presents the findings of a longitudinal study tracking retention rates and degree classification of students who attended the 2003 and 2004 'Flying Start'. These results are compared to those obtained by non 'Flying Start' attendees who entered the same department in the Engineering Faculty in 2004. Conclusions are drawn about the effectiveness of the mathematics support offered to students who enter university with a weak mathematical background.

Key Words: engineering education, higher education, mathematics support, progression, retention

Background

Since the 1990's there has been well documented concern and evidence regarding the declining mathematical ability of students entering numerate courses at university, see: LMS, IMA and RSS (1995), Sutherland and Pozzi (1995) and, Savage, Kitchen and Sutherland et. al., (2000). Several government-funded inquiries have investigated the standards, suitability and uptake of pre-19 mathematics qualifications, for example: 'Inquiry Into A Level Standards' (Tomlinson, 2002), 'SET for success' (Roberts, 2002) and 'Making Mathematics Count' (Smith, 2004). Following the Smith report, the Qualifications and Curriculum Agency (QCA) has undertaken a project to evaluate participation in General Certificate of Education Advanced Level (GCE A Level) Mathematics (QCA, 2006). In England and Wales the GCE A Level is usually taken at 18 years of age in three or four subjects. This decline in mathematical ability not only gives rise to difficulties being experienced by students but also poses problems for staff who deliver mathematical topics. The difficulties are further exacerbated by the range of qualifications held by incoming cohorts of students (Mustoe, 2002).

Nevertheless, universities are undertaking many different measures to provide support. These measures include grouping by ability and teaching these groups separately, employing school teachers to teach, rather than lecture, the weaker groups, and the introduction of remedial lectures (Savage & Croft, 2001). Additionally a survey of 106 universities in the UK found that more than 60% of them are offering some form of mathematics support to undergraduates in addition to tutorials and personal tutor groups. (Perkin & Croft, 2004:14-18).
In 2003 The Mathematics Education Centre in conjunction with The Engineering Education Centre at Loughborough University developed and piloted a pre-sessional in-house residential course for incoming Electronic and Electrical Engineering students with a weak or non-traditional mathematics background. Within the Department of Electronic and Electrical Engineering at Loughborough University students will typically have an A Level qualification in mathematics. However, students without A Level Mathematics were accepted onto courses offered by this department if they were able to demonstrate, on an individual basis, ability in other mathematically dependent subjects. Thus the highest mathematics qualifications that some students have, may be General Certificate of Secondary Education (GCSE), which is generally taken at age 16 by pupils in England and Wales or Advanced Subsidiary Level (AS) which equates to half an A Level qualification. This group of students (those with non-traditional mathematics backgrounds) is further enlarged by mature students and students with other mathematics qualification, such as BTEC, which is a UK qualification of a more practical nature than the A Level. Students with non-traditional backgrounds were invited to attend the residential course as they may have gaps in their knowledge or may not have used their mathematical skills for a considerable period of time, increasing the risk that they may struggle in traditional mathematics lectures. From 2004 onwards students with Grade D or below in A Level Mathematics were also invited to attend the course. Engineering students undertake a mathematics diagnostic test on entry to Loughborough University but it was felt that this would not be a suitable means of identifying students for the pre-sessional course as students would be taking it without supervision and may have felt intimidated by it. Furthermore, the diagnostic test would not have distinguished between students who had forgotten topics they had been taught and those who had not previously met the topics. This three day course, known as ‘Flying Start’ was optional and there was no charge for attendees; it was an annual event from 2003 to 2006 inclusive.

In this paper we track the progress of students who attended the 2003 and 2004 ‘Flying Start’ and compare the degree results and retention rates with those obtained by the 2004 Electronic and Electrical Engineering intake.

Methodology

Attempts to evaluate the effectiveness of support mechanisms are often lacking in real evidence due to the difficulties of actually measuring the success or otherwise of the venture. Croft describes two ways of measuring effectiveness as ‘Soft Measures’ and ‘Hard Measures’. Soft measures are described as relying on usage data whereas hard measures generally require more wide-ranging data collection and analysis (Croft, 2009). The research described in this paper takes a hard measure approach.

In order to monitor and compare the performance of ‘Flying Start’ attendees, data were collected on Electronic and Electrical Engineering students entering university with a non-traditional mathematics background from 2003 to 2006. This included students with GCSE or AS Level Mathematics, A Level Mathematics grade D or below, or an alternative qualification to A Level such as BTEC. Records were kept of: who attended the ‘Flying Start’ Course, Diagnostic Test performance on entry to degree programme, and, whether or not, and how often, these students made use of the additional support offered to them. The data does not include independent use of the MLSC drop-in Centre but does include one-to-one and small group support sessions and lunchtime topic based workshops. The MLSC drop-in Centre usage data is not included, as the authors believe that it is unethical to identify individuals using the Centre, however, this exclusion from the data set may mask the effect of additional support to a small degree.

The first year mathematics results of ‘Flying Start’ participants were analysed by comparing their final mathematics module mark with the mark they obtained on a diagnostic test taken on entry. Further comparisons are then made with students who were invited to attend ‘Flying Start’ but did not attend. These variables are then compared to the average mark of all students on the module.

This paper builds on the earlier work of Bamforth, Robinson and Croft et. al., (2007) and presents the findings of a longitudinal study tracking retention rates and degree classification of students who attended ‘Flying Start’ from 2003 to 2004. The progression of the 13 students from Electronic and Electrical Engineering who attended the 2004 Flying Start is compared to the progression of the 2004 Electronic and Electrical Engineering cohort on the same programmes. The 2004 intake was chosen as the 2003 summer school was a pilot study and some students from both the 2005 and 2006 intakes have yet to complete their studies.
This comparison, in conjunction with previous analysis, may give an indication of success but there are, however, many factors that need to be taken into account. For example, we are not comparing 'like with like' as all students are different. Another factor is that the students who attended ‘Flying Start’ were self-selecting and it may be that the students who attended were the ones who were most determined to do well at university. The same may be true of those students who availed themselves of the support on offer.

**Flying Start Summer School**

The ‘Flying Start’ pre-sessional summer school was first held in September 2003 for incoming undergraduates, in the Department of Electronic and Electrical Engineering, with a weak or non-traditional mathematical background. Following positive feedback from participating students, the course was run annually for three subsequent years with participating students registered on: Electronic & Electrical Engineering, Civil Engineering, Mechanical Engineering, and Materials. One student from Physics also attended. On average there were 18 participants each year.

In addition to mathematics sessions there were key skills workshops, group work exercises and social activities. The mathematics sessions focused primarily on algebraic topics such as transposition of formulae, solving linear equations and finding solutions to quadratic equations. Delivery of material was by teaching in a classroom setting rather than by lecturing in a lecture theatre. At each session, as well as the teacher, there were additional staff and postgraduate students on hand to offer assistance and answer questions as required (Bamforth, Robinson & Croft et. al., 2007). During the four day course participants were able to practice forgotten skills and identify topics that required further revision. However, from the outset it was recognised that it is not possible to increase mathematical competence significantly in the time available.

Participants were also introduced to the Mathematics Learning Support Centre (MLSC), in order to raise their awareness of the mathematics support facilities available to them at Loughborough University. The MLSC not only has a wealth of mathematics support material but also offers one-to-one mathematics support, which is available on a drop-in basis.

At the commencement of each academic year, Electronic & Electrical Engineering students (including ‘Flying Start’ attendees) who scored less than 50% on a mathematics diagnostic test given to all incoming engineers were offered individual weekly appointments for additional mathematics support. Additional support generally took the form of one-to-one or small group support sessions mirroring topics covered in lectures but also included lunchtime workshops on set topics. Both of these types of support were designed to help students to address gaps in their mathematical knowledge.

**Performance of ‘Flying Start’ Attendees**

In 2007 a comparison of student’s performance was carried out for the years 2003 and 2004. Originally published in Bamforth, Robinson and Croft et. al., (2007) the results have been updated within this paper to include the final mathematics module mark obtained after the re-sit examinations.

Figures 1 and 2 show the first year performance of Electronic & Electrical Engineering students with non-traditional mathematics backgrounds for 2003 and 2004 and identify whether the students attended the ‘Flying Start’ course and whether they used additional support. The data shows that for both 2003 and 2004 not all of the students who attended the summer school achieved greater than 50% on the mathematics diagnostic test in the first week of term; 50% is the threshold mark below which students are targeted with offers of one-to-one action plan support. This result is not unexpected as only a limited number of topics can be tackled on a four-day course.

Figure 1 shows that of the 17 students with non-traditional mathematics backgrounds who started courses in the Department of Electronic & Electrical Engineering in 2003, nine achieved less than 50% on the diagnostic test. Of these nine students, the three that did not attend the pre-sessional course either chose not to accept any form of additional support or did not frequently use support and subsequently went on to either fail the module or leave the course. Only one student who attended the pre-sessional but failed the diagnostic test refused additional support, he also went on to fail. The five students who failed the diagnostic test and had attended the pre-sessional course accepted additional support, using it between 10 and 20 times during their first year of study and went on to pass their mathematics module.
Figure 1: First Year Performance of Non-Traditional Electronic and Electrical Engineering Students in 2003 (Bamforth, Robinson & Croft et. al., 2007)

The data for 2004 are less clear and are shown in Figure 2. Two thirds of the pre-sessional course attendees passed the threshold grade in the diagnostic test. Of the five that failed, four sought additional support. However, the final mathematics module mark for these students is significantly lower than the previous year, with three out of the four failing.

Figure 2: First Year Performance of Non-Traditional Electrical Engineering Students in 2004
When viewed in light of the rate of support usage, these results become clearer. Of the four students who did access additional support, the rate of usage for three of them is very low (between 1 and 3 times), whereas the one student who went on to pass accessed additional support 16 times during the year. The inclusion of the re-sit data enables a better comparison between the two years and its inclusion has served to reinforce the original findings that “frequent use of additional support is effective in helping less well prepared students to pass their mathematics modules. However, infrequent use of support is insufficient” (Bamforth, Robinson & Croft et. al., 2007). This correlation between success in mathematics examinations and frequent use of mathematics support is in accord with Symonds, Lawson and Robinson (2008) who determined that whilst the MLSC is instrumental in helping a large number of students with mathematical and statistical difficulties there are many students who have never used the MLSC failing their mathematics modules.

The 2003 and 2004 ‘Flying Start’ attendees have all completed their time at Loughborough University. Figure 3 shows the attainment (a 1st is the highest degree classification) of the 11 Electronic and Electrical engineering students who attended the 2003 pre-sessional course.

![Figure 3: Progression of 2003 'Flying Start' Participants](image)

By merging the BEng and MEng results and grouping together those who failed to obtain a degree the results of the 11 2003 ‘Flying Start’ participants are summarised in Figure 4.
Figure 4: Progression of 2003 'Flying Start' Participants - summary

Figure 5 shows the attainment of the 13 Electronic and Electrical engineering students who attended the 2004 pre-sessional course. It should be noted that two students passed Part A but chose to leave undergraduate study.

Figure 5: Progression of 2004 'Flying Start' Participants

By merging the BEng and MEng results and grouping together those who failed to obtain a degree the results of the 13 'Flying Start' participants are summarised in Figure 6.
Figure 6: Progression of 2004 ‘Flying Start’ Participants - summary

The next section will compare progression of the 2004 ‘Flying Start’ students with the 2004 non ‘Flying Start’ students in Electronic & Electrical Engineering.

Comparison of ‘Flying Start’ attendees with the 2004 cohort

Using Programme Population Monitoring Statistics (PPR) we endeavour to compare the completion rates of the ‘Flying Start’ attendees with the 2004 cohort registered on the same programmes in the Department of Electronic & Electrical engineering. This is a small sample but not a straightforward endeavour. The Flying Start attendees were registered on Computer Systems Engineering, Computer Network & Internet Engineering, Systems Engineering, and Electronic & Electrical Engineering. Within each programme there is an option to spend a year in industry and most programmes offer a choice of qualification, Bachelor of Engineering (BEng) or Master of Engineering (MEng). The way the data are collated and displayed also presents difficulties when comparisons are being made. For example, for students entering a three year programme in 2004 information is given for the years 2004, 2005 and 2006, which is the expected year of completion; however students who have to re-sit a year or take a year out will not graduate until the 2007/2008 academic year at the earliest. Furthermore, students who change course may be transferred into or out of the statistics for a particular programme.

Table 1: Comparison of 2004 ‘Flying Start’ attendees with the 2004 cohort on the same programmes who graduated in summer 2007

<table>
<thead>
<tr>
<th></th>
<th>No.</th>
<th>Degree Classification</th>
<th>Failed or graduated later</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st</td>
<td>2:1</td>
</tr>
<tr>
<td>‘Flying Start’</td>
<td>13</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Non ‘Flying Start’</td>
<td>33</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>
Of the 13 ‘Flying Start’ students only 3/13 graduated in their expected year of graduation compared to 25/33 of the remainder of the cohort. We do know that four of the ‘Flying Start’ students graduated later after re-sitting a year of their course. For the eight non ‘Flying Start’ students who failed or graduated later it is not known how many of them did successfully complete their studies.

Analysis of the statistics is not conclusive; it may be the case that the ‘Flying Start’ students with their weaker mathematical background, were more likely to have to re-sit a year of their undergraduate study or it may be the case that those students who opted to attend the pre-sessional course were those most likely to succeed, albeit with re-sits.

Concluding Remarks

The data suggests that students who would benefit from ‘Flying Start were correctly identified and provided with support that for many was effective and helpful. However, the number of students we were able to invite was small due to demands on staff time and financial issues. Early analysis of the data showed that there were many more students in need of additional support than those who could be invited to ‘Flying Start’. The data illustrates the importance of providing support and in 2006 it was decided to discontinue the ‘Flying Start’ summer school and introduce support measures that would benefit a wider group of students. This extra-curricula support is in the form of additional first year tutorials and lunchtime courses and aims to encourage students to become independent learners, which has been identified by Bamforth, Robinson and Croft et. al., (2007) as a key element of successful progression. The authors will, in due course, review the effectiveness of this approach. Staff in the MLSC also encourage students to become more independent in their approach to learning. However, the problem of how to reach and engage all students remains. We have shown that students who frequently attend additional support sessions are more likely to succeed but it is not clear how we can reach those students most in need of help who do not engage with the support that is available to them. Most engineering students who fail their first year mathematics modules are not availing themselves of the support that is provided for them.

References


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