2014

What Role Does Mathematical Preparedness Play for Engineering Students Who Transfer from and Ordinary Degree into an Honours Degree?

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Recommended Citation

Carr, M., Llorens, M., O'Shaughnessy, S. et al. (2014). What Role Does Mathematical Preparedness Play for Engineering Students Who Transfer from and Ordinary Degree into an Honours Degree?*European Society for Engineering Education:The 17th. SEFI Mathematics working Group Seminar* 23rd–25th. June, Dublin, Ireland. ISBN: 9782873520113

What role does Mathematical preparedness play for engineering students who transfer from an Ordinary degree into an Honours degree

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Students who have not achieved a high level of mathematics at secondary school but have a pass in ordinary level mathematics have the option of entering onto a 3-year Ordinary degree (Level 7). Upon successful completion of this award students may apply to progress to the third year of the Honours degree. Up until relatively recently an upper merit (60%) was the minimum required to make this transition. In recent years this requirement has been reduced with many students with lower marks being offered the possibility of transferring.

Relatively little work has been done on the transition from an Ordinary degree to an Honours degree and in particular the mathematical preparedness of these students. In the third and fourth year of many Honours engineering courses within the DIT it is not unusual to have 30-50% of the students coming from an Ordinary degree background. The majority of these students come from within the DIT while others transfer in from other Institutes of Technology in Ireland. Previous work has shown that students from an Ordinary degree background are more than twice as likely to fail mathematics in their third year of the Honours degree when compared with students who have proceeded directly through an Honours degree programme. In this study we analyse students' performance across all subjects and examine if there is a relationship between mathematical performance in the final year of the Ordinary degree and overall performance across all subjects in the third and fourth year of the Honours degree.

Introduction

There are two seperate routes to an Honours degree (Level 8) in engineering in the Dublin Institute of Technology (DIT). Students with a C3 (55%) or higher in Higher level mathematics in the Irish Leaving Certificate (the terminal secondary examination in Ireland) may enter directly onto a 4-year Honours degree. Students who have not achieved this level of mathematics but have a pass in ordinary level mathematics may enter a 3-year Ordinary degree(Level 7). Students who successfully complete this award may then apply to progress to the third year of the Honours degree. Up until relatively recently an upper merit (60%) was the minimum required to make this transition. In recent years this requirement has been relaxed with many students with lower marks being offered the possibility of transition upon successful completion of an interview. In this study we examine how this relaxation in threshold has affected the performance of students who transfer across from the ordinary degree.

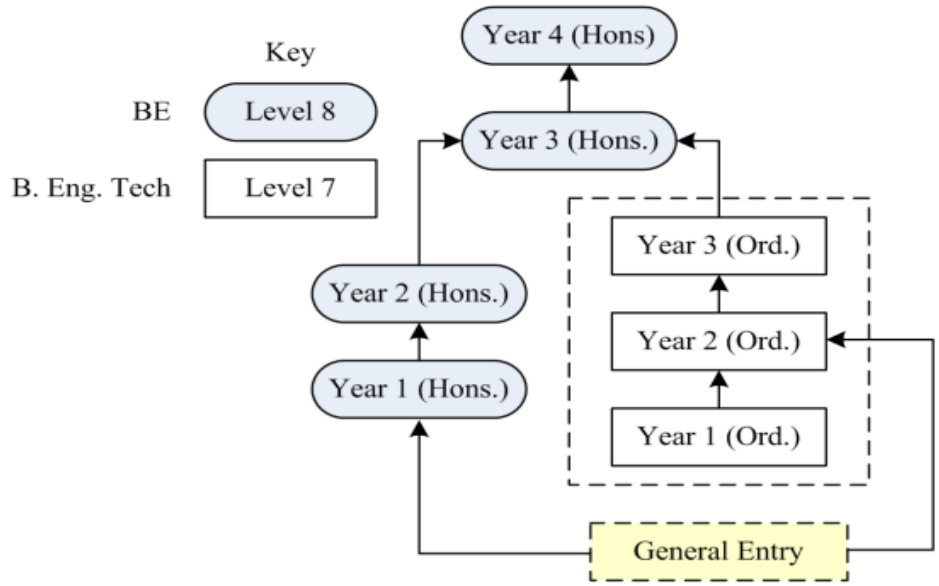

Figure 1: Schematic of the alternative routes to an Honours degree in Engineering in Ireland(Llorens et al.2014)

Previous work has shown that students from an Ordinary degree background are more than twice as likely to fail mathematics in their third year of the Honours degree when compared with students who have proceeded directly through an Honours degree programme (Carr 2013).

In this study we examine the performance of the group of students from the Ordinary degree in mechanical engineering who entered the third year of the honours programme in 2007 and 2008 and who subsequently graduated in 2009 and 2010 respectively.

In addition the entry criteria, for students who transfer from the Ordinary degree onto the Honours degree, has been reduced. The entry criteria to transfer to the Honours had been an average of 60 or greater. This was gradually reduced to 50 or greater with some students in exceptional circumstances being allowed to transfer with an average less than 50.

A quantitative analysis was performed on student's performance. This is broken up by year.

The results for 2009 and 2010 are presented together as the entry criteria were the same for both of these years. Subsequent to this as there was a gradual reduction in the threshold for the years 2011,2012 and 2013 these results are presented separately.

Results

2009 and 2010	Direct Entry to level 8	Entry via Level 7 course
N	85	33
Average mark (Standard deviation)	53.4(18.8)	62.1(8.1)
Number with grade of more than 60%	37/85	27/33
Graduated on time(Complete pass)	62/88	32/33

Table 1: Comparative performance of students who transfer onto an honours degree programme and those who enter directly from secondary school

In table1 above we show a combined analysis for the combined mechanical engineering classes of 2009 and 2010. There were a total of 85 students who graduated who came from an Honours degree background i.e they had entered the course directly from secondary school. In contrast 33 students graduated who had entered the Honours degree programme after having completed the 3 year Ordinary degree. The average mark of the direct entry students was 53.4 % with a standard deviation of 18.8. In contrast the students who had entered via the ordinary degree had an average of 62.1% with a standard deviation of 8.1%. A two sample t-test was applied to this data and the average mark of the Ordinary degree students was found to be significantly different with p=0.000.

In addition we measured the proportion of students who achieved a 2.1 degree or higher. Of the direct entry students 37/84 achieved a 2.1 degree or higher in comparison with the ordinary degree students where 27/33 achieved a 2.1 degree or higher. This difference was found to be significant using two proportion test(p=0.000) and the Fisher exact test(p=0.000).

Of the students who entered from the ordinary degree background 32/33 graduated on time in comparison with 62/88 who had come through the direct entry route. Again this is significantly different using both the two proportion test(p=0.000) and the Fisher exact test(p=0.002)

Maths results

The original motivation for this study was the failure rate in the 3rd year Honours mathematics module. We now show the performance of these students in the mathematics module.

Results for the 2009 and 2010 graduating class

Correlation Coefficient(R^2)	3rd Level 8 maths R^2 (p value)	4th Level 8 Maths (p value)	4th Level 8 Overall (p value)
3rd year Level 7 Maths	0.139(0.454)	0.533(0.001)	0.57(0.001)

Table 2: Correlation between 3rd level 7 maths grade, 3rd level 8 maths grade, 4th level 8 maths grade and 4th year level 8 overall

What we see here is little or no correlation between the 3rd year level 7 maths grade and the third year level 8 maths grade with a correlation coefficient of R^2= 0.139 and p=0.454. This is rather worrying. But when we look at the relationship between the 3rd year level 7 maths grade and the 4th year level 8 grade we see a strong correlation (R^2=0.57), that is highly significant (p=0.001). We are also seeing a strong relationship between the 3rd year level 7th maths grade and their overall performance in the 4th year (R^2 =0.57, p=0.001).

Maths grade as a predictor of success.

Given the strong correlation we see between the maths grade and the overall grade in fourth year should we use the 3rd year Level 7 maths grade to select students for entry onto the honours programme. In this section we compare whether we should use the overall 3rd Level 7 average grade, 3rd year Level 7 maths grade or the 3rd year Level 7 project grade. We see from table 3 below that the 3rd year level maths grade is as good a predictor of overall success in the honours degree as the 3rd year level 7 overall grade.

Correlation Coefficient(R^2)	3rd Level 7 maths R^2 (p value)	3rd Level 7 Overall (p value)	3rd year Level 7 project (p value)
4th year Level 8 overall	0.57(0.001)	0.585(p=0.000)	0.308(p=0.08)

Table 3: Correlation between overall 4th year performance, 3rd year level 7 maths grade, 3rd year level 7 overall grade and 3rd level 7 project mark

Results post 2011

2011

For students graduating in 2011 the bar for entry onto the Honour degree programme was significantly reduced with students with less than 60% progressing onto the Honours degree.

Profile on Entry

Mean mark on entry is 64.6, 11 out of 18 have a grade above 60% and the lowest grade was 56%.

Correlation Coefficient(R^2)	3rd Level 8 maths R^2 (p value)	4th Level 8 Maths (p value)	4th Level 8 Overall (p value)
3rd year Level 7 Maths	0.6(0.008)	0.54(0.03)	0.19(0.45)

Table 4: Correlation between 3rd level 7 maths grade, 3rd level 8 maths grade, 4th level 8 maths grade and 4th year level 8 overall

Correlation Coefficient(R^2)	3rd Level 7 maths R^2 (p value)	3rd Level 7 Overall (p value)	3rd year Level 7 project (p value)
4th year Level 8 overall	0.19(0.45)	0.101(0.69)	0.012(0.96)

2011	Direct Entry to level 8	Entry via Level 7 course	Significant difference
N	50	18	
Average mark (Standard deviation)	55(13.1)	64.6(7.07)	P=0.000(t-test)
Number with grade of more than 60%	22/50	8/18	P=1 (Fisher's exact)
Graduated on time(Complete pass)	45/50	16/18	P=1(Fisher's exact)

In 2011 even though the threshold for transfer to the Honours degree has been reduced we are still seeing the students from a level 7 background outperform the students who entered directly onto the level 8. This time we see there is no significant difference between percentage of 2.1s or the percentage who graduated on time.

2012

Profile on Entry

In this year 14 students progressed with only 7/14 having achieved a mark of greater than 60%. The overall average on entry was 60.75% and the lowest mark was 53 %.

Correlation Coefficient(R^2)	3^{rd} Level 8 maths R^2 (p value)	4^{th} Level 8 Maths (p value)	4^{th} Level 8 Overall (p value)
3^{rd} year Level 7 Maths	0.323(0.259)	0.684(0.010)	-0.08(0.771)

Table 4: Correlation between 3^{rd} level 7 maths grade, 3^{rd} level 8 maths grade, 4^{th} level 8 maths grade and 4^{th} year level 8 overall

Correlation Coefficient(R^2)	3^{rd} Level 7 maths R^2 (p value)	3^{rd} Level 7 Overall (p value)	3^{rd} year Level 7 project (p value)
4^{th} year Level 8 overall	-0.08(0.771)	0.22(0.45)	0.098(0.739)

2012	Direct Entry to level 8	Entry via Level 7 course	Significant difference (P value)
N	40	14	
Average mark (Standard deviation)	53.9(13.6)	60.7(5.7)	P=0.011(t-test)
Number with grade of more than 60%	14/40	5/14	P=1(Fisher's exact test)
Graduated on time(Complete pass)	35/40	13/14	P=1 (Fisher's exact)

2013

Profile on Entry

Average mark on entry is 57.3 with only 7 out of 17 satisfying the old criteria for transferring.

Correlation Coefficient(R^2)	3rd Level 8 maths R^2 (p value)	4th Level 8 Maths (p value)	4th Level 8 Overall (p value)
3rd year Level 7 Maths	0.714(0.001)	0.51(0.03)	0.36(0.13)

Table 4: Correlation between 3rd level 7 maths grade, 3rd level 8 maths grade, 4th level 8 maths grade and 4th year level 8 overall

Correlation Coefficient(R^2)	3rd Level 7 maths R^2 (p value)	3rd Level 7 Overall (p value)	3rd year Level 7 project (p value)
4th year Level 8 overall	0.36(0.13)	0.35(0.134)	0.174(0.477)

2013	Direct Entry to level 8	Entry via Level 7 course	Significant difference
N	65	19	
Average mark (Standard deviation)	54.7(9.4)	51(19.45)	P=0.422(t-test)
Number with grade of more than 60%	38/65	9/19	P=0.439(Fisher's exact)
Graduated on time(Complete pass)	54/65	17/19	P=0.723(Fisher's exact)

By 2013 the average mark (57% v 65% in 2011) of ordinary degree students who transfer has been significantly reduced to the point where there is now no significant difference between the performance of these students in terms of overall mark, percentage of 2.1s and the percentage who graduate on time.

Conclusion

Several researchers in the U.S. have identified a phenomenon known as "transfer shock" (Cejda, 1994; Lanaan, 2001; and Hills, 1965). Through transfer shock, community college students who transition to a university typically experience a drop in grades for the first semester or two immediately after transfer. Grade point averages will typically recover by the time that students graduate and the dip in grades is typically attributed to the effort it takes to transition from one educational setting to another. We seem to be observing a similar phenomenon in the DIT, whilst

there is a temporary dip in the performance of transfer students in the first semester these student quickly recover and there is a very strong correlation between their performance in the ordinary degree and their final performance. The American literature recommends that well-defined articulation agreements between the community college and the university as being critical to transfer student success. At DIT, the faculty teaching the ordinary and honours programs are typically in the same department and, in fact, most faculty teach in both programs. Thus, it appears that conditions are ripe at DIT for successful transition of students between the programs.

In addition whilst previously these transfer students were outperforming their direct entry comparators they are still performing equally well after the barrier has been reduced significantly. This is still a rather interesting result as historically it had been felt that these student wouldn't be able to cope with the rigour of an honours degree but we are no seeing they are coping just as well as their direct entry counterparts. We hope to extend this study to students in other areas of Engineering and see if there are similar levels of success for transfer students.

In addition work is required in this area and we hope to follow up this work with focus groups of students who have articulated in the past, along with a focus group of staff who have taught these students on both the ordinary and honours programmes.

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