Factors Which Influence The Academic Performance Of Level 7 Engineering Students *

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Abstract

High module failure rates can lead to poor student retention and a need exists for improved understanding of the determinants to academic performance. This research examines the influence of a number of factors on academic performance among Level 7 Engineering students in Dundalk Institute of Technology over a four year period. Using statistical regression techniques age-group, attendance, marks available for continuous assessment, class-size, semester of study and year of study were investigated. Statistical evaluations based on a sample set of 1263 identified that mature students, students with positive levels of attendance and modules with high levels of continuous assessment marks appear to result in better performance. It is envisaged that this work will contribute significant data to the limited knowledge base in this area especially in terms of engineering education. Based on the findings of this study, it is recommended that continuous assessment activities, which take place during class time, be used to incentivise student attendance and engagement, which should lead to better academic performance.

Keywords: Engineering, attendance, performance, statistics and regression.

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Introduction

A Level 7 degree in Engineering usually takes three years to complete. Engineering degrees typically employ a mixture of traditional teaching and assessment approaches including lectures, practical laboratories, problem based tutorial sessions, and terminal exams. Typically, the accreditation body, Engineers Ireland (EI, 2007) specify that Engineering programmes must enable graduates to demonstrate a range of attributes whereby an engineer can be defined as a professional practitioner of Engineering and should have a wide knowledge and understanding of science, and mathematics, and be able to apply these to a range of problems. In addition to technical Engineering skills, engineers must also develop Engineering attributes such as communication and team working skills and have an appreciation of professional and personal ethics.

Effective programme design should be informed by experience and research. Programme delivery is influenced in part by the physical resources, lecturing staff and ultimately the students undertaking a programme of study. This study was undertaken in part to support the School of Engineering's Programmatic Review process. The objectives of the programmatic review include reviewing the development of programmes with a particular emphasis on the achievement and improvement of educational quality (HETAC, 2010). With this in mind, a study was developed to investigate factors that may contribute to academic performance. It was envisaged that the outcomes of the study would be used in some way to better inform effective programme design and delivery. However, understanding the key determinants to undergraduate student success in engineering disciplines is a complex problem and in this work only a select number of contributing factors were investigated. These factors include age group, class size, module continuous assessment weighting, semester and year of study. These factors will be investigated in terms of their impact on attendance and performance.

Literature Review

Performance may be influenced by external factors other than student centred characteristics. In this work, factors including those associated with the delivery of programmes will be investigated. The core of the literature review focuses on those analyses which aim to quantify the relationship or not between performance and contributing factors. Much of the reported literature focusses on the role of attendance on performance. At the end of this section a number of key research questions are proposed.

Observations in Performance and Attendance

For the purpose of this study, attendance can be defined as the act of being present and performance is defined as the end of module mark achieved by a student for a particular module. Research has shown that a range of factors may affect performance. Factors include gender, race and existing knowledge (Anderson et al., 1994). The importance of attendance has been discussed widely in the literature and in this work attendance will also be investigated.

Non-attendance at universities, institutes of technology and schools is a world-wide issue which transcends all disciplines (Leufer & Cleary-Holdforth, 2010; Romer, 1993; Oghuvbu, 2010), yet much more research effort is needed to facilitate better understanding of the underlying relationship between attendance and performance. This is especially true in engineering education where there is a lack of studies in this area. Students and academics may perceive that positive levels of attendance should therefore result in improved performance. This perception has been investigated and debated in the literature for various disciplines (Romer, 1993) although more effort is needed in terms of engineering focus. It has been shown that non-attendance can ultimately lead to poor attrition and that student engagement can lead to improved retention, student completion and employability (Zepke and Leach, 2011). In this work, participation will not be directly measured, however it is noted that student participation is generally critical to student success and that participation is more than just attendance alone (Woods, 1996).

Typically, factors that influence student attendance have been shown to include motivation and financial status (Devadoss, 1996). Morning classes have been shown to have higher rates of absenteeism than afternoon classes (Burd and Hodgson, 2006). an Irish context, it has been shown that the main reasons for non-attendance at Engineering lectures are: assessment deadlines, lack of perceived benefit from attending lectures, timing and poor standard of teaching (Fitzpatrick et al., 2011). From an engineering point of view, programmes are usually delivered by instructors, whether through lectures or in laboratories. Quite often engineering education is underpinned through the use of software in key areas such as computer aided design and computer aided manufacture. In most cases software is not available to the student at home and therefore attendance should be a must if they are to meet the learning outcomes of those modules.

In recent years at DkIT, more mature students are enrolling on engineering programmes. In accordance with the definition provided by the Higher Education Authority (HEA), a student is considered mature if they are at least 23 years of age on the 1st of January of the year of entry or re-entry to an approved course. Conversely, in another international institution a student would have to be 26 years of age or older to be defined as mature (McCarey et al., 2007). In some instances, mature students have been shown to miss more classes than non-mature students due to reasons such as family and employment commitments; despite this, the literature tends to show that mature students perform better than their younger counterparts (Jansen and Bruinsma, 2005; McCarey et al., 2007).

The effect of increasing class-size on both performance and attendance in third level Engineering education is not widely understood. A study carried out by the School of Economics in University College London (Bandiera et al., 2010) identified that larger class-sizes generally have a negative impact on student performance and that class-sizes below 100 resulted in the best performance. The study was limited in the fact that the relationship between class-size and attendance was not quantified, unlike a study carried out at the Binghamptom University, New York, where it was shown that as class-sizes increased, both attendance and performance levels decreased (Kokkelenberg et al., 2008). In Engineering at DkIT, typical entry to first year can be in the region of 50 students, which is below the class-sizes reported above.

Trends in attendance over the course of a semester are well reported in the literature. The same cannot be said for trends between semesters. In a number of similar investigations attendance was shown to steadily decline during a semester (Van Blerkom, 2001; Burd and Hodgson, 2006; Nyamapfene, 2010). Reasons for declining attendance rates during a semester included student dis-interest, workload from competing subjects and self-confidence in doing well without the need for attendance (Van Blerkom, 2001). More research is needed to investigate the effect between semesters for both attendance and performance.

A number of conflicting studies have shown that attendance can vary depending on year of study. In one study average attendance was shown to decline from 1st year to 3rd year for a cohort of Civil Engineering students at University College Dublin (Purcell, 2007). Conversely, attendance rates were shown to increase year on year (Burd and Hodgson, 2006). In all these studies the statistical significance of the results is not evident and the sample sizes are relatively small. This may explain why some of the studies show conflicting results.

The relationship between attendance, performance and magnitude of Continuous Assessment Marks (%) available for a given module is poorly understood which is especially true for engineering disciplines. In engineering programmes in DkIT different modules have different assessment methods. Typically, theoretical subjects can require students to take a terminal exam worth 70% with continuous assessment accounting for the remaining 30%. On the other hand practical subjects are commonly 100% continually assessed. In a cohort of Engineering students at Dublin City University, improved continual assessment performance was a general consequence of positive attendance (Nahar, 2008). The current study aims to investigate the relationship between module assessment breakdown and performance.

In summary the review of literature has highlighted that more work is needed in understanding the key determinants to performance for Engineering disciplines. It is clear from the literature that performance is governed by more than just attendance alone and in this work a number of factors will be investigated. These factors include age-group, attendance, continuous assessment marks (%), class-size, semester of study and year of study.

Attendance as an Indicator of Performance

The existence, or not, of a link between attendance and academic performance is reported for various disciplines within the literature, although engineering focus is lacking. A study of this nature is greatly needed to evaluate if regularly attending engineering students perform better than their poorer attending counterparts. It is acknowledged however that in some instances marks are awarded for regular attendance, therefore by definition regularly attending students will gain more marks for this type of element. However, this does not suggest that attending students are engaging with the class, instead they may attend with the goal of registering attendance marks rather than attending for learning. The relationship between attendance and performance is complex in nature and the literature has presented conflicting arguments for and against the existence of this relationship.

In a key study, a quantitative statistical analysis was used to investigate the relationship between attendance and academic performance for Economics students (Romer, 1993). Romer showed that attendance was a problem, and on the basis of these findings, compulsory attendance policies were considered. Through statistical findings, Romer, (1993), supported the view that attendance did in some way have a causal effect on performance. It was also pointed out that it was not possible to isolate the effect of attendance on performance because students choose whether or not to attend class. Instead, he points to suggestive rather than definitive evidence for a link between attendance and performance. The importance of the work of Romer, (1993) is still relevant today and in terms of Engineering education, studies of this nature are greatly needed.

Following the work of Romer (1993), a number of studies have used similar statistical methods in an attempt to quantify the relationship between attendance and performance (Devadoss, 1996; Stanca, 2006). In many of these studies it was accepted that performance is thought to be a combined function of attendance and unobservable factors, such as engagement, motivation and subject interest. A number of researchers have aimed to control for these hidden variables in their regression analyses and in many cases the positive relationship between attendance and performance still remains (Devadoss, 1996; Stanca, 2006).

In addition to regression techniques, a number of researchers have also used correlational studies to show positive relationships between attendance and performance (Gatherer and Manning, 1998; Maloney and Lally, 1998; Cohen and Johnson, 2006; McCarey et al., 2007; Nyamapfene, 2010; McCarthy, 2011).

Conversely, no relationship between attendance and academic performance has also been reported (Rodgers, 2002; Grabe, 2005). The work of Rodgers (2002) showed that while attendance did improve based on an incentive scheme whereby students would get rewarded with attendance related marks, improved attendance did not translate into improved academic performance. Similarly, Grabe (2005) showed that students who used online class notes as opposed to attending class did not display any difference in examination performance.

In summary the literature supports the suggestion that performance is in some way positively associated with attendance, however more research for engineering disciplines is required. It is accepted however, that the existence of a definitive quantifiable relationship between attendance and performance is not realistic, due to the complexity of the interlinked relationships between controlling factors. In the following sub-section the core research questions are proposed.

Scope of Study

The key focus of this research is to determine to what degree a number of factors have on attendance and academic performance for Engineering students. This research is therefore driven by the following key questions:

Q1 – does age-group influence performance?

Q2 – does class-size influence performance?

Q3 – does continuous assessment breakdown influence performance?

Q4 – does the semester of study influence performance?

Q5 – does year-group influence performance?

In addition to the five research questions outlined above, this work aims to understand the impact of attendance on performance which will be addressed through the following research question:

Q6 – does attendance influence performance?

Methodology

In order to answer the proposed research questions, the methodology consists of two key sections; (section 1) descriptive statistics, and (section 2) multi-variable model.

Descriptive Statistics

Summary mean attendance and mean performance data is presented for all modules.

Multi-variable Model

To best examine and quantify the relationship between the factors of interest and performance (Q1 – Q6) a multiple regression technique was used. Multiple regression analysis enables the prediction and weighting of the relationship between two or more independent variables (Cohen et al., 2011, pp. 663). Each factor has levels as shown in Table 1. These categories of data represent institutional and programme delivery factors rather than student centred factors such as motivation and personality.

Table 1 – Data Categories used for Analysis.

Independent Variable	Code	Level
Age-group	AG	Any
Attendance	AT	Any
Class-size	CS	Any
Continuous Assessment Marks (%)	CA	30, 40, 50 and 100
Semester	S	Winter (1) and Summer (2)
Year-group	Y	1^{st}(1), 2^{nd}(2) and 3^{rd}(3)

In line with the HEA definition for mature students, in DkIT mature students are classified as being 23 years of age or older. In recent years mature students have accounted for over 20% of the annual intake across the institute. In DkIT, class-size is limited by resources such as lecture room size and computer laboratories which would normally have a maximum number of 20 seats. Typically, Engineering programmes are split between a winter (1) and a summer (2) semester. Modules are composed of either a mixture of both continuous assessment and a terminal exam or in some cases 100% continuous assessment.

In engineering programmes gender imbalance in favour of males is a common issue (Nyamapfene, 2010). The same is true in DkIT, where the intake of female students into engineering disciplines over the years has been extremely low. As a result, gender will not be considered for this work.

Data Collection and Sorting

In total, 1263 observations from students enrolled in Engineering modules, spanning a period from 2010 to 2014, across 18 five credit modules, three year-groups and both semesters are evaluated. No yearlong modules were included in this study as they did not exist on the programmes at the time of writing. In a number of studies attendance data was collected by a single lecturer (Romer, 1993; Caviglia-Harris, 2006; Nyamapfene, 2010). In the current study the data was collected by four lecturers across both Mechanical Engineering and Electrical/Electronic Engineering programmes. In total, the modules evaluated account for 25% of the modules on the programmes evaluated. All four lecturers have similar lecturing experience (approximately five years) and have varying areas of expertise.

Summary module data is given in Table 2. It should be noted that the actual module names have been anonymised to protect the identity of both students and staff. Instead, a general theme is given which relates to the module content. The modules evaluated represent a broad mix of both practical (denoted P) and mathematical (denoted M) subjects. Or, in some cases modules are effectively described as being a combination of both (denoted P/M).

Only students with both an examination mark and attendance record were used in the study. Owing to this, a total of 56 data points were removed from the study. It is important to note that of the 1263 student records evaluated, in some cases individual students contribute multiple data points across multiple modules. Similarly, some modules were counted more than once from year to year. In total there were 393 unique students. Similar studies have demonstrated a number of limitations in the collection of attendance data such as incomplete data (Romer, 1993), students required to self-report absences (Durden and Ellis, 1995) and limited sample size (Purcell, 2007, Nyamapfene, 2010). In this work a comparatively large sample size is used and attendance data represents all classes scheduled for all modules across a thirteen week semester. Attendance records were completed by lecturers and not students.

Table 2 – Module Information (standard deviation in parenthesis).

Module	*Semester*	*Year*	*CA (%)*	*Lecturer*	*Count of Students*	*Average Attendance (%)*	*Average Performance (%)*
Automation (P/M)	1	2	30	1	69	75.4 (19.4)	57.0 (15.7)
Control (P/M)	2	3	30	1	53	88.2 (15.2)	59.4 (17.8)
Energy 1 (P/M)	1	2	30	2	123	82.0 (18.0)	56.1 (21.2)
Energy 2 (P/M)	1	3	30	2	62	87.4 (13.4)	65.0 (13.8)
Computing (P)	1	1	30	1	152	79.1 (18.9)	64.3 (15.2)
Manufacturing (P/M)	1	3	50	1	91	83.7 (11.5)	62.7 (11.6)
Mathematics (M)	1	1	30	4	55	74.8 (18.6)	53.3 (23.5)
Mathematics (M)	2	1	30	4	46	60.9 (25.4)	55.3 (22.1)
Mathematics (M)	1	2	30	4	32	70.9 (24.1)	55.2 (22.5)
Mathematics (M)	2	2	30	4	30	65.7 (26.8)	60.2 (26.5)
Mathematics (M)	1	3	30	4	26	87.1 (14.0)	77.6 (16.4)
Mathematics (M)	2	3	30	4	26	76.3 (22.6)	72.3 (17.3)
Project (P)	1	1	100	3	99	84.7 (15.8)	70.9 (12.5)
Project (P)	2	1	100	3	52	80.8 (21.0)	64.2 (16.7)
Project (P)	1	2	100	1	37	87.3 (22.0)	52.7 (22.5)
Quality (M)	2	3	30	1	68	78.0 (16.1)	59.9 (15.0)
Energy 3 (P/M)	2	3	30	2	43	77.1 (17.2)	57.7 (14.6)
Science (P/M)	1	1	30	2	199	73.9 (22.2)	57.2 (22.1)

Results

The following section presents the results of the descriptive and inferential statistics evaluated in this work. The results section begins by presenting the findings from the descriptive statistics.

Descriptive Statistics

The mean performance and attendance data is given in Table 2 for all the modules evaluated in this work. The overall mean performance was 60.7% (standard deviation 19.0) and the overall mean attendance was 78.8% (standard deviation 19.9), both of which compare favourably to other reported rates (Burd and Hodgson, 2006, Purcell, 2007, Nyamapfene, 2010, and McCarthy, 2011). averages for attendance and performance are presented for each of the variables of interest in the study in Tables 3 to 7.

Table 3 – Average Attendance and Performance Data for Non-Mature versus Mature Students.

Student Type	***Student Count***	***Average Attendance (%)***	***Standard Deviation Attendance***	***Average Performance (%)***	***Standard Deviation Performance***
Non-Mature	787	76.6	20.7	58.8	19.1
Mature	476	82.5	17.7	63.8	18.4
Totals	**1263**	**78.8**	**19.9**	**60.7**	**19.0**

Table 4 – Average Attendance and Performance Data for Class Size ranges.

Class Size	***Student Count***	***Average Attendanc e (%)***	***Standard Deviation Attendance***	***Average Performance (%)***	***Standard Deviation Performance***
10 - 19	30	74.6	19.3	58.9	18.3
20 - 29	382	83.0	15.8	61.8	16.4
30 - 39	301	78.0	20.9	58.5	20.2
40 - 49	222	72.6	23.2	61.6	21.5
50 - 59	328	79.3	19.5	61.0	18.8
Totals	**1263**	**78.8**	**19.9**	**60.7**	**19.0**

Table 5 – Average Attendance and Performance Data for Modules with Varying Degrees of CA.

CA (%)	*Student Count*	*Average Attendance (%)*	*Standard Deviation Attendance*	*Average Performance (%)*	*Standard Deviation Performance*
30	834	77.1	20.8	58.7	20.3
40	30	74.6	16.6	58.9	18.3
50	91	83.5	11.5	62.7	11.5
100	308	82.7	18.6	65.6	16.1
Totals	**1263**	**78.8**	**19.9**	**60.7**	**19.0**

Table 6 – Average Attendance and Performance Data for Individual Semesters.

Semester	*Student Count*	*Average Attendance (%)*	*Standard Deviation Attendance*	*Average Performance (%)*	*Standard Deviation Performance*
1	767	79.6	19.3	60.5	18.9
2	496	77.7	20.8	61.0	19.2
Totals	**1263**	**78.8**	**19.9**	**60.7**	**19.0**

Table 7 – Average Attendance and Performance Data for Individual Year of Study.

Year	*Student Count*	*Average Attendance (%)*	*Standard Deviation Attendance*	*Average Performance (%)*	*Standard Deviation Performance*
1	601	76.7	21.1	61.4	19.3
2	262	77.4	21.9	56.3	21.5
3	400	83.0	15.6	62.6	15.6
Totals	**1263**	**78.8**	**19.9**	**60.7**	**19.0**

Multi-variable Linear Model

To investigate the effects of the independent variables on the performance a multi-variable analysis was conducted and the results are shown in Table 8. An adjusted R^2value of 0.291 was found, indicating that 29.1% of the variance in performance can be explained by the independent variables tested, which indicates a moderate fit (Cohen et al, 2011, pg 662). Similarly, the results indicate that the relationship is statistically significant. The Beta (β) weighting of the independent variables are given in Table 3 in the Estimate column. The Beta weightings are calculated relative to each other rather than independently to each other.

Table 8 – Determinants of Academic Performance (n=1263)

Model	Estimate β	Std. Error	t value	Pr(> | t |)	Significance Code[1]
(Intercept)	13.80	4.95	2.79	0.005	**
Age	0.30	0.08	4.02	0.000	***
Attendance	0.49	0.02	20.60	0.000	***
Class Size	-0.02	0.06	-0.24	0.81	
Continuous Assessment	0.05	0.02	3.10	0.002	**
Semester	1.41	1.03	1.36	0.17	
Year	-1.32	0.85	-1.60	0.12	
R^2	0.295				
Adjusted R^2	0.291				
Model's F test	87.48				
Significance Level	0.000				***

[1] Significance Codes: 0 '***', 0.001 '**', 0.01 '*', '*' 0.05, '.' 0.1, ' ' 1.

Discussion

This section will discuss each research question in-turn and highlight the relevant findings from the statistical analysis.

Q1 – does age-group influence performance?

In this work, mature students are statistically more likely to perform better than non-mature students as shown in Table 8 and Figure 1. Interestingly, on average mature students attended more classes and performed better than non-mature students as shown in Table 3. It has been shown that mature students tend to adopt a deep approach to their learning as opposed to younger students (Richardson, 1995) which may explain the findings in this work. Based on the data, it would be worthwhile to consider the needs for different levels and types of support for younger versus mature students as also acknowledged elsewhere (Caviglia-Harris, 2006). It has been recognised that mature students have an important role to play in engineering programmes. For example through the inclusion of more diagnostic assessment in modules, in some instances mature students have an effective platform for disseminating their industrial experience and prior knowledge. This has been used effectively in Engineering in DkIT and quite often mature students have a positive influence on group work and younger students.

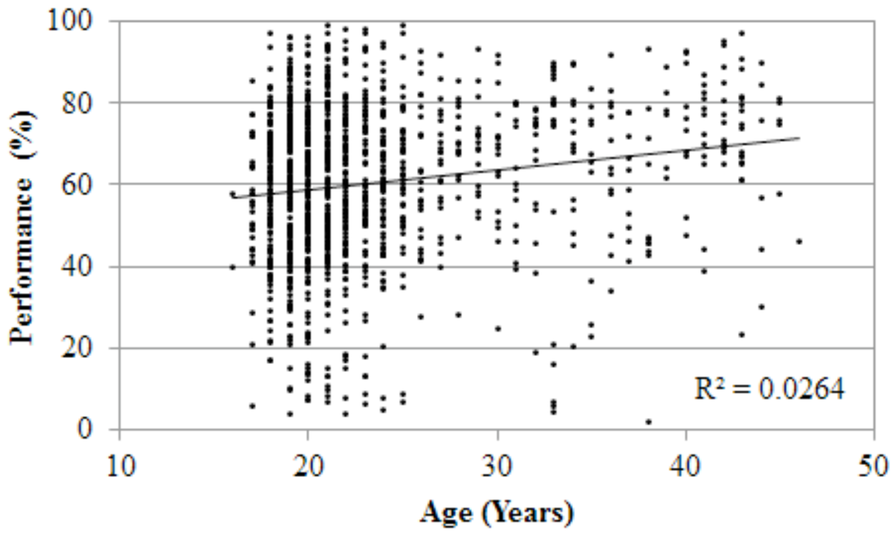

Figure 1 –Performance as a function of Student Age.

Q2 – does class-size influence performance?

In this work, class size had little or no effect on observed performance as shown in Table 4 and Table 8. Conversely it has been shown elsewhere that class size has a negative impact on performance as evaluated by Kokkelenberg et al. (2008). It must be stressed however that class sizes in DkIT Engineering courses are relatively low compared to larger institutions. Due to the comparatively small class sizes in Engineering, there may be more of an opportunity to divert from the more resource efficient lecture centred approach to teaching. In smaller classes it is more practical to incorporate more active and problem based learning approaches which in the longer term may serve to improve student engagement.

Q3 – does continuous assessment breakdown influence performance?

Students generally appear to perform better in those subjects with greater levels of continuous assessment marks available as shown in Table 5 and Table 8. In Engineering, practical subjects tend to be laboratory based and quite often constitute 100% continuous assessment. Perhaps those subjects with greater levels of continuous assessment marks encourage student engagement and participation or perhaps students find practical subjects more enjoyable. In first year in particular more hands-on modules could be used to encourage and engage students in new programmes. With respect to Level 7 programme delivery, teaching and assessment strategies could evolve beyond the classic lecture centred approach that has been used in engineering education for so long, especially given that Engineering is primarily a hands-on discipline.

Q4 – does the semester of study influence performance?

In this work, performance improved from the winter semester to the Summer Semester but the results were not significant as shown in Table 6 and Table 8. Despite this observation, it is common to consider placing perceived difficult modules in the second semester, especially in first year. By doing this, students in first year could have sufficient time to adapt from their previous situation whether that is in employment or finishing secondary School. It is not however suggested that the second semester in first year is loaded with difficult subjects, instead a balance in desirable. It is recommended that the study be extended to include performance data from all modules in a programme to retest this variable for statistical significance.

Q5 – does year-group influence performance?

In this work, a negative relationship existed between year-group and performance however the findings were not statistically significant as shown in Table 8. These findings may be explained by the fact that the course difficulty increases from first year to final year. It is recommended that the study be extended to include performance data from all modules in a programme to retest this variable for statistical significance.

Q6 - does attendance influence performance?

In this work, for the sample set investigated, students are statistically more likely to perform better the more they attended, as evidenced in Table 8 and Figure 2. However, it is acknowledged that this study does not control for inherent student ability and therefore any conclusions are presented with caution.

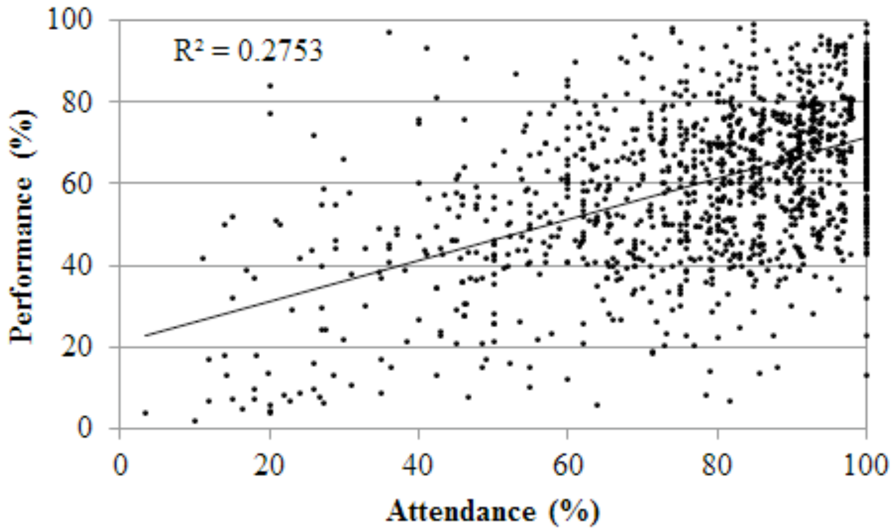

Figure 2 –Performance as a function of Attendance.

While the evidence outlined in this study does on the whole support the need for positive attendance it does highlight some conflicting observations. In total, the study consisted of 1263 observations of which 153 failed to meet the pass mark of 40. Of these 153 failed observations, a total of 35 students actually met or exceeded the average attendance figure of 78.8% as shown in Figure 2. Similarly, it was demonstrated that in some instances students achieved exceptionally high marks with well below average attendance as in the case of a student attending 36% of the time whilst earning a 97% module mark. In these cases naturally gifted students may be more inclined to elope from class knowing that they can easily catch up in their own time without being adversely affected by absences. Similar observations were also reported by Hyde and Flourmoy, (1986) for medical students, which suggests that in some instances a student may exhibit high levels of engagement outside the classroom despite poor classroom attendance. These findings rather like those of Romer, (1993), question whether attendance alone has an effect on learning.

As in many institutions there are those students who choose for whatever reason not to engage with their studies as evidenced by those who are both poor attenders and poor performers. It has been suggested that the inclusion of more engagement focussed and active learning activities (Zepke and Leach, 2011) could be effectively used to target those students at DkIT who exhibit poor engagement despite having positive attendance. Conversely there are those students on the programme who are not as gifted and no matter how often they attend they do not add to their performance.

Further interrogation of the relationship between the performance and attendance is shown in Figure 3. Interestingly, a simple regression has shown that those students in the fail category (performance <40%) who exhibit more attendance appear to be more likely to gain more marks than those with poor attendance. The trend decreases outside of the fail category as demonstrated through the reduction in the subsequent regression slopes. The results could suggest that vulnerable students could be identified as early as possible and encouraged to engage with the learning process.

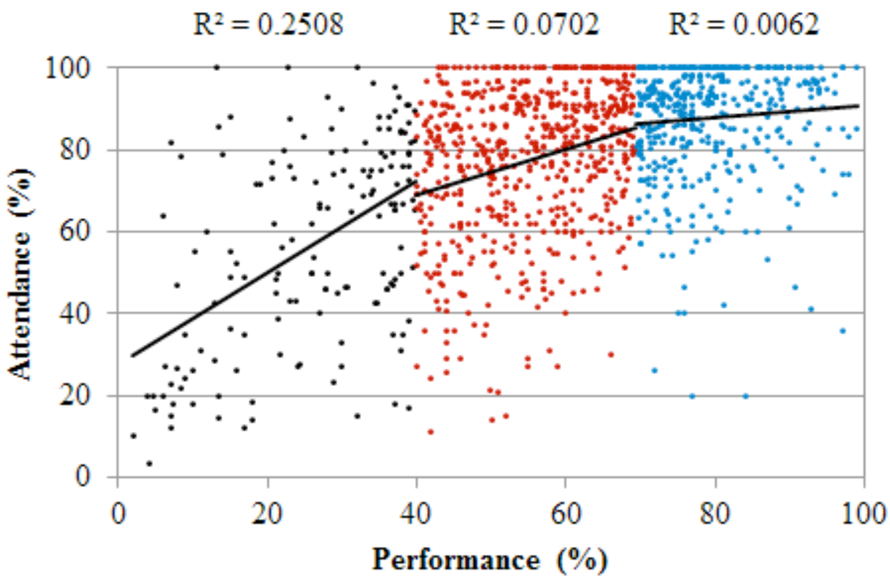

Figure 3 –Attendance as a function of Performance.

In terms of programme design the results outlined above should be considered especially in terms of the potential provision of online modules. Perhaps at Level 7, the divide between naturally gifted students and those who rely heavily on face to face contact with the traditional approach to course delivery could pose a barrier to the future implementation of such courses at this level. From a practical teaching point of view, it is clear that non-attendance is frustrating for lecturers and can impact on the learning of those students who choose to take their attendance seriously.

Recommendations

The main implication from this study is that students should be actively encouraged to attend as many classes as possible. Although this study does not take into account student ability, motivation or engagement, the results of this work show that students are statistically more likely to perform better the more they attend. This raises the important issue of how best to encourage students to attend and prompts the question of whether or not compulsory attendance policies should be introduced in this and other higher education institutions.

Compulsory attendance policies have been widely debated in the literature with many conflicting views on their appropriateness (St. Clair, 1999). In a study by Caviglia-Harris (2006) the introduction of a mandatory attendance policy resulted in an increase in attendance with no corresponding increase in performance. Rodgers (2002) used an incentive scheme to encourage attendance, whereby marks were deducted for absenteeism. Although the introduction of this scheme resulted in improved attendance, academic performance was not found to increase. These studies suggest that attendance alone does not ensure that learning is taking place. Results from the current study are consistent with this view as in some instances students were found to fail modules despite above average attendance, while some others achieved extremely high marks with well below average attendance. The introduction of a compulsory attendance policy or an incentive scheme to encourage attendance would not be of benefit to students in these cases. Therefore, it is recommended that attendance should not be encouraged through compulsory attendance policies or incentive schemes, but activities which enhance student engagement in class should be considered instead.

Results from this study show that student performance was statistically better in subjects which have greater levels of continuous assessment marks available. In these subjects, much of the continuous assessment activity is carried out during class time and in order to gain continuous assessment marks, students must actively participate and engage in these classes. It is therefore recommended that continuous assessment activities, which take place during class time, be used to incentivise attendance and engagement, rather than introducing a compulsory attendance policy which simply rewards students for turning up to class.

A final recommendation from this study comes from the fact that mature students were found to perform better than non-mature students. It is therefore recommended that a variety of different learning styles and different types of supports be considered when teaching these two cohorts of students.

Limitations of Current Study

The main limitation of the current study is that not all modules were evaluated across the programmes in question. A comprehensive analysis involving all lecturers could result in a more representative study and perhaps the conclusions could be stronger based on a more complete statistical analysis. Similarly, the study could be extended to include other engineering programmes on offer in the institute such as Civil

Engineering. However, for these proposed studies to be realised it would require a high level of coordination and commitment from all involved.

The aim of this work is not to elevate attendance as the key contributor to academic success, rather to understand its role in the learning process. This is especially the case in Level 7 Engineering programmes where this data isn't freely available. To reduce the scope of the study the concept of student ability was neglected and should be considered in subsequent studies.

As outlined previously the data collected is from 393 unique students and 18 unique modules. In some cases students and indeed modules contribute multiple data points. Multiple measurements per subject may result in correlated errors that are explicitly forbidden by the assumptions of standard and regression models. linear model presented in this work ignores the fact that a number of students are represented on a number of occasions as they take different modules. This raises the question that the results may be skewed or biased. A mixed-model approach could be used in further analyses. In the mixed-model each student and module is assigned a unique student identification and respectively. This approach results in students being grouped into modules and groups into students.

Conclusions

As a result of a detailed quantitative analysis the following key conclusions are proposed:

- Older students are statistically more likely to perform better than their younger counterparts.
- Class sizes evaluated in this work have no major effect on student performance.
- Student performance is statically better in those subjects with more continuous assessment.
- Semester of study did not influence the performance of students.
- There was no significant difference between student performances across all three years of study.
- The majority of students who take attendance seriously are generally rewarded with positive performance, however this is not always the case and in some instances the opposite is true.

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