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Comparison of Examination Performance in Mathematics, Physics and Electricity of First Year, Level 7 Student Cohorts in Electrical Engineering

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Comparison of examination performance in mathematics, physics and electricity of first year, Level 7 student cohorts in electrical engineering

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Abstract: This contribution reports on the highly statistically significant relationship ($p < 0.001$) established in student examination performance in the three central scientific subjects in a Level 7, Year 1 engineering programme at Dublin Institute of Technology. A range of data is taken over seven academic years (from 2005-12 inclusive). Recommendations for learning and teaching as a result of this analysis are proposed.

BACKGROUND

The three-year, Level 7, Bachelor of Engineering Technology degree in Electrical and Control Engineering of the Dublin Institute of Technology (DIT) educates students for careers in Ireland's electrical power, automation, robotics, pharmaceutical and manufacturing industries (DIT, 2012). The predecessor of this course was established in September 1967 as a result of discussions between the then Kevin St. College of Technology with the Electricity Supply Board (ESB), regarding their future requirements for technician engineers. The first students were recruited from both clerical and technical departments within the ESB. In 1967, the College's prospectus stated that the first year of the course covered the subjects Mathematics, Physics, Electricity, Drawing, Materials and Processes and General Studies; it was planned that later years would deal with electrical equipment, machines, materials and techniques together with appropriate instruction in the background sciences and industrial practice. The course description is similar to what it was forty-five years ago; the changes are in the details of the "electrical equipment" (O'Dwyer, 1997).

Such technician programmes are now referred to as Level 7 programmes; candidates apply for such programmes (in common with all higher education programmes) through the Central Applications Office, in which points are given for examination results in six subjects taken in the Leaving Certificate, or equivalent. The maximum point score possible for a candidate is 600, with 55% of candidates scoring more than 300 points in 2009, for example (CAO, 2009a). Minimum points levels for programmes are set by student demand for the limited number of course places; the minimum points level for the programme was 185 in 2009 (CAO, 2009b), with a median points level of 265 (DIT, 2010). Though there is some debate as to whether the points scored by candidates in an examination process dominated by a terminal examination is the best predictor of subsequent success on an engineering programme, nevertheless it is clear that many, if not most, of the students entering the programme have lower academic ability when compared to their wider peer group. In a typical year, between 25 and 35 learners commence the degree programme, the majority of whom come directly from second-level education; there are a small number of students who are mature learners (categorised as students over 23 years of age in Ireland) and a further small group of international students.

Considering the first year of the current programme, the three central scientific subjects of Mathematics, Engineering Science and Electrical Principles map onto the corresponding subjects of Mathematics, Physics and Electricity proposed in 1967. Since 2005, the author has had responsibility for development, instruction and assessment in the present version of the Electrical Principles subject and, more widely, has been Year 1 tutor with a broad responsibility for student learning in all subjects.

DESCRIPTION

Considering the three central scientific subjects, they are each divided for learning into two thirteen-week semesters; in each semester, students attend five structured learning hours in each subject each week (three hours lectures and two hours tutorials in Mathematics; two hours lectures, two hours laboratories and one hour tutorial in the other two subjects). The subjects are assessed in the following manner:

- Module examination (12.5% of the subject mark for all subjects), held after the completion of the first semester.
- Terminal examination (75% of subject mark for Mathematics, 50% of the subject mark for the other two subjects), held after the completion of the second semester. This examination has a compulsory question and five other questions, three of which are to be attempted.
- Continuous assessment, based on laboratory and student project work, make up the remainder of the Engineering Science and Electrical Principles subject credits.

EXAMINATION PERFORMANCE RELATIONSHIPS

For the three subjects, the relationships between individual student performances in the module examinations are studied for the four academic years from 2008-2012 inclusive; for the terminal examinations, relationships are studied for six academic years from 2005-2011, inclusive. A summary of this work is as follows:

- There is a highly statistically significant, positive correlation between performance in the Electrical Principles and Engineering Science subjects, in the module examination ($n=115$, $p<0.001$, $r=0.68$).
- There is a highly statistically significant, weakly positive correlation between performance in the Electrical Principles and Mathematics subjects, in the module examination ($n=115$, $p<0.001$, $r=0.40$).
- There is a highly statistically significant, positive correlation between performance in the Electrical Principles and Engineering Science subjects, in the terminal examination ($n=159$, $p<0.001$, $r=0.73$).
- There is a highly statistically significant, positive correlation between performance in the Electrical Principles and Mathematics subjects, in the terminal examination ($n=153$, $p<0.001$, $r=0.65$).

The weakly positive correlation determined between the Electrical Principles and Mathematics marks for the module examinations is largely due to poor student performance in Mathematics in the 2011-12 academic year; this requires further study.

Figures 1 and 2 show the relationships between subject terminal examination performance summarised above.

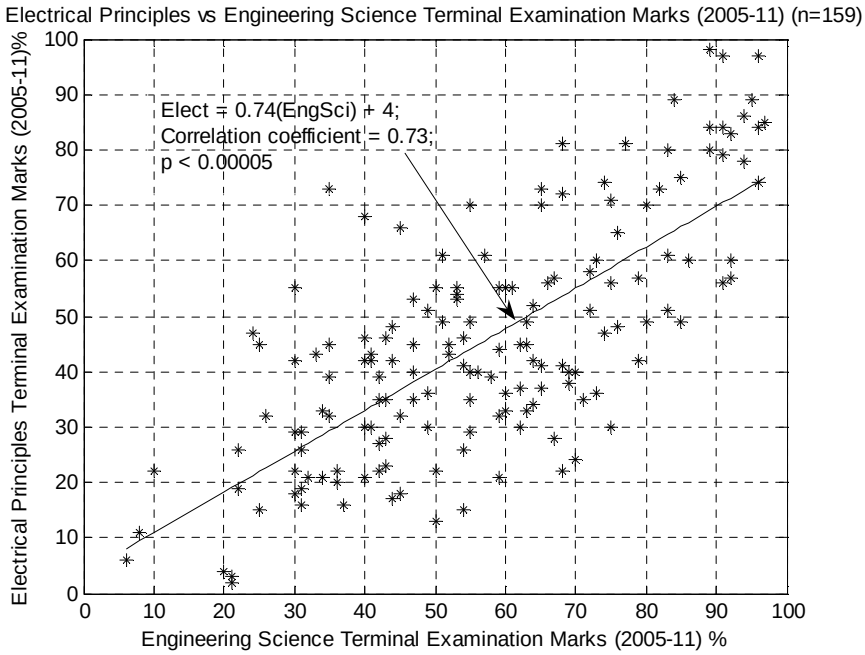

Figure 1: Relationship between the terminal examination marks for Electrical Principles and Engineering Science (Physics) 2005-11

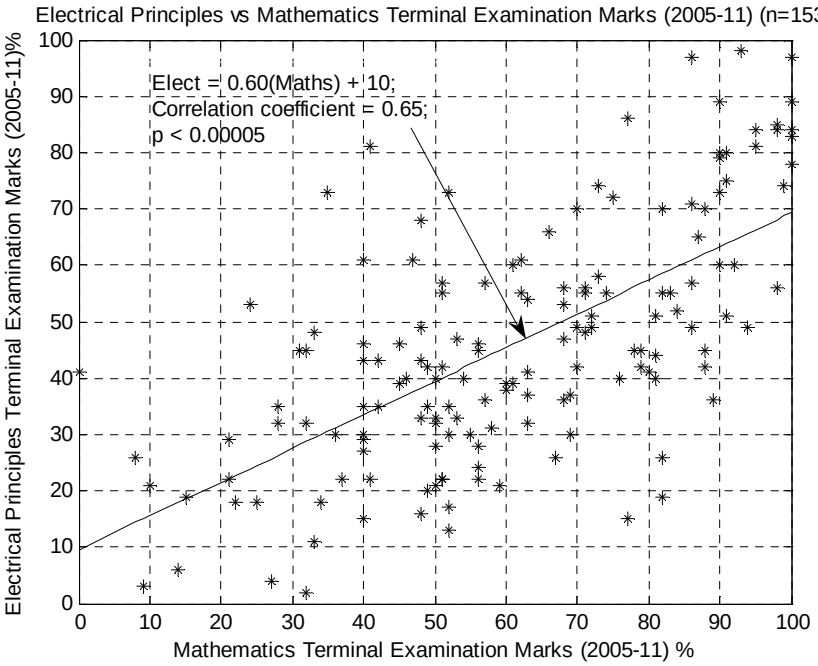

Figure 2: Relationship between the terminal examination marks for Electrical Principles and terminal examination marks for Mathematics 2005-11

CONCLUSIONS

The author has taken an evidence-based approach to examining student performance, in the module and terminal examinations, on the core subjects in the first year of a three-year, Level 7, degree programme in Electrical Engineering at Dublin Institute of Technology over the 2005-12 period. The conclusions of this work are that there are

highly statistically significant relationships between student module and terminal examination performances in these core subjects.

Mean student assessment performance in these core subjects remains disappointing. In the 2012-13 academic year, the author will take the following actions with the aim of engaging students more deeply in the subjects:

(1) In the first classroom session, the learning outcomes of the individual subjects will be explained in detail. In addition, the author will continue to communicate to students the statistically significant relationships between assessment performance and lecture attendance that has been reported in other work (O'Dwyer, 2011).
(2) Throughout the lecture programme, regular formative assessments, perhaps with the aid of clickers, will be encouraged; preliminary work on a pilot study carried out by the author has revealed that such formative assessments have improved student performance in achieving some learning outcomes in the Electrical Principles subject over the past three academic years.
(3) Further active learning techniques, including more structured mini-projects, will be proposed.

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