# GENERAL ELECTIVES IN CIVIL ENGINEERING AND COMPUTER SCIENCE

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**Abstract:** In 2005, University College Dublin (UCD), introduced the Horizons initiative that resulted in the development of fully modularised, semesterised and credit-based degree programmes. One of the key features of the initiative was the introduction of a degree of elective choice for students in the first three years of their undergraduate studies. Students can select two modules out of the twelve modules they take each year from any programme across the University. This paper examines the impact of the Horizons initiative on two disciplines in University College Dublin, namely, Computer Science and Civil Engineering. Examination of the data shows that a significant number of the students (approximately two-thirds of Civil Engineering students and approximately half of Computer Science students) choose electives outside their programme areas of study. Few non-Civil Engineering students (5%) avail of electives offered by the programme, while in the case of Computer Science a significantly greater number (46%) avail of the opportunity to study Computer Science electives.

*Keywords;* civil engineering education, computer science education, core modules, elective modules, breadth, depth.

## 1. INTRODUCTION

The development of undergraduate university education has been profoundly affected by the thoughts of two men - Wilhelm von Humboldt and Cardinal John Henry Newman - both of whom wrote extensively on the subject of university education in the 19th century. In 1810, Von Humboldt, the Prussian philosopher and minister of education, established a university in Berlin with the unity of teaching, research and graduate education as one of its basic principles (Albritton, 2006). The teaching efforts of all academics were directed towards the production of either future investigators or future professionals whose work depends upon a sophisticated knowledge base. This 19th

century German model of higher education was the model emulated by several of what were to become the most prestigious universities in the United States.

Newman had quite a different view of the purpose of an undergraduate education. In 1852, he wrote his treatise called "The Idea of a University", a work still widely regarded as the most influential attempt to define a university education. Newman defends the value of learning for its own sake and vigorously opposes the notion of specialisation. According to Newman, undergraduate education "is the education which gives a man a clear conscious view of his own opinions and judgments, a truth in developing them, an eloquence in expressing them, and a force in urging them."

During the early years of the 20th century, undergraduate curricula at leading universities worldwide gradually evolved in a direction which is a compromise between the broad undergraduate education espoused by Newman and von Humboldt's philosophy that a student study one particular subject in depth. Breadth is achieved by requiring students to take courses in the arts and sciences while depth is achieved by requiring students to select a major in which a student is required to take a prescribed number of modules in a single discipline.

For example, at Yale University in the U.S.A., an undergraduate must take 36 courses over 4 years. *Breadth* (*distribution*) is achieved by requiring students to take at least two courses in the arts and humanities, two courses in the sciences, two courses in the social sciences, two courses in quantitative reasoning, two courses in writing skills, and at least one course to further their foreign language proficiency (Yale University Academic Requirements, 2010). Thus at least 11 - or almost 1/3 - of a student's total of 36 courses are employed to meet the requirement of breadth. *Depth (concentration)* is achieved by requiring students to select a major from among the more than 70 major programmes available. A major programme usually includes 12 courses in a single discipline taken for the most part in the final 2 years.

In Ireland, there is now some element of elective choice by students in practically all undergraduate programmes. The most common use of elective choice is to allow students to specialise in later years in particular areas of their main discipline. Elective options that allow students to explore other disciplines outside of their main area of specialisation have been much rarer. University College Dublin (UCD) has been at the vanguard of leading universities by introducing significant elective choice for students throughout most of their undergraduate years (UCD Horizons, 2005). This initiative will be more fully described in the next section.

There have been numerous calls to broaden the education of engineers and thus prepare them to serve society with an awareness of and sensitivity to the cultural, political, economic and social dimensions of their work (Canadian Academy of Engineering, 1999). This paper will present the experience of two disciplines in the College of Engineering Mathematical and Physical Sciences in UCD, namely, Civil Engineering and Computer Science, in providing a broader education through the provision of non-programme electives for their students.

## 2. UCD HORIZONS

In keeping with the philosophy of Newman, the founder of UCD, the introduction of the UCD Horizons initiative in 2005 resulted in the development of fully-modularised, semesterised and credit-based degree programmes. Modular degrees provide a more flexible, faster and cost-effective way to educate the growing number of students entering third-level education (Betts and Smith, 1998). Under the re-structured curriculum at UCD, in a given academic year, students choose *core* modules from their specific subject area, a number of *options* (if applicable) and *elective* modules, which can be chosen from within the student's programme of study (in-programme electives) or from any other programme across the entire University (non-programme or general electives). The philosophy underlying this curricular transformation is to give the freedom of choice to students to broaden their knowledge in different areas or deepen their knowledge in their chosen programme of study. Crucially, Horizons facilitates the formation of 'creative and innovative graduates', central to UCD's Strategy for Education and Student Experience (2009 – 2013).

General electives can be categorized as being either: (a) general interest (e.g. improving foreign language competence) or (b) generic/transferrable skills (e.g. research skills). The evolution of general electives at UCD and their impact on the undergraduate Civil Engineering and Computer Science Programmes since the inception of the Horizons initiative will be described below. The general modular structure at UCD is summarized in Table 1.

| **Module** | | **Comment** |
|---|---|---|
| Core | | Students are required to take these modules |
| Options | | Students may be required to select a number of modules from a specified suite of modules |
| Electives | In-programme | Students can select a maximum of 2 modules from a suite of modules offered by the programme |
| | General | Students can select a maximum of 2 modules from any programme across the University, subject to timetable and space restrictions |

**Table 1 General modular structure at UCD**

## 3. ELECTIVE POPULARITY ACROSS UNIVERSITY

The highest demand for elective places across the University is in modules offered by the Colleges of Arts and Human Sciences and that particular subject areas in these Colleges are significantly more popular than those in the other Colleges of the University (Table 2). In the context of the present discussion, examination of Table 2 shows that Computer Science features amongst the list of most popular general electives, while no general electives offered by Engineering feature. A more detailed analysis of the data pertaining to these two disciplines will be presented below.

| Subject area | Number of students |
|---|---|
| Languages | 2009 |
| Nursing Studies | 1614 |
| Psychology | 846 |
| Economics | 765 |
| Sports Management | 678 |
| Computer Science | 673 |
| Politics | 644 |
| History | 605 |
| Physiotherapy | 602 |
| Philosophy | 589 |
| Law | 560 |
| English | 515 |
| Geography | 401 |

Source: Michael Sinnott, Director of Administrative Services, Registrar's Office, UCD

**Table 2** Subject areas with largest number of elective places taken in 2008-2009

## 4. CIVIL ENGINEERING

The UCD Civil Engineering bachelor's degree has traditionally been a four-year 240-credit degree programme, although, in line with Engineers Ireland and the Bologna requirements, is moving gradually to a two-cycle 5-year degree structure. Table 3 outlines the number of core, option and elective modules that students of the current 4-year Civil Engineering programme take in each Stage (Year) of their studies.

| | Core | Option | Elective |
|---|---|---|---|
| **Stage 1** | 10 | 0 | 2 |
| **Stage 2** | 10 | 0 | 2 |
| **Stage 3** | 10 | 0 | 2 |
| **Stage 4** | 8 | 4 | 0 |

**Table 3** Modular structure of the 4-year Civil Engineering degree programme

In respect of the elective choice, students can choose either:

(a) two in-programme electives which enable students to deepen their engineering knowledge,
(b) two non-programme (general) electives which allow students to widen their knowledge in modules of general interest to the student or
(c) one in-programme elective combined with one general elective.

In-programme electives are provided in stages 2 and 3. For example, for second year Civil Engineering, the following in-programme electives are offered:

CVEN20100 Applied Mechanics

MEEN20030 Applied Dynamics

MEEN10020 Materials Science

EEME10010 Energy Challenges

The popularity of the electives for the 2008-2009 academic year is shown in Fig. 1. The Figure is presented in terms of 'student equivalents' (2 elective modules per student). It should be noted that students could choose two in-programme electives, two non-programme electives or one in-programme elective plus one non-programme elective. Examination of Fig shows that less than a third of the students (28%) choose electives from within the programme, while more than two-thirds (72%) of the students chose from 60 modules outside the programme across the University. Note that the number of core module student equivalents does not exactly equate to the sum of the in-programme and non-programme student equivalents because the numbers include repeat students. It is also interesting to examine the popularity of engineering electives vis-à-vis students from outside the programme. In respect of the four in-programme electives listed above, only 19 in number of the 378 students (5%) taking these four electives were non-engineering students.

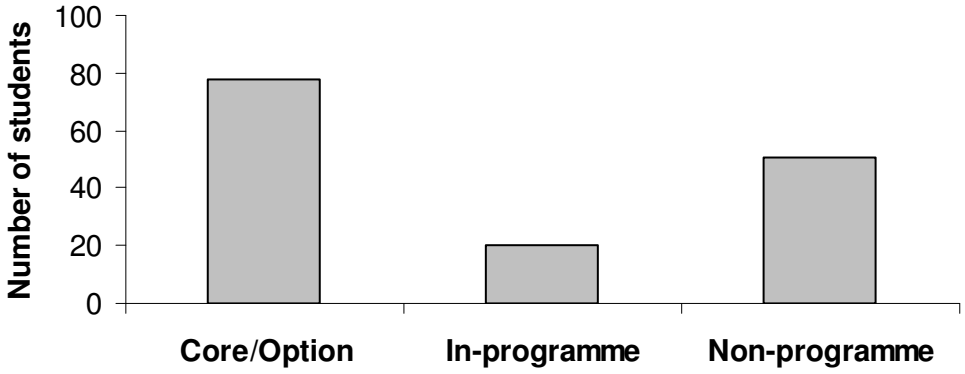


**Fig. 1** Popularity of elective provision for second year Civil Engineering in 2008-2009

## 5. COMPUTER SCIENCE

UCD offers fours programmes through which students can obtain degrees in Computer Science. The BSc (Computer Science) and BA (Computer Science) programmes, taken by most students who take a degree in Computer Science, are four-year 240-credit degree programmes. Students can also obtain a four-year 240-credit degree in Computer Science through the general BSc programme and a three-year 180-credit degree through the general BA programme. While this multiplicity of offerings is somewhat complex, it does offer students a huge choice and enormous flexibility, both in terms of the amount of Computer Science they may study and the other modules they may take. This flexibility is demonstrated in Table 4, which gives an outline of the number of Core (C), Optional (O) and Elective (E) modules students studying Computer Science may take in each of the Stages of their studies.

| | BSc (Computer Science) | | | BA (Computer Science) | | | B Sc | | | BA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | O | E | C | O | E | C | O | E | C | O | E |
| Stage 1 | 5 | 5 | 2 | 4 | 6 | 2 | 4 | 6 | 2 | 4 | 6 | 2 |
| Stage 2 | 7 | 3 | 2 | 6-10 | 0-4 | 2 | 7 | 3 | 2 | 4-10 | 0-6 | 2 |
| Stage 3 | 10 | 0 | 2 | 6-10 | 0-4 | 2 | 10 | 0 | 2 | 4-10 | 0-6 | 2 |
| Stage 4 | 12 | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 0 | N/A | N/A | N/A |

Key: **C** = Core module **O** = Option module **E** = Elective module

**Table 4** Summary of the types of module available in each Stage of the various Computer Science degree programmes in UCD.

While the original stated intention of the provision of electives in the Horizons system was to allow students to broaden their education through taking modules of general interest to them, Schools were subsequently encouraged to provide "in-programme" electives to allow students "go deeper" in their subject, i.e. facilitate students in taking extra modules, thereby allowing them to study their chosen subject to an even greater depth. The School of Computer Science and Informatics embraced this idea and immediately offered four non-programme elective modules in Computer Science:

COMP 20090 Introduction to Cognitive Science
COMP 20100 E-Learning: IT in Education
COMP 20130 Introduction to Computer Forensics
COMP 20140 Introduction to Project Management.

The first of these modules is a Level 1 (1st year level) module and may not be taken by Computer Science students; all the others are at Level 2 (2nd year level) and may be taken by Computer Science and other students in Stages 1, 2 and 3 (Years 1-3).

The goals of the School of Computer Science and Informatics in providing these general non-programme electives may be summarised as follows:

- To provide the opportunity for Computer Science students to study the subject in greater depth, as outlined above;
- To give non-Computer Science students the opportunity to study some Computer Science modules and thus gain some exposure to the subject;
- To give Computer Science staff the opportunity to design and give an introductory module in their specialist area or an area of research in which they have an interest.

The popularity of the electives for the 2008-2009 academic year is shown in Fig. 2. In respect of the four in-programme electives listed above, 191 in number (46%) of the total number of students (414) taking in-programme electives were non-programme students.

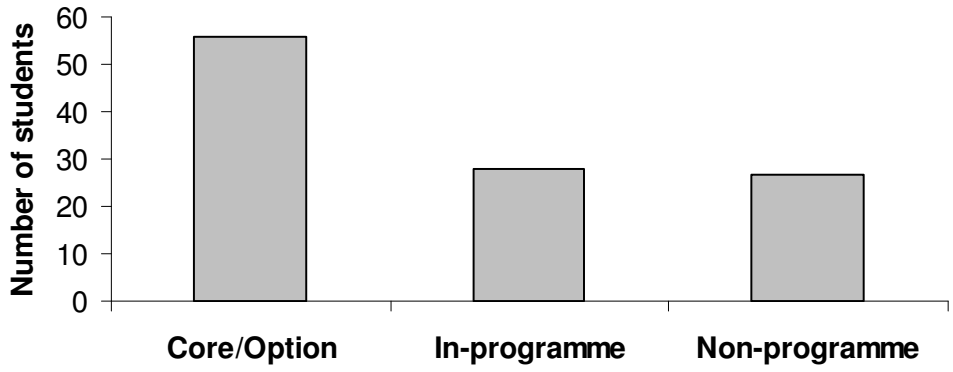


**Fig. 2** Popularity of elective provision for second year Computer Science in 2008-2009

## 6. CONCLUSIONS

Examination of the data presented above shows that a significant number of the students (approximately two-thirds of Civil Engineering students and approximately half of Computer Science students choose electives outside their programme areas of study). Few non-Civil Engineering students (5%) avail of electives offered by the programme, while in the case of Computer Science a significantly greater number (46%) avail of the opportunity to study Computer Science elective modules.

## 7. ACKNOWLEDGMENTS

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