General Electives in Civil Engineering, Computer Science and Social Science

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Abstract

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 [1]. This paper will present the experience at University College Dublin (UCD) in providing a broader education through the provision of non-programme electives for their students. In 2005, UCD introduced the Horizons initiative that resulted in the development of fully modularised, semesterised and credit-based degree programmes [2]. One of the key features of the initiative was the introduction of an element of elective choice for students in the first three years of their undergraduate studies. In each year, students can select two modules out of the twelve modules they take from any programme across the University. The proposed paper will examine the impact of the Horizons initiative on three disciplines in University College Dublin, namely, Civil Engineering, Computer Science and Social Science. Examination of the data shows that 72% of Civil Engineering students, 47% of Computer Science students and 16% of Social Science students avail of the opportunity to study modules 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 and the popularity of Social modules to non-programme students ranged from 6% to 27%, depending upon the module on offer.

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 [1]. The teaching efforts of all academics were directed towards the production of either future

investigators or future professionals whose work depended 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 [2]. 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 studies 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 four 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 [3]. Thus at least eleven - 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 two 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 [4]. 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 [5]. Engineers Ireland requires that, in addition to the normal technical competence expected of a professional Engineer, graduates must be able to demonstrate:

- An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment;
- The ability to work effectively as an individual, in teams and in multi-disciplinary settings together with the capacity to undertake lifelong learning;
- The ability to communicate effectively with the engineering community and with society at large [6].

One of the key objectives of introducing general electives into the undergraduate engineering curriculum at UCD was to develop the non-technical attributes listed above in engineering students graduating from UCD. The paper will compare the experience of an engineering discipline with two non-engineering disciplines in providing a broader education through the provision of a small number of non-programme elective modules 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 [7]. 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). Students can select two modules out of the twelve modules they take each year from any programme across the University. 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 graduates that are 'intellectually flexible and globally engaged', central to UCD's Education Strategy 2009 – 2014 [8].

Table 1: General modular structure at UCD

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 per year from a suite of modules offered by the programme
	General	Students can select a maximum of 2 modules per year from any programme across the University, subject to timetable and space restrictions

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, Computer Science and Social Science Programmes since the inception of the Horizons initiative will be described below. The general modular structure at UCD is summarized in Table 1.

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. 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.

Table 2: Subject areas with largest number of elective places taken

in academic years 2008-2009 and 2009-2010

Subject area	**Number of students**	
	2008 - 2009	**2009 – 2010**
Languages	2009	1183
Nursing Studies	1614	1663
Psychology	846	1041
Economics	765	565
Sports Management	678	365
Computer Science	673	676
Politics	644	574
History	605	277
Physiotherapy	602	530
Philosophy	589	586
Law	560	664
English	515	392
Geography	401	378

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

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 five-year degree structure. Table 3 outlines the number of core, option and elective modules that students of the current four-year Civil Engineering programme take in each Stage (Year) of their studies.

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

	Core	Option	Elective
Stage 1	10	0	2
Stage 2	10	0	2
Stage 3	10	0	2
Stage 4	8	4	0

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

Figure 1 shows the type of electives chosen by second year Civil Engineering students in the 2008-2009 academic year. The data is presented in terms of 'student equivalents' (two 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 Figure 1 shows that less than a third of the students (28%) chose electives from within the programme, while more than two-thirds (72%) of the students chose from 60 modules from other disciplines across the University (outside the Civil Engineering programme). Of the 60 general electives chosen, the number of civil engineering students per module typically varied from a minimum of 1 student to a maximum of 4 students, with the exception of a biosystems engineering module which attracted 10 civil engineering students. It is also interesting to examine the popularity of engineering electives vis-à-vis students from outside the civil engineering 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.

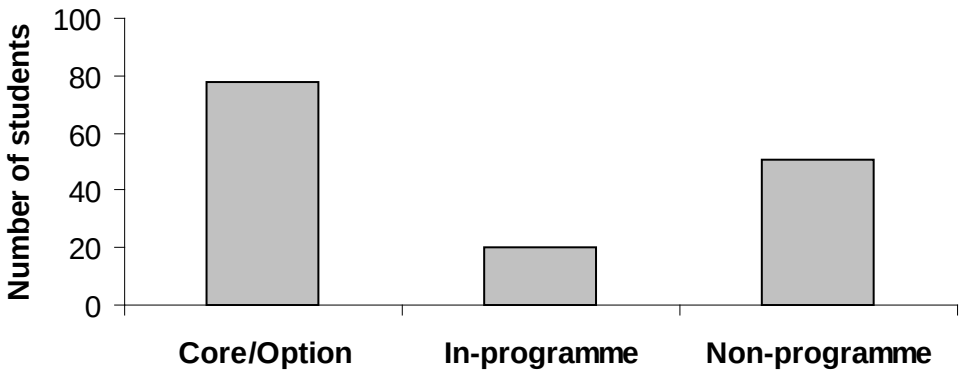

Figure 1: Popularity of elective provision for second year Civil Engineering in 2008-2009

5. Computer Science

UCD offers four 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 to 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.

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

	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

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 general elective modules in Computer Science, which could be availed of as in-programme electives by Computer Science students or as non-programme electives by students from outside the Computer Science programme:

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.

Figure 2 shows the type of electives chosen by second year Computer Science students in the 2008-2009 academic year. Examination of the figure shows that 47% of computer science students avail of the opportunity to study modules outside their programme area. 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.

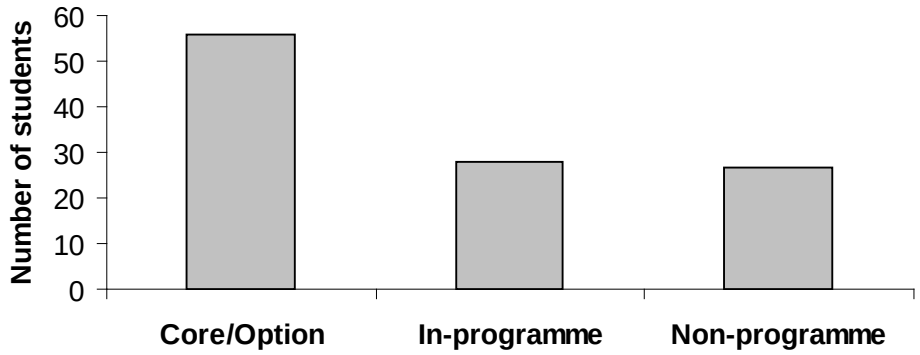

Fig. 2: Popularity of elective provision for second year Computer Science in 2008-2009

6. Social Science

UCD offers an undergraduate degree programme in social science (B.Soc.Sc.). There is a core curriculum for all students, but there are also opportunities for students to choose specific pathways in line with their special interests. The programme is divided into three stages.

In stage 1, the core subject areas are Social Policy and Sociology. Each student takes 4 core modules in each of these subject areas and 4 other modules (either in-programme modules, elective modules, or a combination of both). The in-programme modules include: Geography, Psychology, Politics, Economics, Archaeology and Information Studies. The electives can be chosen from any school throughout the University, subject to timetabling restrictions. In stages 2 and 3, a social science student can choose from any one of seven programme pathways (Table 5).

Table 5: Outline of Social Science undergraduate curriculum

	Core		**Options**	**Electives**
Stage 1	Social Policy (4 modules)	Sociology (4 modules)	2 modules	2 modules
Stages 2 and 3	7 pathways (social work, policy analysis, crime and social order, advanced research, information studies, environmental, and human and organizational paths)			

The social science degree is therefore an attempt therefore to offer both breath across the many disciplines within the social sciences and also depth through concentration on two major subject choices. The opportunity to select options/electives in all stages of the programme enables social science students to select modules that give increased depth in some area of special interest or add breath by expanding the range of areas they explore.

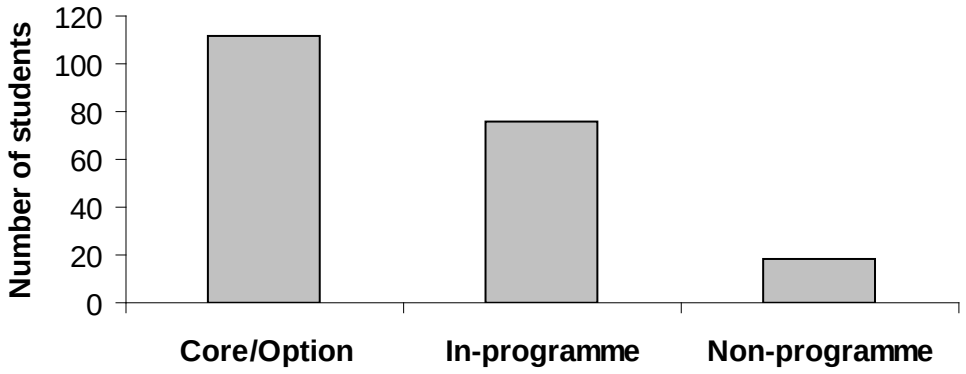

Fig. 3: Popularity of elective provision for second year Social Science in 2008-2009

Figure 3 shows the type of electives chosen by second year Social Science students in the 2008-2009 academic year. Examination of the figure shows that only 18 (16%) social science students take the opportunity to study electives outside their programme. The popularity of Social Science modules to non-programme students ranges from 6% to 27%, depending upon the module on offer.

7. Conclusions

Examination of the data presented above shows that 72% of Civil Engineering students, 47% of Computer Science students and 16% of Social Science students avail of the opportunity to study modules outside their programme areas of study. Few non-Civil Engineering students (5%) avail of electives offered by the programme;in the case of Computer Science a significantly greater number of non-programme students (46%) avail of the opportunity to study Computer Science elective modules; in the case of Social Science, the popularity of Social modules to non-programme students ranged from 6% to 27%, depending upon the module on offer.

The rationale for introducing elective modules into the undergraduate curriculum at UCD was to provide the opportunity for students to broaden their knowledge of other disciplines. In the case of Civil Engineering students, the data shows that a majority of the students opt to take modules outside their core programme and that this breadth of study should contribute to these students meeting the non-technical competences expected of professional engineers.

8. Acknowledgements

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