The roles of General Education Courses in engineering curriculum

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***Abstract**: The paper discusses the role and importance of general education in engineering curricula. It describes the general education requirements in accreditation of engineering programmes. Using global trend, the paper focuses on the experiences of the University of Botswana in introducing general education courses for the purpose of broadening the educational experience of engineering students. Results indicate that engineering students mainly took general education courses (GECs) offered by the science and technology disciplines. It is argued that GECs should remain as part of the curriculum but the student advisory system should be improved and that GECs should not be used to provide for competences important for the professional development. Instead, such issue should be embedded and attended to in core courses.*

Introduction

Modern societies where knowledge is driving global economies have seen a trend developing in universities curricula where students are offered more than just disciplinary courses for a given academic programme. Whilst the subject specific course offerings are always treated as the core to engineering degrees, offerings from disciplines such as business, law, the humanities and communication are often required as complementary studies, electives or general education (GE) modules. The primary motivation for such courses is to broaden the knowledge of the graduates and the assumption is that a graduate from such a rich blend of academic courses would be ready for the integrated world of work beyond the academic environment. Job advertisements for fresh graduates often seem to confirm this expectation or demand of a multi-skilled employee by emphasising the advantaged position of candidates who understand the business imperatives of work settings in addition of course to the core engineering skills expected of any engineering graduate.

Accordingly, current requirement in engineering curricula is that engineering graduates should, apart from being educated in a particular engineering field, be grounded in financial, ethical, legal, economic, environmental fields and be knowledgeable about socio-cultural issues of the society in

which they work. In order to achieve such attributes GE elements have been infused into the curricula to such an extent that they have become vital components of engineering education (Smerdon, 2001).

GE as a requirement for accreditation of engineering programmes

Accreditation is currently a desired benchmark for any engineering programme. Engineering programmes in different countries are designed to satisfy the accreditation requirements imposed by national professional bodies to allow graduates achieve the professional engineer status. The recognition and equivalency of the engineering programmes in different countries is determined according to the Washington Accord (International Engineering Alliance, 2009), which provides a mechanism for mutual recognition of engineering qualifications obtained in member countries.

The Washington Accord includes elements of GE or complementary studies in the attributes and professional competency profiles for graduate engineers (ABET, 2009). Engineering education should become more flexible and must not only teach the fundamentals of engineering theory, experimentation, and practice, but should prepare students for a broad range of careers and life-long learning (Shuman, Besterfield-Sacre and McGourty, 2005). GE may not be listed as a formal condition for accreditation but it is indeed required in all engineering programmes (Mathur and Venter, 2000, Webster, 2000, Wasser, 2005).

Academic programmes at the University of Botswana

University of Botswana (UB) is currently the only tertiary institution in Botswana offering degree programmes in Engineering. The University was established in 1982 and had no engineering faculty until the erstwhile Botswana Polytechnic was incorporated as the Faculty of Engineering and Technology (FET) into the University in 1996.

FET is relatively small compared to other faculties of the university. There are four engineering programmes leading to a B.Eng degree in Construction Engineering & Management, Civil Engineering, Electrical/Electronic Engineering and Mechanical Engineering. The programmes commence with the first year (post "O level") within the Faculty of Science. It is followed by a transfer of engineering students to FET, where they follow a Common Engineering Year 2 curriculum. After one year of fundamental courses in engineering the students then specialise in different disciplines in Years 3, 4 and 5.

Prior to 2002 UB followed a subject based system of mainly year-long courses and the progression from year to year was dependent on passing a certain number of courses during the end-of-year-examinations held once a year. In 2002 UB undertook a major reorganization of its academic programmes by changing from the subject based system to a semester system with course credits and grade point averages.

It was envisaged that conversion to the new system would stimulate a university wide curriculum review which would achieve, among other objectives, a holistic approach to common courses with transferable skills. Such courses should be part of a much broader concept of GE modules, which would be more effective to deal with general knowledge topics.

Introduction of GECs at UB

Semesterised programmes consist of four categories of courses; namely core, optional, elective and GE. All students at UB were compulsorily required to take GECs. However, in order not to compromise the content of each academic programme the regulation was set that at least two thirds of the total credits required for graduation should consist of core and optional courses. The remaining one third of the credits is from GE and elective courses. Elective courses were defined as courses that count towards the requirements of an award but are not core or optional courses required for a particular programme.

The GE courses were to address such crosscutting issues as employers' expectations, competence in communication skills, ICT and information skills literacy, gender, HIV/AIDS, environment, energy, cultural diversity, and globalisation. General Education courses were not specific or specialized courses but general enough to be grasped by non-specialists in a particular discipline.

GEC was introduced without any restrictions on students' registration but the students were allowed to take elective courses only from their subject areas. Therefore, it was possible for a student to take a GEC from his/her department.

Each GEC was generally assigned 2 credits which are equivalent to 2 lecture hours per week for a 15-week semester.

The minimum number of credits to be passed from GE was 16 but with the following specific conditions (University of Botswana, 2008):

- at least four credits in courses in Areas 1 and 2 in each of the first two semesters of study,
- at least two credits from Area 3 and
- the balance from at least two other areas.

The GECs were grouped into 7 areas as shown in Table 1. Each of the areas was to have a set of courses at different levels, and students from any Faculty could enrol in such courses.

Table 1: General Education Course Groupings at UB (University of Botswana (2008))

Area	Description	Objective
1	Communication and Study Skills	To promote acquisition of better communication of ideas and study habits.
2	Computer and Information Skills	To promote the utilization of computers and Information Technology in University studies and to provide vital life long skills.
3	Modes of Inquiry and Critical Thinking	To gain an awareness of various methods of inquiry and promote how to think critically in the academics and life in general.
4	Physical Education, Health and Wellness	To encourage students to develop a physically active way of living and adopt positive attitudes to health so as to enrich the quality of life.
5	Sciences and Technology	To promote understanding of the contribution of science and technology in life.
6	World Civilisation	To promote an understanding of the diversity and complexity of different world cultures.
7	World Economy and Business Skills	To instil an appreciation of how economic and business activities shape human affairs, nationally, regionally and internationally.

Methodology of Study

Students' registration was captured on the integrated tertiary software (ITS) system which is commercial software with proprietary capabilities. The ITS provides fully integrated enterprise resource planning administrative software systems to support various functions and processes of the university such as financial and student systems. Although the systems within the ITS suite are fully integrated with one another, it is possible to utilise individual systems in a flexible and modular way (Integrated Tertiary Software, 2008). Excel software was used to manage, analyse and present the results.

Results and Discussion

The introduction of the GECs were intended to broaden the knowledge of students, giving them the chance, or even forcing them, to take some courses outside of their main area. The quite obvious question however is whether the implementation has been successful and whether it is really serving its purpose. In order to make the assessment, the analysis of number of students registered for GE courses in the 5 academic years (from 2001/02 to 2006/07) is presented graphically in Figures 1 to 4 below. Special concern has been given to engineering students as they should have benefited the most from taking courses in areas different to science and engineering.

The results shown do not include the 4 compulsory courses in Year 1 in Areas 1 and 2 (Communication and Study Skills 1 & 2 and Computing & Information Skills Fundamentals 1 & 2). Also, it should be bear in mind that although regulations required students to obtain at least 16 credits from GECs (equivalent to at least 8 courses) some students did not fulfil these requirements. The non-compliant students were those following "transitional regulations" (i.e. for students who were

registered in the programmes before semesterisation was introduced) which were less restrictive on GE requirements.

Figure 1 shows that engineering students are a tiny speck in the GEC landscape at the University of Botswana, a fact further amplified in Figure 2 which shows engineering students are overly represented in Area 5; the area in which they normally study, being science and technology subject area. In fact, more than 70% (Figure 2) of engineering students, study a GEC coming from their own faculty.

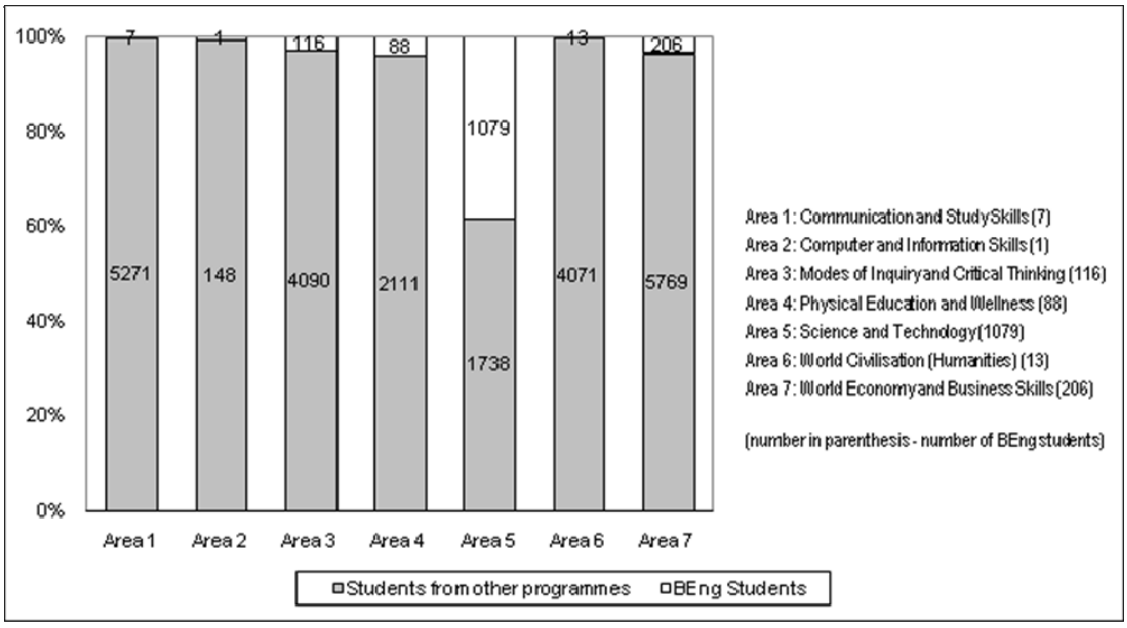

Figure 1: Student registration among GEC course at UB.

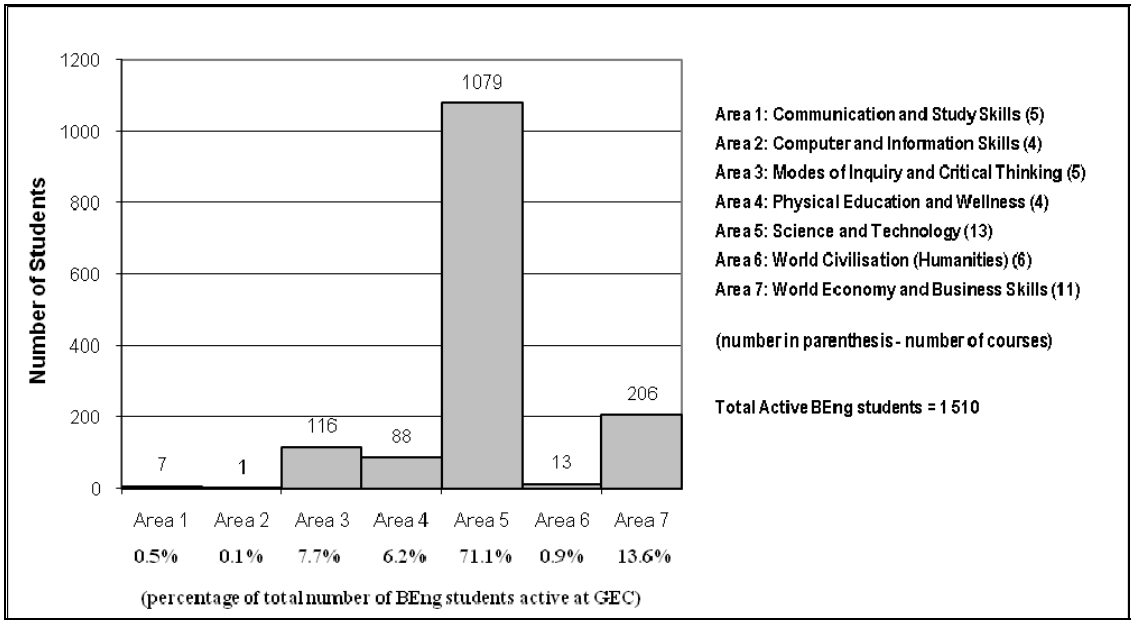

Figure 2: Registrations of Engineering students in GEC areas at UB.

Figure 3 further confirms the popularity of GE courses in engineering as choices for engineering students. In fact the four most popular GECs for engineering students come from the engineering faculty. Conversely, when it comes to knowledge area science and technology only 18 students (from a potential pool of more than 11000) of other UB students have taken GECs offered in the faculty of engineering (Fig. 4). One abiding truth can be gleaned from this, whilst engineering students are not

getting the broad education that GECs were designed for (to gain knowledge in business, the humanities, law and others) the same is equally true of other non-engineering students who may be deficient in science and technology part of their university education.

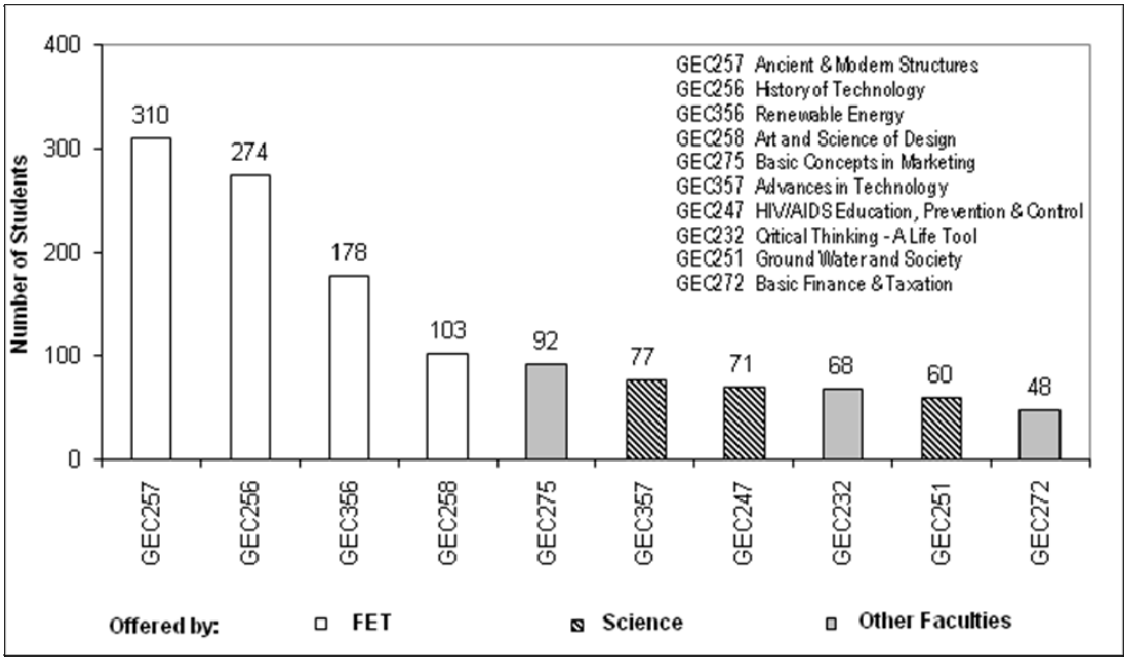

Figure 3: GEC Course Popularity for Engineering Students

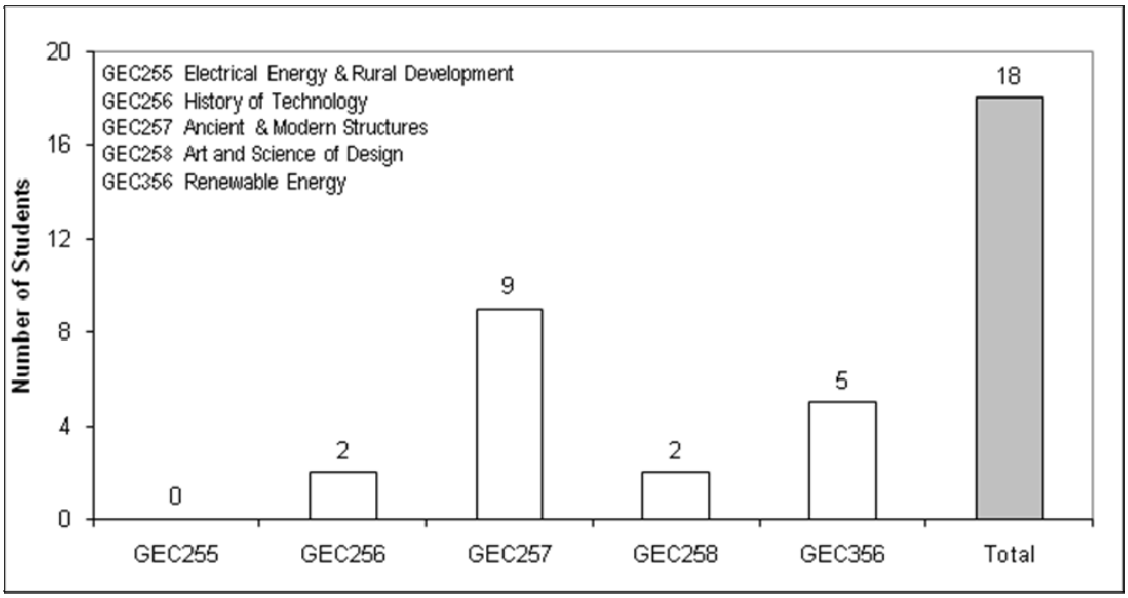

Figure 4: Registration of other UB Student taking GEC Course offered by the Engineering Faculty

Conclusions

The idea that every university graduate should have some general knowledge not only in his/her area of specialization is fully understandable and rational. A common expectation that a graduate should be all-rounded and conversant with financial, moral, legal, economic, environmental and cultural obligations cannot be realized without GE elements in curricula. The above applies also to an engineering graduate and hence the GECs, or more implicitly GE component, are a vital element of engineering education. The introduction of GECs at UB had exactly the same purpose. However, the implementation of GECs has failed to achieve the desired purpose of "broad-based educational experience". The picture for engineering students has been especially less successful. They have

principally participated in GE provided "in-house", that is within their faculty or worse within their departments. So what lesson can we learn from the whole exercise? Should we still try to retain such courses in the curriculum of the engineering students?

The answer to the second question is a definite "Yes"; we should still continue to seek ways in which the elements of general knowledge can be introduced to engineering students. They would definitely need it, especially after graduation. Whether specially prepared GE courses is the solution to the above is however a separate dilemma. We consider that the concept of specially prepared GECs as offering an avenue for broadening the knowledge base should be discarded in favour the existing electives options. Electives (across all faculties and knowledge areas) so offered should be availed by each department as a list from which students make their choices. Another lesson learnt is that GECs are not the proper way to ensure skills important for professional development. The results of GECs in areas of Communication Skills and Competence in IT and Information Skills are deeply disappointing and especially pronounced for engineering students. In order to improve Communication Skills and Computer Skills for students taking professional courses, it is necessary to prescribe such courses as core in the curricula and also incorporate these skills into other core courses.

Finally, a well defined and effective advice system for students would enhance selection of GE courses. Before semesterisation, the University adopted a system of "course tutors by year of study" to engage and advise cohorts of students. However that system was terminated with the introduction of semesterisation. With hindsight it seems that the erstwhile system should have been retained and improved upon such that a student and an advisor could sit down to select course offerings outside the core engineering curricula that would enhance a student's professional skills and competencies. One to one student-advisor services would allow for students' future career aspirations to be catered for in choosing the course mix.

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