The Engineering Augmented Degree Programme: increasing access and success in engineering

by Prof Diane Grayson

The development of foundation programmes has taken many forms, and the University of Pretoria (UP) is about to launch a new, more comprehensive Engineering Augmented Degree Programme to better prepare students for mainstream studies and careers in engineering.

In the 1980s, a few South African universities began to offer courses designed to help students from township and homeland schools succeed in science and engineering. It was recognised that the teaching of mathematics, physical science and English at many of these schools was very poor. As a result, many talented students achieved low marks – too low to grant them access to university science or engineering degrees under normal circumstances.

Universities thus began to develop ways of identifying students with potential and allowing them to register through alternative access routes. By the end of 2000, most universities in South Africa offered some form of foundation year programme, and most of these programmes were successful in enabling students from disadvantaged backgrounds to succeed in science-related studies, at least at higher rates than students from similar backgrounds who did not attend the programmes.

The various special programmes around the country were generally characterised by well-designed curricula incorporating both content knowledge and cognitive skills, taught in small groups by committed and skilled teachers. Unfortunately, these programmes rarely impacted on the teaching approaches or curricula of the mainstream programmes, and many students experienced an enormous shock when they entered first-year mainstream lectures.

In 2007, the national Department of Education thus instructed universities to stop offering add-on programmes, and to develop properly articulated extended degree programmes. Where, in the past, credits obtained during foundation programmes did not count towards the degree, the Department of Education required all courses to be credit-bearing. Furthermore, it was stipulated that to qualify as an extended degree programme, at least 0.5 of the Higher Education Management and Information System (HEMIS) credits allocated to a degree (a total of four for engineering) should be foundational in nature. They also made funds available to support extended degree programmes.

As the regulatory environment has become more conducive to offering extended degree programmes, the case for such programmes has become more compelling. Scott et al (2007) conducted a tracer study of the cohort of students who entered universities, both traditional universities and universities of technology, in 2000. Their findings are sobering. After five years, only 30% of all students entering universities or technikons for the first time had graduated, 14% were still registered and 56% had left without graduating. For engineering, only 32% of registered students graduated in the regulation time of four years, and 54% had graduated after five years. Since these are some of South Africa's brightest students, we cannot afford such high attrition rates.

Extended engineering degree programme at the University of Pretoria

In 1994, the School of Engineering at UP began to offer an extended degree programme called the Five-Year Study Programme (5YSP). This programme was not extended in the sense used by the Department of Education today. Instead, it extended the length of the degree, allowing students more time to find their feet and get used to the pace of work at the University. Extra tutorials were offered in some of the first-year modules. The 5YSP students also took a specially designed foundation module, Professional Orientation (JPO), to help develop communication, mathematics, technology, IT and life skills.

As the years passed, the student intake changed from those who came from an educationally disadvantaged background to those who did not obtain high enough marks to enter the mainstream programme, regardless of their background. Student numbers increased from 73 in 1994 to 232 in 2009. Extra tutorials are no longer compulsory in all first-year modules, and less than half of the students now take JPO. Graduation rates in the 5YSP show a large racial divide, with 65% of white students and only 23% of black students who started in 2003 completing after six years. A new problem that was identified in 2009 is that the first recipients of the new National Senior Certificate who entered universities in 2009 seem to be struggling more than previous first-year students. It is time for a new kind of programme to allow more students to graduate as engineers.

The Engineering Augmented Degree Programme (ENGAGE)

Early in 2009, a process began to explore whether it would be desirable and feasible to offer a new extended degree programme in engineering that would meet the Department of Education's criteria and better address the needs of more students. In designing a new curriculum, it was assumed that as the level of the course (1, 2, 3 or 4) increases, so does:

- the degree of complexity;
- the amount of prior knowledge required;
- the demand for higher-level thinking skills; and
- the need for independent learning skills.

1. The workload should be high throughout the degree (about 60 hours per student per week during the semester).
2. Early on in their studies, students need more of their learning time to be structured and supported. As they reach higher levels, they should be able to spend more time learning independently.
3. There should be 'impedance matching' as far as possible between the characteristics of the teaching input and the characteristics of the students at different levels.
4. Sharp discontinuities in demand and volume of work from year to year should be avoided. As students progress from year to year, they become capable of doing more work (greater volume and cognitive demand) in the same time. The volume of work should increase steadily over a period of time.
5. In general, students should encounter the more familiar early on in the degree, and the less familiar later on.

→ *1. Curriculum design principles for the new extended degree programme in engineering.*

For the purposes of the design, 'workload' was defined as the number of hours the student works, including lectures, practicals, tutorials and time spent studying alone or with other students, while 'volume of work' was defined as the amount of content that is covered. Figure 1 shows the design principles that were developed to guide the construction of the new curriculum.

The implications of the design principles include the following:

1. Students need to register for a small number of mainstream courses with considerable extra, formal support at the beginning of their programme. This ensures a high workload in terms of time on task, improves students' time management and discipline, provides structured opportunities to get help, and increases students' ability to gauge their own level of understanding. In first-year modules, this support will take the form of augmented modules, which will help students acquire the thinking skills, conceptual

→ *The Engineering Augmented Degree Programme (ENGAGE) improves students' preparedness for mainstream studies and careers in engineering.*

understanding and background knowledge that are assumed to be in place by the lecturers of the mainstream courses.

2. As time goes by, the amount of structured, formal support needs to be phased out.

3. The volume of work should be increased continuously over the programme. Modules at the higher levels should cover more material in the same time as those at lower levels. In later years, students will take a larger number of distinct subjects than in earlier years.

4. Subjects related to school subjects should be done early on, while unfamiliar subjects should be introduced later. Thus, Physics and Chemistry should be done in the first year, while introductory engineering subjects, such as Materials Science and Graphical Communication, should only be done in the second year.

In the new Engineering Augmented Degree Programme (ENGAGE), first-year mainstream modules are augmented with additional modules, which are classified as foundation modules. For each 16-credit, level 1 module, students will take a compulsory eight-credit additional module at the same time. As with the old 5YSP, students will take the mainstream subjects of the first two years of the BEng degree over three years. Initially, high workload and low volume of work are attained by having students take a combination of mainstream and foundation modules. Over the next two years, the workload remains high, while the volume of work increases. This is done by gradually increasing the number of mainstream credits until they are not far below the 72 credits for which students will register in the first semester of their fourth year. At this point, ENGAGE students will join the mainstream third-year students for their last two years.

All ENGAGE students will also take Professional Orientation in the first year, a foundation module that includes life skills, projects and an introduction to IT and technology. The table below shows the curriculum for the first two years for all first-year engineering students, except Chemical and Computer Engineering. In the first year, 43% of the credits are foundation modules, in the second year, this goes down to 27%. In the third year, students take the remaining level 2 modules. The number of credits is a little lower than for mainstream students, because two of the level 2 mathematics modules are taken in the second year. In the last two years, they join the mainstream students and take the standard level 3 and level 4 modules.

FIRST YEAR			
Semester 1 modules	**Credits**	**Semester 2 modules**	**Credits**
Chemistry	16	Physics	16
Calculus	16	Linear Algebra	8
Professional Orientation	8	Calculus	8
Additional Chemistry	8	Professional Orientation	8
Additional Mathematics	8	Additional Physics	8
		Additional Mathematics	8
Total mainstream	32	Total mainstream	32
Total foundation	24	Total foundation	24
SECOND YEAR			
Computer Literacy	4	Information Literacy	4
Community-based Project	4†	Community-based Project	4†
Graphical Communication	16	Materials Science	16
Electricity and Electronics	16	Mechanics	16
Differential Equations (level 2)	8	Numerical Methods (level 2)	8
Additional Electricity and Electronics	8	Additional Materials Science	8
Additional Graphical Communication	8	Additional Mechanics	8
Total mainstream	48	Total mainstream	48
Total foundation	16	Total foundation	16

† *Effective credits, since this is an eight-credit course spread out over two semesters*

The School of Engineering plans to offer the ENGAGE programme for the first time in 2010. Students whose mathematics and physical science marks in Grade 12 are one level too low to qualify for the four-year programme or who meet the requirements but feel they need more support will be eligible for ENGAGE.

The School of Engineering hopes that ENGAGE will allow many more students to obtain engineering degrees over the next few years.

References

1. Scott, I, Yeld, N and Hendry, J. (October 2007). A case for improving teaching and learning in South African Higher Education. *Higher Education Monitor,* No 6, Council on Higher Education.

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