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Kevin Kelly

Technological University Dublin, kevin.kelly@tudublin.ie

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The implications of the curriculum process on the design of a modern engineering programme in the Dublin Institute of Technology

Introduction

In the Dublin Institute of Technology (DIT) the curriculum usually starts with a programme document. The programme document will be a snapshot of faculty thinking at a point in time, usually at the validation stage of the programme. The programme document lays down clearly the aims, objectives, facilities, staff, syllabi, learning/teaching methods, assessment procedures, programme-management arrangements and all of the other characteristics of the programme. It provides a basis for critical scrutiny by all involved. Compilation of the document is an iterative process, and the final document is scrutinised by an expert panel as part of the validation process.

A dynamic faculty will not consider the programme document to be written in stone; rather, they will regard it more as a template to which changes are constantly made. Students' learning must not be restricted within the parameters set by a programme document. To do so would be to limit their learning to the confines of the imagination of the programme designer.

[Boud et al. \(1996\)](#) suggest programme designers should not presume that the experience they hope to elicit, would actually take place. The nature of the experience will be determined largely by what the learner brings to the situation. In other words, what emerges from a learning activity will have more to do with the learner than the designer or provider.

[Stenhouse \(1975\)](#) argues that objectives that are easily assessed sometimes take on a greater importance in student assessment, simply because they are easily assessed and defended. The key to good programme design may well be finding a way to assess student learning and give them credit (in marks) for what they learn, including that which is outside the syllabus. With student-centred learning this can be significant and varied.

Changing students

The tiger economy has raised most peoples' expectations in life. [Knowles \(1998\)](#) believes that as people mature, their self-concept moves from being a dependent personality towards one of self-directing human beings. Many students at third level now feel a responsibility to make themselves as financially independent as possible: whole-time students expect their third-level education to fit around their lives – and particularly their part-time jobs – in a flexible manner.

Up to the early 1990s, students entering third level had high Leaving Certificate points. The probability is that these outstanding students would have succeeded under any learning/teaching method we used, such was their motivation and ability. We now have to educate students with a lower number of entry points. To do this successfully we must evaluate the learning/teaching methods we are using and develop alternative strategies for a variety of learning styles. Many of the students entering third level with moderate points are very bright and motivated, but may not have responded well to the teaching style used in second level. We must strive to provide students with an opportunity to find the learning style which best suits them. The role of teaching is changing to one of facilitating learning. The students needs are at the centre of the process.

Learning and teaching

Modern educational research focuses on the learner: learning and teaching has replaced teaching and learning, in modern third-level education. Most lecturers begin teaching in the same way they were taught. [Garratt \(1994\)](#) believes engineers have a high need for certainty and an impulsion towards action rather than thought – action-fixated behaviour rather than learning. In the engineering faculty at DIT, lecturing posts are filled on the basis of industrial experience and research in the field of engineering. New lecturers have little or no experience teaching. Until recently, these lecturers were encouraged to pursue research in engineering as opposed to research into the career they had now chosen, teaching.

Surface and deep learning

Working in Sweden, [Marton and Saljo \(1976\)](#) first categorised student approaches to learning as deep and surface. Research in the UK and Australia uncovered remarkably similar findings. On one hand, surface learners are strategic and tend to memorise information. They focus on the requirements of tests and examinations. They cram before exam and seldom interrelate material to other topics and their experience. They concentrate on getting satisfactory or high marks in assessments. Any learning, which occurs, is a by-product. Deep learning, on the other hand, is where students seek understanding and meaning to what they are studying. They relate new material to previous knowledge and interact with the material by using it in other areas of their study, such as assignment and project work. Examinations and assessment are not the primary motivation for these students: learning is the priority.

According to [Boud et al. \(1996\)](#), association and integration are higher-order learning skills. Association is the connection of new learning with existing knowledge and attitudes. Integration seeks to find the nature of relationships; it draws conclusion and seeks insights. These are the essential features of deep learning.

Surface learning has evolved over the years on engineering programmes in DIT. Teachers and programme designers kept expanding syllabi to include new information, which *it was essential for engineers to know*. Little or nothing was taken out of syllabi with the result that students were exposed to ever-expanding syllabi without being given time to think reflectively or critically. The premise was that the student is an empty vessel waiting to be filled with knowledge by the expert teacher.

Student-centred learning

[Sheingold \(1991\)](#) argues that effective learning hinges on active engagement by the student. The construction of knowledge around their own knowledge leads to a much deeper understanding. The result of this is the use of higher order cognitive skills, as defined by Bloom and collaborates in the 1950s. According to [Dick \(1992\)](#), the classroom of the future will support the constructivist belief that learning must be BIG (Beyond the information given) if not WIG (without the information given). BIG/WIG puts emphasis on the learner, but the assessment method must be appropriate.

The constructivist teacher facilitates the students and provides the tools for the students to work out a solution. This gives them an opportunity to develop their critical thinking. The student learns how to learn. This is an important asset, in an age where the shelf life of what is learned on an engineering programme is becoming progressively shorter.

It is no longer necessary to expand syllabi with new information the student must know. We can relax in the confidence that graduates will have the meta-skills necessary to find out later anything they need to know. Students also improve their communication skills and ability to work in a team. Confidence and self-esteem are thereby nurtured in the student in a way which is not possible with traditional methods of teaching. Constructivist learning programmes should also encourage peer support and a collaborative learning environment. Curricula that encourage student cooperation and discourage student competition are likely to create a much better learning environment.

Programme DT244 curriculum

[Chickering and Gamson \(1987\)](#) brought together experts in the field of third-level education. They formulated seven principles of good practice for undergraduate education:

1. Contact between students and faculty: staff interest in students helps them get through difficult times.
2. Cooperation among students.
3. Active learning (deep learning).
4. Prompt feedback: students must find out early if their learning is correctly applied and be given an opportunity to correct mistakes early.
5. Time on task: students need time to reflect on their learning.
6. High expectation: expecting students to do well can be a self-fulfilling prophecy.
7. Respect diverse talents and ways of learning: encourage diversity.

I was appointed project leader for the development of a programme document in preparation for a validation event, which took place in March 2002. The programme was to be upgraded from a two-year certificate in Electrical Services Engineering (ESE) to a three-year diploma/ordinary degree. As project leader it was my role to coordinate the work of a programme team in the preparation of the document. In particular, I wanted to get subject matter experts to write their syllabi in a way which was student centred. I also wanted to incorporate the seven principles above into our programme. We had to take cognisance of the views of all stakeholders. We had to be prepared for opposition from within an engineering faculty where traditional forms of teaching were the norm. Teacher unions are very strong in DIT and change cannot be forced upon an unwilling community. [Lumby \(2000\)](#) warns that managing teaching and learning is a political as well as a technical process, and any innovation will only be accepted in proportion to the degree of support that exists or has been constructed.

The programme was designed in such a way as to gradually introduce a constructivist learning paradigm. We had found previously that first-year students found constructivist learning to be quite a shock initially. They had tended to bunk off when they were supposed to be doing research for their assignments and problem-based learning. After much discussion between teaching staff and students, it was decided to design much of the first-year programme around traditional teaching methods. First-year students have enough that is new to contend with on entering third level: meeting new people, finding accommodation, working part-time etc. We wanted to provide them with a broad base of information delivered in the most efficient way possible.

We did however include a number of assignments, which made up a total of 60% of the overall assessment. In this way constructivist learning was introduced. We broke the tradition in the engineering faculty of students having to pass both examinations and continual assessments. We were happy to see the students achieve the programme objectives in whatever way was most suited to their learning style. As long as they achieved a pass in each subject it did not matter how this was achieved. There was no minimum mark in either the examination or the continual assessment. In this way we were respecting diverse talents and learning styles. We also provided tutorial support to students and introduced a peer-mentoring scheme (the peer mentoring scheme has been modified and extended to other programmes by Leslie Shoemaker. It is an important factor in the success of this programme). Allocating a lecturer to each class group provided some tutorial support. The lecturer chosen in each case was somebody who it was felt would be perceived by the students as a friendly face. This lecturer was allocated hours in a computer laboratory to support the students in their assignment work.

We also made a particular point of monitoring students' progress, particularly that of first years, and speaking to any student falling behind in a supportive way. Contact between

students and faculty was assured. The 40% examination/60% programme work continued in second year but a major project was introduced. The project allowed students to construct their learning. Application and synthesis instead of memory and understanding evolved. This helped us develop a collaborative learning environment that encouraged deep learning.

Monitoring of students progress, particularly 1st years, is a particular feature on our programme. The Head of department Kevin O' Connell takes a particular interest in this as he sees this as a key feature in improving attrition rates. On successful completion of the second year of the programme, the students were awarded a certificate in electrical-services engineering. To continue to the third year and thereby acquire a diploma, the students were warned that the academic level would be raised. This was necessary to satisfy the validation panel. The diploma was stated in the programme document as being equivalent to an ordinary degree in order to ensure it would comply with the Bologna agreement for harmonisation of engineering qualifications.

On the third year of the programme overall assessment is 50% examination and 50% programme work. Most of the subjects are learned through constructivist methods in a collaborative environment. The major project work in second year has developed autonomous and collaborative learning skills in the students, which now make this workable.

We have had problems providing adequate access to computer laboratories. I regularly have situations where third-year students request access to spare terminals in a computer laboratory whilst other classes are going on in the laboratory. Some lecturers object to this, and if they feel it interferes with their scheduled class then this is a legitimate objection. There are also problems allowing students unsupervised access to computer laboratories at lunchtimes and at night. This is a measure of the success of the programme inspiring student-centred learning, as well as being a problem. We are trying to get across a student-centred ethos to all staff, not just to teaching staff. We point out that because of a shortage of facilities it behoves us to provide whatever support we can in the short term. It also provides great example to first-year and second-year students in a laboratory to see third-year students hungry for every spare moment on an online PC.

We have had to request funds to develop a longer-term solution. A learning resource centre, where students can work together on problem-based learning, assignments and project work is presently being built. This centre will have adequate numbers of online PCs, catalogues, journals, old projects and textbooks, as well as meeting areas with tables and whiteboards. We will also provide semi-formal tutorial support. We have reduced lecture time on the programme to 13 hours per week. We provide 13 hours of access to laboratories where students get an opportunity to carry out assignments in a collaborative environment. In this way they are given adequate time and support on the task: students have time to reflect on their learning. Assignments are carefully scheduled so as not to overload the students at any point in the year. Provisional marks and feedback is provided to students within two weeks. We do have high expectations of our students, and we make them aware of these expectations. We have found that this is successful with most students. We have also become aware of and respect the diversity of learning which is apparent on the programme.

How is the new programme going? Applications for the programme are increasing each year. In 2001, first preferences were 38. In 2002 they rose to 70, and in 2003 they rose to 175. We have one of the lowest attrition rates of any programme in engineering in DIT. Teachers are slowly coming to terms with a new learning/teaching paradigm. Initially teachers were using laboratory classes to deliver pre-planned experiments. Now they are gradually coming around to allowing students to dictate what will go on. They still find it strange to sometimes having to sit back and let the students get on with it. Some first-year students are still tending to bunk off during scheduled laboratory times and are failing to submit assignments. We have addressed this issue by having a pep talk with these students in early December each year.

Conclusion

[Silcock and Brundrett \(2000\)](#) offer three models of curriculum design:

- **Teacher/subject centred**
- **Student centred**
- **Partnership approach**

[Hanson \(1996\)](#) argues that any theory of adult learning, which advocates the importance of student-centred learning but avoids issues of curriculum control and power, does little to address the actual learning situation. There are sound practical and theoretical reasons why teachers might wish to take charge of learner behaviour. For example, a closely prescribed curriculum can only be realised through a tightly controlled pedagogy.

In this situation, Hanson suggests adults may well suspend some of their rights at the door of the institution in order to learn. They temporarily accept an unequal relationship between teacher and student, and accept the authority of the teacher provided the teacher has something to offer to justify his/her authority. programme designers must decide how to implement learning strategies into their programmes. They must be conscious in the design of their programme whether they are being student-centred or teacher/subject centred, and what learning/teaching strategies are being encouraged. Ideally the learning strategy should be made explicit in the programme document.

There is no panacea for teaching. All students are different and there are very many learning styles. programmes must be designed to offer as many parallel methods of learning to the student as is possible within the academic parameters set out by the faculty. In order to respond adequately to changes in the external environment, programme designers must design programmes that take into account all of the major changes which have occurred in the external environment in recent years. All of the stakeholders must be considered. programmes must first be attractive to students and not place obstacles to entry. In order to do this, it is my view that our programmes must be designed in such a way as to retain students by being 'student centred' and they must be orientated towards the needs of a modern economy in the twenty-first century. Last, but not least, the views and needs of teaching staff must be considered.

For prolonged change to occur in any work environment, staff must take ownership of the change. Responsiveness to the external environment and an adoption of change is best implemented in a learning organisation. Constructivist programmes are problematic to develop, expensive to run and difficult to assess. Teachers have less control and students need to be well motivated. Teachers must have a wider range of knowledge and skills from which to draw. Nonetheless, a gradually evolving constructivist programme has been shown in this assignment to be popular with students, a challenge to teaching staff and to arouse the interest of industry.

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