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## EVALUATION OF A PART-TIME ENGINEERING PROGRAMME THAT AIMS TO IMPROVE DIVERSIFICATION TO MATURE STUDENTS

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**Abstract:** This paper evaluates a part-time engineering degree programme that initially set out to address the issue of diversity and make higher education available and user friendly to mature students (mostly electricians), in the Dublin Institute of Technology (DIT), in Ireland. The part-time degree in Electrical Services Engineering began as a certificate in 2000 and as a degree in 2002. This four year evening programme was validated as the equivalent of a three year whole time degree and had a number of innovations for DIT:

- Recognition of Prior Learning (RPL)
- Application of a Student Centred paradigm
- Innovative Curriculum Development using Constructivist principles and Project Based Learning (in part).
- Use of *WebCourses* an electronic based learning platform

When the programme began, 20 places were made available to students finishing the educational part of their electrical apprenticeship programme. Such was the demand from apprentices and in turn from mature electricians that 40 places were made available the following year and 60 in subsequent years. Even at that there is generally a one year waiting list for *would be* entrants each year, with those not finding places assured of a place the following year. The first graduates came through with what are classified as Ordinary Degrees (3 year whole time equivalent) at level 7 of the Irish National Qualifications Framework (NQF) in 2005.

This evaluation concludes that this innovative programme has been successful in attracting mature students and that it's constructivist student centred design is appropriate to the cohort of students taking part. The final awards to graduates of this programme being at a higher level of achievement than the directly comparable cohort of school leaving students on the equivalent whole time programme. Most graduates of the part-time programme say they intend to pursue higher degrees but there were some downsides and surprises in this evaluation including that the cost of part-time education can be prohibitive for some and that traditional delivery is sometimes favoured.

**Keywords:** Evaluation, Diversity, Student Centred Paradigm.



## 1. Introduction:

The Dublin Institute of Technology (DIT) is the largest higher education institute in Ireland with over 20,000 students. 13,000 of these are whole time students and the rest are part-time, including apprentices. The School of Electrical Engineering within DIT attempted to address the challenge of increasing diversity in Engineering Education by developing a part-time Electrical Services Engineering degree programme that began as a certificate in 2001 and as a degree in 2003. This four year evening programme had a number of innovations:

## 2. Programme Design

This programme had four main aims:

- To provide improved opportunities for adults to access higher education.
- To address the problem of falling student numbers in the Faculty of Engineering, DIT.
- To address the skills shortage of technicians, engineers and managers in the electrical engineering sector in Ireland.
- To allow graduates of the programme to extend their studies into higher degrees

The DIT strategic plan (2000-2015) emphasises the *promotion of the capacity to learn and reason. It promotes learning skills as being more important than learning content.*

There is a developing consensus in the field and the literature that the modern worker increasingly requires problem-solving, teamwork and leadership skills in a work environment requiring flexibility, adaptability and mobility. ....a broadly based, person centred active learning approach.

White paper on Adult Education (2000: p 76).

The School of Electrical Engineering is in a position to attract large numbers of mature students, from the bank of past apprentices who have completed its apprenticeship courses, into its part-time programmes. Approximately 700 electrical apprentices attend DIT Kevin Street every year as part of their vocational education.

Electrical Services are the services associated with any building, which require an electrical supply. They include lighting, power, emergency supplies, fire alarms, cabling for information technology, communications, electrical distribution systems, security of supply to essential services, automation and electrical plant.

### Changing students.

Easy access to a vast amount of raw data on the World Wide Web means that the role of teaching is rapidly becoming one of facilitating learning. Present day third-level students used computers in secondary school and most are at least I.T. literate.



Future students will have used computing in primary school and computers will be second nature to almost all of them. Accessing information on the World Wide Web is now straightforward for these students.

The needs of mature students doing part-time courses are different to the needs of younger wholtime students. The latter must postpone application of their learning until they begin their careers. Mature students enter courses with many questions from their workplace. They have the opportunity of immediate application of their learning. They can contextualise their learning. This provides opportunities for mature students to develop higher order learning skills such as application and synthesis.

Mature students expect their learning to be relevant to their needs. If it is not, they are likely to vote with their feet and leave the course. Course delivery must become student centred and related to the needs of students and industry. If the programme content is designed to meet the needs of industry then graduates of the programme are likely to be in high demand.

New learning paradigms, assessment methods and methods of delivery were applied on the programme. In addition there would be provision for cross over from whole time to part-time courses and vice versa. This was enabled through modularisation of programmes working to a semesterised schedule.

The Qualifications (Education and Training) Act 1999: p54 states that the DIT shall implement procedures for access, transfer and progression as determined by the Authority. Semesterised delivery and off campus provision are recommended in the Government white paper. The special needs of adults as learners and the non-linear nature of adult learning must be recognised. A co-operative learning environment must be fostered with the provision of mentoring and tutorial support where needed.

The importance of Lifelong learning will increase in the 21<sup>st</sup> century. The importance of learning how to learn must be emphasised. New learning paradigms such as constructivism, using information computer technology, multi media and e learning provide the means for students to learn for themselves. Modern programmes must be designed to allow students exploit as many methods of learning as possible.

### **Student Centred Learning**

Burton, in Middlewood & Burton (2000) argues that a curriculum that focuses upon content can be seen as an academic approach to learning. Teaching methodology will concentrate on the delivery of knowledge and is best served by assessment techniques that emphasise recall, interpretation and analysis.

Silcock & Brundrett, in Middlewood & Burton (2000), offer three models of curriculum design:

1. Teacher/subject centred
2. Partnership approach
3. Student centred



Modern educational research suggests that focus should be on the learner as distinct from the teacher. Learning and teaching is replacing teaching and learning in modern third level institutes. On the other hand it can be difficult to move a conservative engineering community from an academic, teacher centred approach all the way to a student centred approach overnight. Indeed such a drastic change could even be risky and if not fully supported on the ground, irresponsible. A partnership approach whereby students increasingly takes responsibility for their learning as they progress through the course is recommended for the new programme. Assignment and project work will be designed into the programme but science subjects will still be delivered using traditional subject centred approaches.

### **Surface and Deep Learning**

Marton & Saljo (1976) in Sweden were the first to identify students' approaches to learning as surface and deep. Independent research in the UK and Australia produced similar results, Toohey (1999). Surface learning has evolved over the years on engineering courses in DIT. Teachers and course designers kept expanding syllabi to include new information, which it *was essential for engineers to know*. Little or nothing was taken out of courses with the result that students were exposed to ever expanding curricula, 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.

Surface learners are strategic and tend to memorize 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.

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. Integration draws conclusion and seeks insights. These are the essential features of deep learning.

### **5 Constructivist Learning**

Sheingold, (1991) argues that effective learning hinges on active engagement by the students. 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 1950's.

The constructivist teacher facilitates the students and provides the tools for the students to work out a solution and gives them an opportunity to develop their critical thinking. The students **learn how to learn**. This is an important asset, in an age, where the shelf life of what is learned on an engineering course is becoming progressively shorter. It is no longer necessary to expand syllabi with *new information the student must know*. Faculty 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 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 co-operation and discourage student competition are likely to create a much better learning environment.

Programme designers have to provide curricula that increasingly encourage teachers to become facilitators and encourage students to take responsibility for their own learning. Teachers must be responsive to students needs.

Learning outcomes are not always predictable with a constructivist approach. Assessment methods must be flexible and teachers should not attempt to control the learners. Multi media techniques may be used to enrich the learning environment.

Design of modern courses must reflect the new paradigm of a student centred, holistic approach to lifelong learning. "Traditionally, Institutions have been judged on the quantity of resources and the provision of instruction rather than the attainment of quality in student learning." Harvey (2001)

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. Constructivism puts a greater emphasis on higher order learning, application and synthesis rather than mere memory.

Students also improve their communication skills and ability to work in a team. Confidence and self-esteem are nurtured in the student in a way, which is not possible with traditional methods of teaching.

Teachers using a constructivist philosophy are more likely to use active learning methods such as student projects, assignment work and small group work. They infrequently use direct instruction activities. They are more likely to get students to make presentations, do analytical work or write. They encourage collaborative, project based learning where students present their work to peers. They use computers in cognitively challenging tasks. They finally conclude that course designers need to be thoughtful and creative in the design of learning environments for students.

Bodner et al (1992) argues that constructivist learning should be set in a rich context, reflective of the real world. Tennyson & Barron (1993) also argues that constructivism can be improved by providing a learning environment which is rich in resources. Time must also be provided for the student to seek out answers to pre-defined and self-defined problems. Computer based enhancements provide rich facilities that are under the control of the student.





It is argued in Educational Technology May- June 1999, that it is the practice and results that make a difference not the tools. We must not add lots of high-tech hardware and software to our classrooms without changing our practice.

## **2.2 Androgogy**

Knowles (1984) believes that as people mature, their self-concept moves from being a dependent personality towards one of self-directing human beings. At teenage years, the needs of many young people to take responsibility for managing their own lives becomes so strong that many rebel against control by the adult world. As people mature they begin to see themselves increasingly as producers or doers.

The behaviour of the teacher probably influences the character of the learning environment more than any other single factor. Teachers convey in many ways whether their attitude is one of interest and respect for the student, or whether the students are seen as receiving sets for the teacher's transmission of wisdom. Knowles suggests that once teachers put students in dependent roles they are likely to meet rising resistance and resentment.

Adults respond best in a collaborative environment. Many get satisfaction from helping others. Teaching others also reinforces ones own learning – it is a learning experience in itself. Quite often it is only when another asks a question we suddenly realize we did not understand something fully in the first place. An environment where students can ask questions of one another (or the teacher) without fear of embarrassment is the best environment for collaborative working. The role of the teacher is often to stand back and allow this happen without interference. Facilitate the learning process, guide it and ensure everybody is moving in the right direction generally with the odd detour expected here and there. There is much learning to be found in some of the detours – the teacher should remember this.

Knowles (1984) argues that a competitive environment should be discouraged. This will lead to students keeping information to themselves, which could be of benefit to all. Programme designers have a role here in ensuring this does not happen. He goes on to conclude that adults respond better to internal motivation than to external sanctions (grades).

This may be true to some extent but are adult students not also interested in getting good grades?

Hanson, in Edwards, Hanson & Raggatt (1996) argues that Knowles theory of learning for adults is somewhat utopian. She believes that any theory of adult learning that advocates the importance of each individual but avoids issues of curriculum control and power does little to address the actual learning situations of adults. The paternalistic offerings of courses for study, the certification ceremonies indicating success, are legitimate aspects of control of the learning environment. Hanson concludes that adults will often relinquish self-direction and autonomy when learning something new. They may well suspend some of their rights at the door in



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.

In my own experience of teaching on a part-time final year honours degree programme, I have found that students want information in the least problematic and time consuming way possible. It makes no sense to them, to have to retrace the lecturer's steps. They are looking to the teacher as the expert to filter the information and deliver it in the most efficient way possible. This programme is designed in a teacher/subject centred traditional format. Students prioritise on passing examinations and any learning, which results from that, is secondary.

In DESE it has been found that first year students find constructivist learning to be quite a shock initially. They tended to disappear when they were supposed to be doing research for their assignments. A good knowledge base and tutorial support is necessary before attempting to implement constructivist approaches. It is expected on the proposed programme that subject matter experts will write their syllabi in a way, which will be student centred and **gradually** introduce a constructivist paradigm. This will be particularly important on subjects requiring problem solving and design skills.

Traditional mathematical and science subjects are likely to be delivered using traditional methods primarily, at least in the early stages. In this way the students can build a good base of knowledge in an efficient way. Cognisance must be taken of the views of all stakeholders and some opposition is to be expected from within an engineering faculty where traditional didactic forms of teaching are the norm. Teacher trade unions are very strong in DIT and change cannot be forced upon an unwilling community. Lumby, in Middlewood et al (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. It must be expected that that opposition will present itself and divergent views offered.

### 3. This Research

This paper will be an evaluation of the four year part time degree programme. The popularity of the programme is one strong point in it's favour and an accreditation by Engineers Ireland also provided positive feedback with this degree fulfilling the academic requirements of Associate Engineer with Engineers Ireland. Engineers Ireland are members of the European Network for Accreditation of Engineering Education (ENAE) and accredit Irish Engineering programmes to EUR-ACE standards as well as to the Washington, Sydney and Dublin Accords.

But there are issues deserving investigation with regard to the programme. The research questions for this piece of research are:

- What do academic staff and students think about the programme. How



successful has it really been in widening diversity, applying a student centred paradigm and how innovative has it really been in practice. What part does Project Based Learning really play and does it all work?

- Are opportunities and service to students on the part time programme satisfactory? Is it fair that fees apply to part-time students? Is there easy transfer to wholtime programmes if students wish to accelerate their progress academically?
- What happens to graduates of the programme and are there ladders of opportunity for them to higher degrees if they wish to pursue them? Are they well equipped to take on research degrees with what they learn on this programme?

The methodology used to answer these questions is a combined quantitative and qualitative analysis. Surveys of students will be carried out along with interviews/focus groups of students and staff teaching on the programme.

This paper may be of interest to delegates at this conference because the theme of the conference is *Diversity Unifies*. This programme offered opportunities to students who previously had difficulty gaining access to professional engineering degree programmes and who previously were given no credit for their prior learning. The degree programme under investigation has attempted to diversify and unify wholtime and part-time students but there have been surprises along the way that are informative for others contemplating such change. There were conflicts and difficulties as mature students from the part-time programme were mixed with traditional students on the whole time programme. This raised challenges for staff and students alike.

#### 4. Data

		Penultimate Year	Final Year	Total	%
<b>Sex of students</b>	Male	21	21	42	100
	Female	0	0	0	0
<b>Age</b>	20 - 25	1	6	7	18
	26 - 30	11	6	17	40
	Over 31	9	8	17	40
	No Return	0	1	1	2
Qualified for Advanced Entry		17	16	33	78

**Figure 1.**

Student Background		
	Number	%
Apprentice Electrician	6	14
Electrician	28	67
Other	7	17
No return	1	2

**Figure 2.**

Programme Suiting Student Needs
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	Penultimate Year	Final Year	Total	%
Yes	19	17	36	86
No	1	3	4	9
No Return	0	2	2	5

**Figure 3.**

Module Satisfaction				
	Penultimate Year	Final Year	Total	%
Majority appropriate	20	18	38	90
Majority Not Appropriate	1	1	2	5
Don't Know/NR	0	2	2	5

**Figure 4.**

**Suggested Improvements** included more use of good quality software, application of a Sustainable Energy module,

Students appeared to have a good understanding of the term *Student Centred*, using descriptions such as : *Programme focused on students; Tries to further peoples skills in certain areas; Continuous assessment; Student to study external to course material; Students pursues most of their own research;* but in one case a student responded that *he had never heard of it.*

When students were asked whether modules were delivered in a student centred manner the response was as follows:

Student Centred	Penultimate Year	Final Year	Total	%
Yes	15	14	29	69
No	1	2	3	7
No Return	5	5	10	24

**Figure 5.**

When students were asked were they provided with sufficient support for successful completion of the programme they responded as follows:

Sufficient Support	Penultimate Year	Final Year	Total	%
Yes	16	13	29	69
No	2	3	5	12
No Return	3	5	8	19

**Figure 6.**

Ladders of Opportunity	Penultimate Year	Final Year	Total	%
Yes	13	7	20	48
No	2	3	5	12
No Return	6	11	17	40

**Figure 7.**



Planning FE	Penultimate Year	Final Year	Total	%
Yes	14	13	27	64
No	2	3	5	12
No Return	5	5	10	24

Figure 8.

## Examination Results

Comparison between **Part-time** and **Whole-time** Bachelor of Engineering Technology in Electrical Services Engineering programme 2005-2009:

Mark	70 - 100%		60 - 69%		50 - 59%		40 - 49%		Below 40%		
	Distinction		Merit Upper		Merit Lower		Pass		Referred		Total
P-T	53	53%	29	29%	16	16%	3	3%	0	0%	101
W-T	41	23%	51	28%	44	24%	27	15%	18	10%	181

It is the view of many lecturers in DESE that science and mathematical type subjects should still be delivered using traditional methods. This is the most efficient method and it is often what students want. There is also agreement however, that some subjects are suited to constructivist approaches, and these should be developed. It has also been found on other programmes that project and assignment work have been very successful in motivating students to take responsibility for their own learning. Their learning becomes active and deep. A cooperative learning environment evolves. Balance and variety appears to be favoured by both students and teachers.

## Conclusion

Reigeluth (1992) says that it is important not to be an evangelist trying to sell new learning theories but an educator trying to identify the best way to facilitate learning. It is also just as important to understand the difference between learning theory and teaching theory, as it is to understand the difference between theory and practice.

## Conclusions:

All the students are male (there has only been one female on each of the part-time and whole-time programmes 2005-06 to 2008-09 inclusive) .

The majority of the students are aged over 25 with a significant number over 30.

Of the number of students starting the programme, X have progressed to the degree programme



Bachelor of Engineering Technology in Electrical Services Engineering is the “natural” means of progression for electricians. The vast majority of the students find the programme suits their needs and the programme modules appropriate.

Suggested improvements to the course consisted of:

- Greater use of propriety software.
- More emphasis on technical specifications.

Within the student’s understanding of the term “student centred” the programme was considered to be run in a student centred manner.

The majority of students planning to pursue further education, indicated by 64% of returned questionnaires, elected for the Bachelor of Science in Electrical Services and Energy Management.

The ladders of opportunity available have not been fully explained to all the students. The factors affecting the non return to further education were fees (currently € 1450 per year) and time restraint.

A high number of students were awarded distinctions and merit upper. This may be accounted for by the type of programme been followed. Due to the very high commitment demanded by the programme, three evenings per week, only students expecting to receive a high award tend to complete the programme.

When compared to students on the whole-time programme the part-time student results show a higher number receiving distinctions and merit upper. Part-time students tend to be more mature than their full-time counterparts and are usually in employment in the electrical industry.

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