2014

Evaluating the Implementation of Curriculum Development for Sustainable Design in Electrical Services Engineering

Michael McDonald
Technological University Dublin, michael.mcdonald@tudublin.ie

Stephen Donohoe
Technological University Dublin, stephen.donohue@tudublin.ie

Recommended Citation

McDonald, M., & Donohue, S. (2014). Evaluating the implementation of curriculum development for sustainable design in electrical services engineering. *5th International Symposium for Engineering Education*,, The University of Manchester, United Kingdom, September .

Evaluating the Implementation of Curriculum Development for Sustainable Design in Electrical Services Engineering:

Michael McDonald* and Stephen Donohoe

School of Electrical and Electronic Engineering,
Dublin Institute of Technology, Dublin, Ireland
&
Amazon Data Services Ireland Limited

Abstract: The professional role of electrical services engineers is evolving and changing to meet the needs of industry, both national and internationally. The current demands throughout the built environment are primarily driven by European Directives and Government policies pertaining to sustainable design, energy reduction and energy efficiency. Thus, it is essential that Ireland's Higher Education Institutions meet these challenges head on by developing diverse programmes which have sustainability at the core of curriculum design. Moreover, programmes of this nature will ensure that young engineers of the future command key transferable skills and enhance their lifelong learning which is required for today's competitive labour market. What will the engineers of the future look like – would they be recognisable from today?

This pedagogical research intends to examine the development and restructuring of an existing curriculum for a level 7 degree in Sustainable Design in Electrical Services Engineering in Ireland. The programme maintains the core learning outcomes, which have been reviewed by an accreditation body, while providing engineering graduates with a host of diverse multidisciplinary skills. This curriculum development has been tailored to meet the needs of industry, but more importantly the needs and expectations of future students. How does a programme ensure students are employable? This paper offers a unique insight into engineering education as both authors are graduates of the aforementioned programme and have subsequently returned to lecture on the programme. Moreover, they have been heavily involved in the curriculum development.

Keywords; Engineering Education, Curriculum Development, Student's Perspective

**Correspondence to: Michael McDonald, School of Electrical and Electronic Engineering, Dublin Institute of Technology, Dublin, Ireland. E-mail: michael.mcdonald@dit.ie*

1. INTRODUCTION

This pedagogical research intends to examine the development and restructuring of an existing curriculum for a level 7 engineering degree. At a time when Ireland faces into the sixth year of recession, government deficits are still a concern, Small and Medium Enterprises (SMEs) are still experiencing liquidity problems or have simply closed, and employment, whilst dropping, is still relativity high (approximately 12%) compared to the rest of Europe (Eurostat 2013). Thus, every opportunity must be examined which could potentially enhance gradates' employability both on a national and international level. Globalisation has created a platform which enables nations to interact through business and commerce, thus, allowing graduate engineers the freedom to practice within their discipline at an international level. HEA (2013) suggest that, higher education is the engine for economic growth and innovation. Furthermore, economic growth is driven by knowledge, research and development. Therefore, the engineering programmes must provide the lifelong transferable skill set required to establish a striving sustainable economy. This panacea of higher education is somewhat more challenging with diminishing public funding and direct cuts in education. In fact, the reduction in funding for higher education year on year since 2009 has lead to a widening of the staff to student ratio (McDonald & Donohoe 2013).

The International Energy Agency's (IEA) Wind Energy Roadmap (2009) contends that, if decisive action is not taken, energy related CO_2 emissions will more than double by 2050. If European member states are determined to meet targets, 20% reduction in energy demand and 40% electricity from renewable energy sources by 2020 (The 2009 Renewable Energy Directive (2009/28/EC), it will be largely dependent on substantive efficiencies being achieved from the sector. This will require development of traditional engineering education programmes to incorporate concepts of sustainable design at both undergraduate and postgraduate levels. To ensure this shift in engineering education is seamless it is essential that programmes embed graduates with a sustainable ethos, which they can implement and practice throughout their careers. These are exciting and challenging times for engineers, they are faced with complex problems such as sufficient global food supplies, clean water and habitable environments when they take the helm. In many ways, there are signs of a real engineering renaissance as technology moves at an incredible rate. Thus, the engineering community, academia and industry, must ask the question - *are the current engineering curricula fit for the emerging complexities of modern engineering systems?* Modern engineering curricula must be dynamic by nature and not remain linear (Vaithilingam and Rajkumar, 2011).

2. HISTORY OF PROGRAMME

Dublin Institute of Technology (DIT) is synonymous with quality engineering education and has provided quality technological education since its foundation in 1887. Today DIT is one of the largest Higher Education Institutes (HEIs) in Ireland. The School of Electrical and Electronic Engineering, formally the School of Electrical Engineering Systems has been held in high regard for several decades. DIT's deep-seated knowledge and strength in technology combined with its renowned discipline leadership, specifically electrical services, creates a unique platform for a sustainable design programme. The National Strategy for Higher Education recommends the development of a Technological University for the Institutes of Technology in Dublin. This new age university will prepare students for real life complex professional roles in a changing worldwide labour market. This type of university has the unique opportunity to allow students advance their knowledge through the use of industry specific software, including BIM (McDonald & Donohoe 2013). The National Strategy

acknowledges that one of the key strengths of our higher education system has been, and should remain, institutional autonomy (HEA 2012).

The Electrical Services Engineering (DT010) programme has been running successfully in DIT Kevin Street since 1999, first as a two-year Higher Certificate and then as a three-year Diploma. The programme was converted to a Level 7 Ordinary Degree in 2004 in line with the provisions of the National Qualifications Authority of Ireland (NQAI). Finally, the programme secured a five-year accreditation from Engineers Ireland in 2006, which has been renewed twice since. The programme is reviewed on an annual basis through the DIT quality assurance procedures and the programme has evolved in recent years with new modules in Sustainable Building Engineering, Renewable Energy Plant, Building Automation and other changes which have changed the emphasis of the programme more towards energy and the green economy. Thus, the curriculum development and restructuring has led to a change of name being approved to *Sustainable Design in Electrical Services Engineering* for graduates from 2016.

The aims of the programme are to produce high calibre engineers, who will possess a sound understanding of key technical and interpersonal skills as well as the ability to derive and apply solutions from a deep-seated knowledge in the area of Science, Technology, Engineering and Mathematics (STEM). Graduates will also possess an appreciation of the industrial and business management environment in which they will work. Moreover, graduates will understand the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards society and the surrounding environment.

3. CURRICULUM DEVELOPMENT

The engineering educational institutes cannot simply provide future engineering leaders solely with technical abilities. Modern engineers must also command key skills and have the ability to work effectively within a multidisciplinary team and implement sustainable designs rapidly to ensure new technologies continue to develop in order to alleviate global issue.

The word curriculum has many meanings throughout the educational sector, from primary through to tertiary. It varies from content, material, structure, evaluation to the attainment of educational aims and goals. Curriculum and its reputation are often seen as a baseline for the selection of academic programmes, their learning outcomes and student profiling throughout industry. Saha (2012) states that, curriculum is the formal mechanism through which intended educational aims are achieved. Moreover, there are two prime factors in this process, learning and instruction. In fact, the curriculum / programme content is the first port of call for potential students and employers looking to upskill their staff. Therefore, it is essential that the curriculum portrays the institutions educational road map and the potential student educational journey.

It is challenging to restructure an engineering programme and implement new curricular strategies, whilst maintaining a well established reputation. The newly developed curriculum needs to be cognisant of new technologies whilst ensuring that fundamental concepts are not compromised and allowing flexibility which will enable the student deal with real life complex problems in a dynamic way. Students today need to demonstrate their ability to be creative and innovative whilst also displaying traits such as communication skills, ability to work within an interdisciplinary team. Schon (1983) states that, in industry, engineers reflect in action and that these skills cannot be taught in the traditional classroom. Furthermore, as a

result of the National Strategy for Higher Education to 2030 the National Forum for the Enhancement of Teaching and Learning was launched in 2012. The primary focus being to provide students with the highest quality teaching and learning, integrating research with teaching and learning, interdisciplinary curricula and enhancing the flexibility of programmes. In fact, Ireland has been credited internationally for ensuring a high quality assurance process and also the implementation of the Bologna Process (HEA 2013).

The Engineer's role is to provide solutions to problems identified by a client. The ability to design systems to meet specified needs, taking into account the constraints imposed by design briefs, funds available and rules and regulations is central to the business of design in electrical services engineering. Sustainable Design further implies a need to do this using minimum energy and maximising renewable resources, but again this must be based on sound financial appraisal. The modern engineer must be able to elicit the requirements of the client, formalise these requirements in engineering terms, and develop system specifications.

In 2013, the School of Electrical and Electronic Engineering began the restructuring of its well established Bachelor of Engineering Technology (BEng Tech) in Electrical Services Engineering (DT010), a three-year National Framework of Qualifications (NQF) Level 7 programme. The programme is well regarded throughout the electrical sector and has a reputation of high calibre graduates. The restructuring of any programme in itself presents the challenge of providing a suite of metrics for the evaluation of the overall teaching and learning at an institutional level (HEA 2013). This systematic process is intended to enhance the student learning experience. Thus, a holistic approach is required which evaluates the impacts, positive and negative, on all parties involved, including students, staff and employers.

As of September 2013, first year students entered the DT010 programme under a new name: ***Bachelor of Engineering Technology in Sustainable Design in Electrical Services Engineering.*** It is proposed that part-time students will enter in September 2014.

Programme Restructuring:

1. There is a change of emphasis so that graduates of the new programme will be better acquainted with the green economy and be better equipped to tackle the growing areas of energy management, building control & automation, renewable resources and retrofitting
2. The modules which have been restructured and renamed:
    - ***Introduction to Cable & Wiring systems and Distribution Design***
    - ***Electrical Services Design for Buildings***
    - ***Electricity Regulation, Governance & Safety***
    - ***Lighting Applications***
    - ***Life Safety Systems***
    - ***Distribution Design***
    - ***Electrical Design, Application and Evaluation***
    - ***Advanced Lighting Design***
3. Year 2 Electrical Services Project Redesign
4. Lighting Laboratory

5. Renewable Energy Laboratory
6. Building Information Modelling (BIM)

4. SURVEY METHODOLOGY

LTDI (1998) states that it is crucial to take time whilst developing the questions, to ensure that the data collected is relevant. The survey of current lecturing staff was conducted on-line using the software Survey Monkey (14/30 responded to the survey). The survey consisted of ten short questions. The majority of these questions were closed questions created using the Likert scale. All of questions allowed for comments and opinions.

5. THE PAPER'S FINDINGS

The authors have tried to provide a qualitative overview of the more important questions and responses relating to this pedagogical evaluative study. As outlined in figure 1, it can be seen that a large percentage (60%) of the demographic of those surveyed have been teaching in the area of electrical services engineering for more than 10 years. Therefore, the opinions of the participants are a true representation.

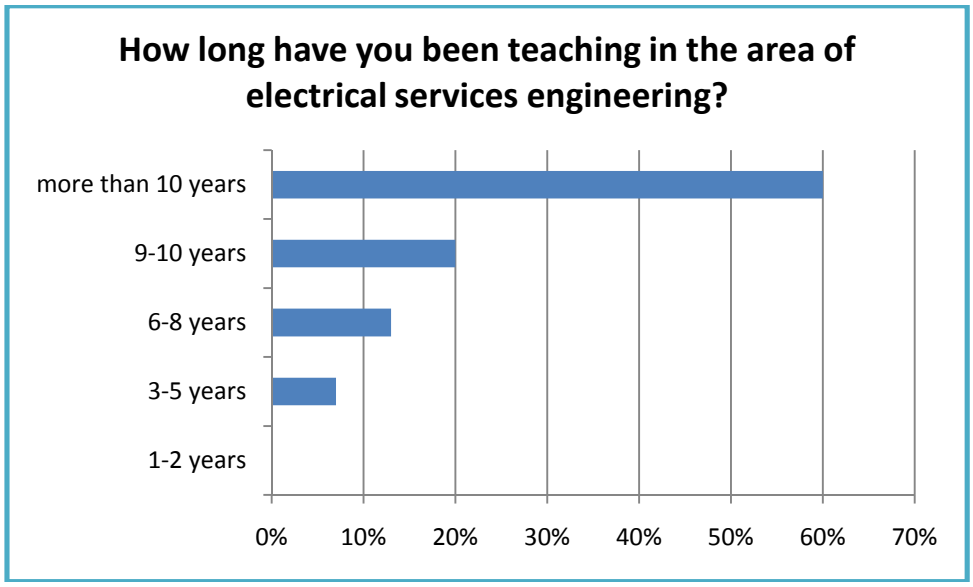

Figure 1

In relation to ensuring programmes are dynamic and are providing graduates with the skills required for industry, the participants were asked; ***Did the programme in question require curriculum development? Will the enhancement of existing modules improve the overall programme?***

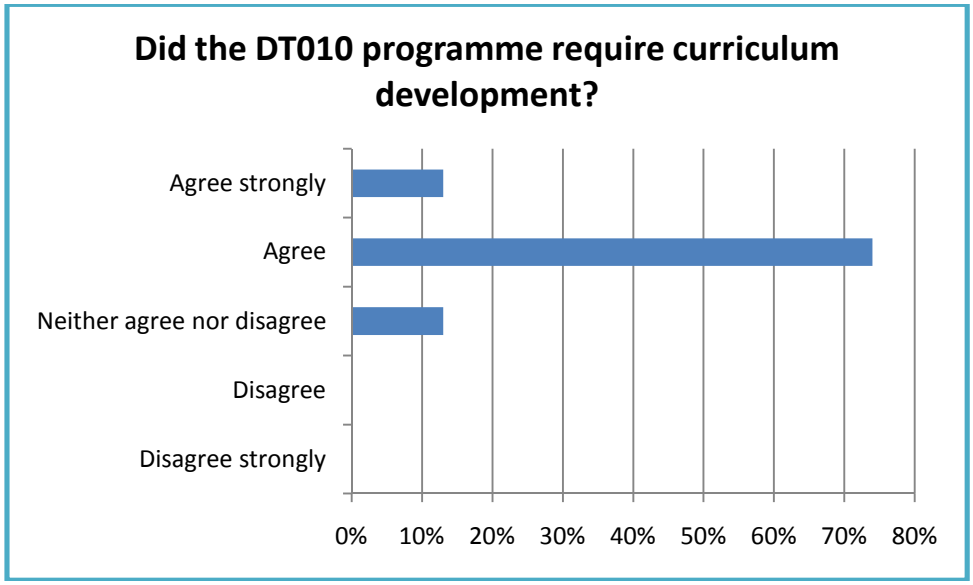

Figure 2

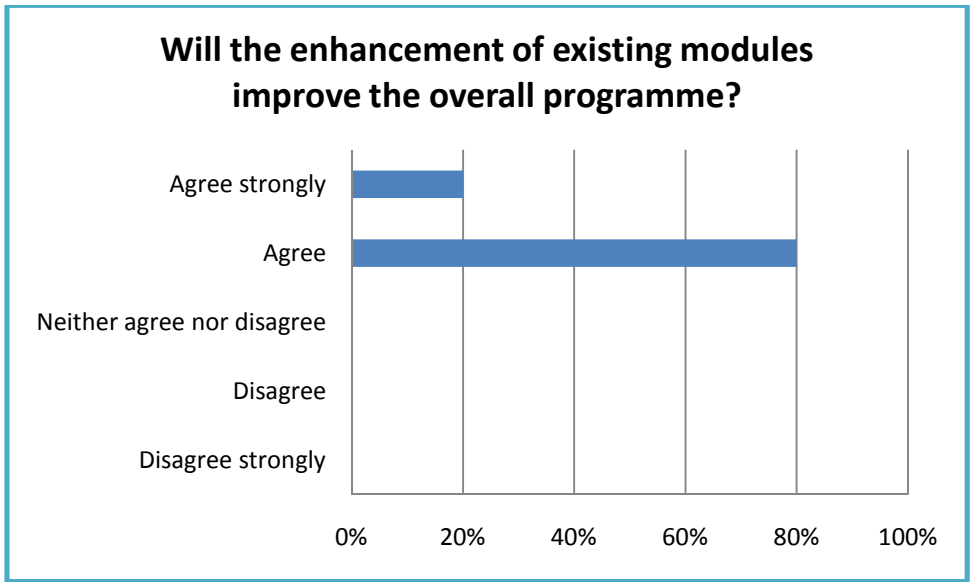

Figure 3

Sciences (2005) declares that, the engineer of 2020 will learn new age technical information, techniques and be conversant with and embrace a whole realm of new technologies. The challenges faced in today's built environment will require rethinking, innovation and creativity from the engineer of the future, at both a macro and micro level.

As outlined in figure 4, it can be seen that a large percentage (80%) of the participants believe that this curriculum development will improve graduates' employability

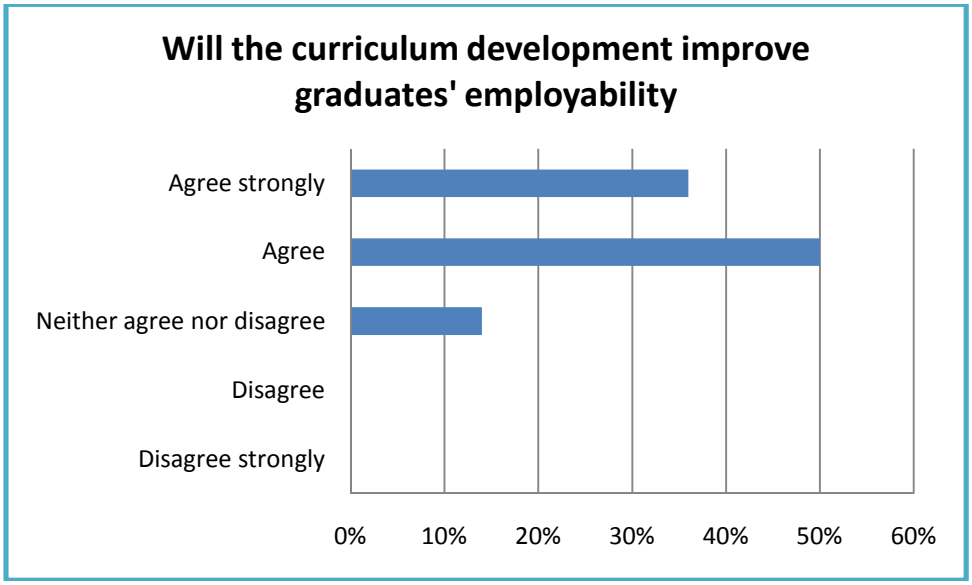

Figure 4

Moreover, the School of Electrical and Electronic Engineering's primary objective is to disseminate leading engineering education and research throughout the sector. This new age approach to sustainable design will ensure that the DIT is in a position to offer the pedagogical skills necessary to provide students with deep-seated learning within the STEM disciplines. Furthermore, it is evident from this research paper that the curriculum development as a whole, will ensure that graduates will enter the labour market with an invaluable skill set.

6. FUTURE WORK

Looking to the future, the authors would like to continually monitor the programme's development as the students' progress through the different stages. One believes that there is plenty of scope for future research and this could include gathering data and comparing future academic results under the new curriculum with past results. The authors truly believe that teaching and learning needs to be constantly reviewed to ensure quality learning outcomes are being achieved in line with the National Forum for Teaching and Learning. Furthermore, as part of future research, it would be very beneficial to the higher educational sector if a new systemic mechanism for student feedback was embedded in to programme documents. The feedback issue is being addressed in part through the establishment of the Irish Survey of Student Engagement (ISSE) (HEA 2013).

7. REFERENCES

Eurostat 2013, *Euroindicators*
[Accessed 31/03/14]
file:///C:/Users/Administrator.KE005-01.005/Downloads/STAT-14-17_EN%20(1).pdf

Higher Education Authority (HEA) 2012, Towards a Future - Higher Education Landscape
[Accessed 25/01/13]
http://www.hea.ie/files/TowardsaFutureHigherEducationLandscape.pdf

Higher Education Authority (HEA) 2013, *Towards a Performance Evaluation Framework – Profiling Irish Higher Education*
[Accessed 31/03/14]
http://www.hea.ie/sites/default/files/evaluation_framework_long.pdf

International Energy Agency (IEA 2009), *Technology Roadmap – Wind Energy*
[Accessed 01/04/14]
http://www.ieawind.org/wnd_info/IEA_Paris/Wind_Roadmap.pdf

Learning Technology Dissemination Initiative (LTDI) 1998, *Evaluation Cookbook*
[Accessed 21.04.14]
http://www.icbl.hw.ac.uk/ltdi/cookbook/cookbook.pdf

McDonald, M., Donohoe, S.,: How are the Educational Institutes of Ireland Embracing the Paradigm Shift towards BIM? CITA BIM Gathering 2013, November 14th -15th Dublin, Ireland

Saha, S., 2012. *Curriculum Design of Mechanical Engineering in a Developing Country*
[Accessed 27/03/14]
http://www.ucc.ie/archive/isee2010/pdfs/Papers/Saha.pdf

Schon, D., 1983. *Educating the Reflective Practitioner: How Professionals Think in Practice.* New York: Basic Books.

Schon, D., 1987. *Educating the Reflective Practitioner: Towards a New Design for Teaching Professional*. New York: Basic Books.

Sciences, N.A. (2005). *Education the Engineer of 2020 - Adapting Engineering Education to the new Century*. Washington DC: The National Academic Press.

Sinnott, D., Thomas, K. 2012. Integrating Sustainability into Civil Engineering Education: Curriculum Development & Implementation
[Accessed 26/02/14]
http://repository.wit.ie/2121/

Vaithilingam, C., Rajkumar, R. 2011. A Dynamic Approach to Outcomes Based on Education in Engineering Curriculum
[Accessed 20/02/14]
http://www.ietec-conference.com/ietec11/Conference%20Proceedings/ietec/papers/Conference%20Papers%20Refereed/Wendesday/WP1/WP1.4_55.pdf