EMPLOYER AND STUDENT PERSPECTIVES ON SKILLS FOR ENGINEERS IN THE TWENTY FIRST CENTURY AND BEYOND

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Abstract. This research focused on skills identified among final year engineering students. It provided evidence of different levels of skills by students and identifies their greatest learning influences in these areas. The skills were self-assessed by students and covered seven areas designated by Engineers Ireland. Competency levels such as science, software, creativity, engineering practice, social and business, ethics, discipline specific were assessed. It also investigated the important role that work placements play in skills developed by students. Key skills sought by leading Engineering firms from graduates now and in the next five years were also researched in this paper. Employers were surveyed to determine and investigate skills needed from graduate engineers and how best to meet these challenges.

The emphasis on work placements and its impact on skills' development in engineering students such as business acumen and working effectively and efficiently in industry were highlighted.

Keywords; career, competency education, Engineers Ireland competency, student surveyl.

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1. INTRODUCTION

The total number of CAO acceptances has increased steadily in recent years due mainly to rises in acceptances for level 8 programmes. Due to the significant contribution of the science and technology sector to the Irish economy, trends affecting the supply of skills to this sector are examined here in greater detail. Higher education can last from two years (leading to a higher certificate award) or three to four years in order to obtain an honours bachelor degree. Postgraduate education then follows and may range from one year for postgraduate diplomas, higher diplomas and taught masters degrees to three or more years for a doctoral qualification. It is widely accepted that students need to be career conscious, multi-skilled and motivated in an ever increasing competitive graduate jobs market [1-3]. There are four interlinked sections in the formal education system (illustrated in Figure 1): primary, secondary, further education and training (FET) and higher education [2]. Present research carried out on a cohorts of thirty five students in the final year of mechanical and manufacturing engineering degrees at Dublin City University. These groups of students, lies in the green box in the Figure 1, who are in a four year bachelor engineering degree course.
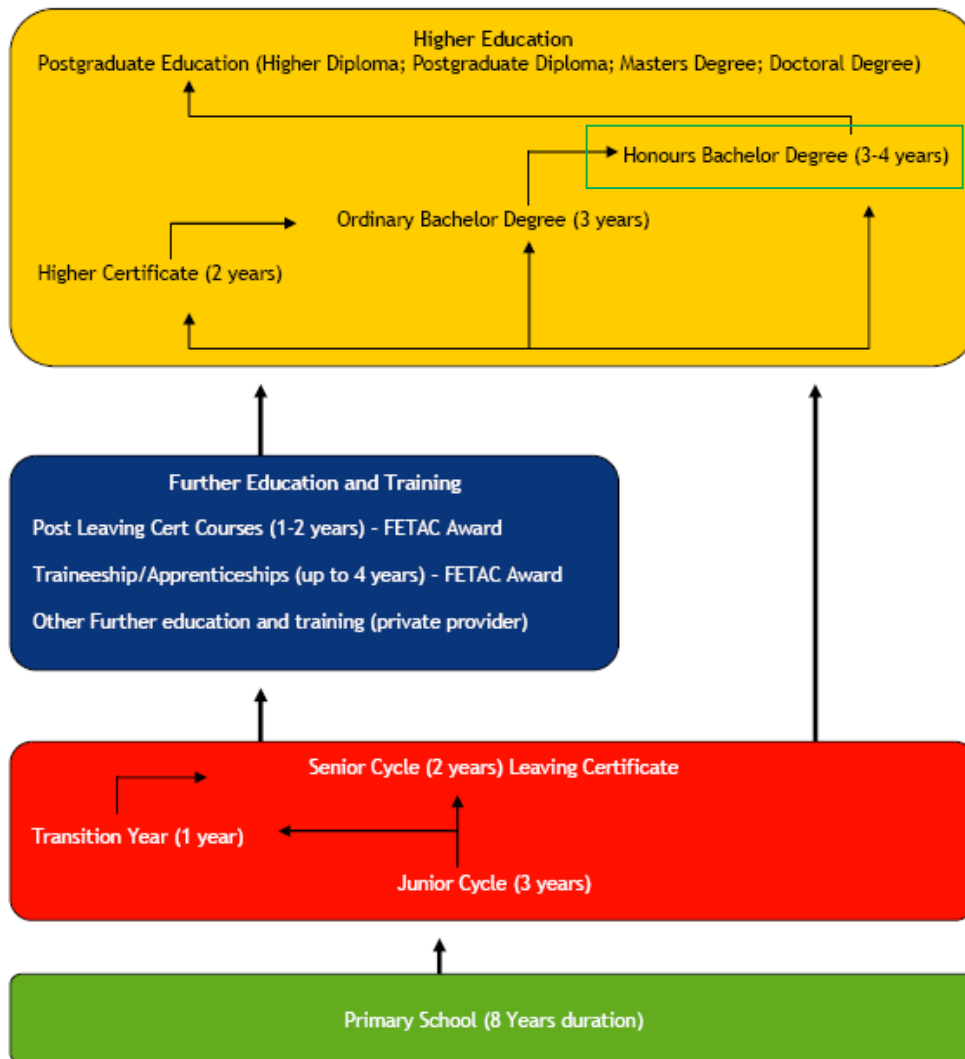
Figure 1: Formal Irish Education System [2]

2. SURVEY

Thirty five final year students in the school of mechanical and manufacturing engineering were surveyed by using a questionnaire which can be found in full in section 2.1. Fifteen leading employers have been surveyed and the Employer survey can be seen in section 2.2.

Parts one of the questionnaires was based on the leaving certificate subjects and part two was based on competency level such as since, software, creativity, engineering practice, social and business, ethics, discipline specific as indicated by Engineers Ireland accreditation criteria. A special emphasis was given to the work placement programme in DCU (INTRA), final year projects and a group project carried out all through the programme to identify improved levels of competency.

2.1 STUDENT SURVEY

The purpose of this research is to identify graduate skills acquired during your programme of study. Final year engineering/ post graduate students and leading engineering firms are being surveyed to assess skills and competency levels acquired and needed respectively. This information can help inform education providers to ensure that priority is given to developing the relevant skills in students which are needed by industry.

STUDENT NUMBER

EMAIL

TEL

What sectors are you interested in working in?

☐ Pharmaceutical, Chemical and Medical Technologies

☐ Electronics, ICT and telecommunications

☐ Manufacturing and Industry

☐ Construction and Civil Engineering

☐ Environmental

☐ Power Systems

☐ Others_____

PART 1

Did you have physics in your leaving certificate ☐ Yes ☐ No

Did you have chemistry in your leaving certificate ☐ Yes ☐ No

What level of maths did you take in your leaving certificate?

Did you have applied maths in your leaving certificate ☐ Yes ☐ No

Are you satisfied overall with the level of competency you have acquired during your studies?

☐ Yes ☐ No

If not, which areas of the course would you liked to have studied more?
_____

Are you satisfied with the range of subject areas covered on your programme?
_____

If not what other areas would you have liked to have been covered?
_____

PART 2
Please assess your level of competence in the following competency areas.

(a) Sciences and Mathematics

Biology	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Chemistry	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Physics	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Maths	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent

(b) Software and Information Systems

Programming	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
IT Skills (Internet, networking, multimedia, …)	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent

(c) Creativity and Innovation

Brain storming methods	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Product design	◉ Very Strongly Agree	☐ Strongly Agree	☐ Agree	☐ Do Not Agree	☐ Do Not agree at all
Research methodology	☑ Very Strongly Agree	☐ Strongly Agree	☐ Agree	☐ Do Not Agree	☐ Do Not agree at all
Team work	◉ Very Strongly Agree	☐ Strongly Agree	☐ Agree	☐ Do Not Agree	☐ Do Not agree at all

(d) Engineering Practice

Problem Solving	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Project Management	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent

(e) Social and Business Context

Problem-solving	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Language Skills	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Oral Communication	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Written Communication	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Interpersonal Skills	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Leadership	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Continuous Learning	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Financial Awareness	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Legal Skills	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Entrepreneurship	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Multicultural Skills	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent

(f)Ethics

Health & Safety	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Industry standards	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
Product regulation	Very competent	Competent	Reasonably Competent	Not Competent	Not at all competent
Social responsibility	Very competent	Competent	Reasonably Competent	Not Competent	Not at all competent
Research ethics	Very competent	Competent	Reasonably Competent	Not Competent	Not at all competent
Business	Very competent	Competent	Reasonably Competent	Not Competent	Not at all competent

(g) Please list any other four discipline-specific technology areas that you have learnt during your programme of study and that are not mentioned elsewhere in this questionnaire (e.g. Finite Element Analysis, Advanced Manufacturing, Advanced Materials, Automation, CAD, …)

1._____	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
2._____	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
3._____	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent
4._____	☐ Very Competent	☐ Competent	☐ Reasonably Competent	☐ Not Competent	☐ Not at all competent

Have you completed a work placement ☐ Yes ☐ No

If yes, how relevant has your work placement being for improving your skills overall?

Relevance of work placements for development of skills	☐ Very Relevant	☐ Relevant	☐ Fairly Relevant	☐ Not Relevant	☐ Not at all Relevant

Are there any skills which you consider very important not currently being developed as part of your studies?
_____

Please indicate on a scale of 1 to 5 how much you feel the final year project, INTRA and group project work contributed to the listed learning outcomes. Where 1 stand for high contribution and 5 stand for low contribution.

Competency area	Final year project	INTRA placement	Group project work
Sciences and Mathematics			
Discipline-specific Technology			
Software and Information Systems			
Creativity and Innovation			
Engineering Practice			
Social and Business Context			
Ethics			

2.2 EMPLOYER SURVEY
PART 1: Same as Student Survey
PART 2: Same as Student Survey
Additional questions asked to the employer were as follows:
 a. Are there any skills which you consider very important not currently evident in graduate engineers?
 b. Are there any skills which you consider very important not currently evident in graduate engineers but will be mandatory to have in five years time?

3. RESULTS AND DISCUSSION
3.1 Student Survey
Among 35 students, 13 students would be happy to work in pharmaceutical, chemical and medical technology sector, 4 in electronics, ICT and telecommunication and 20 in manufacturing industries, 1 in construction and civil engineering, 6 in environment, and 9 in power system.

Students mentioned Stryker, Motor Sports Ferrari, Creganna, Consultant in IT/Business Accenture, Wyeth, Bayer., Capella Medical Devices, Boston Scientific, prosthetic industries like Truelife, Aerospace, ESB, AbboTt, Aerlingus, Procter & Gamble, Medtronic, oil company in Nigeria and middle east, Siemens, BMW, Eco-power generation, EFD energy, Rolls Rice in UK, Takeda, Airtricity, Wind prospect, Research and Development, Safety, ABO wind, HP, Intel, Air Bus, SEI, Retail Management, Fitness Industries, Bosch, Honda, Aquamarine.

Out of 35 students, 27 had physics, 14 had chemistry, 24 had higher and 3 had ordinary maths, only 5 had applied maths in their leaving certificate. 29 students are satisfied with their level of competency acquired during their studies. Overall 80% of the students are happy with their level of achievement from their graduate studies.

DCU, mechanical students considered themselves to be more competent in physics and maths than biology or chemistry. They have well balanced IT and programming skills. Students are creative and innovative and have a strong knowledge of ethics. Students think that they are lacking in social and business skills as they do not have any training on those. They would like to improve their legal, entrepreneurship, interpersonal and conflict resolution abilities.

In an open question in part 2g, they have indicated to have wider knowledge on CFD, CAD, FEA, Automation, signal processing, pneumatics and control. They would like to have more practical knowledge to be able to handle the equipment machined by them. Most of the students are not happy with the final year project as they felt that there are not properly trained to do the project with previous courses or training gathered from the degree. The majority of the students pointed out that LabView and more programming skills should be developed as part of the course.

3.2 Employer Survey
Ten leading DCU work placement and graduate employers partook in this survey for the purpose of this research paper. All of the companies surveyed (100%) were satisfied overall with the level of skills found in placement students and graduates in Engineering/IT. Of those surveyed,

80% found students/graduates very competent in Physics and Maths and reasonably competent in Biology and Chemistry where it was relevant to their industry. Employers were very satisfied with software and information systems abilities evident in students/graduates. The inclusion of e-commerce as part of their programme development was mentioned. The majority scored very well on creativity and innovation but appeared weaker on brainstorming activities and project management.

Results indicate that employers found graduates competent in engineering practice skills but expressed the need to develop their leadership abilities. Results also indicated the need for students to be competent in Industry Standards and Health & Safety.

Employers expressed that their professional development skills such as presentation and written skills could be improved. Some employers responded that students and graduates were shy in their initial days of employment and at interview needed to improve motivation for the roles offered. Overall their business acumen could be improved and they need to realise the reality of starting at entry level within companies.

Some employers expressed the need for more specialists training in areas such as Radiofrequency, Internet Protocol Networks. Others expressed the need to improve their industry knowledge and become more aware of what is happening in the industries which employ them.According to the research results, placement students and graduates need guidance on new technologies within the companies. An emphasis on AutoCAD is needed as part of their programme development. Legal and regulatory skills should be covered within their programmes of study as well as quality assurance. For the pharmaceutical industry employers expressed concern over the lack of awareness amongst students/graduates about clean rooms.

As we move into the next five years, there is an increased effort to reduce energy consumption and alternative energy sources need to be further development. This is an area which should be concentrated on as part of Engineering/IT programme development in the future. There are strong agreements between the students self assessment and the employers opinion on the competency level and the future competency needs.

4. REFERENCES

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