EXPERIENCES OF TEACHING, LEARNING AND ASSESSMENT OF STUDENT RESEARCH SKILLS ON A LEVEL 9 TAUGHT PROGRAMME IN ENGINEERING

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Abstract: This contribution reports on the teaching, learning and assessment of a Research Methods module on a Level 9 taught programme in engineering at DIT. The module was run in the 2008-9 and 2009-10 academic years. The module is a generic one, whose aim is to facilitate students in developing a comprehensive proposal for their engineering research project. A team approach was taken to module instruction. Students were assessed (at different stages during the module) by evaluation of a written research proposal planner document, a reflective PowerPoint presentation and a final written research project proposal. The contribution reflects on the module experience, including the lessons learned and the proposed further development of the module.

Keywords; research methods, level 9.

1. INTRODUCTION

The Faculty of Engineering of the Dublin Institute of Technology (DIT) introduced, in September 2002, a programme leading to a ME degree in Advanced Engineering. To respond to changing requirements, this programme was replaced by four denominated ME programmes in September 2008 (in *Mechanical Engineering*, *Sustainable Electrical Energy Systems*, *Pharmaceutical Process Control and Automation* and *Signal Processing*). These programmes can be taken on a full-time or part-time basis. The programmes are semesterised and modularised, allowing learners to advance from a Postgraduate Certificate (on completion of six taught modules or 30 ECTS credits) to a Postgraduate Diploma (on completion of twelve taught modules or 60 ECTS credits) to a Masters degree (on the completion of twelve taught modules and an engineering project or projects, a total of 90 ECTS credits). Single module certification is also available. Full details of the programmes are available (DIT, 2010).

Research Methods is a core module, shared by all of the ME programmes. The module learning outcomes are that, on successful completion, the learner will be able to:

- Construct a strategy to conduct research;
- Appraise and evaluate library resources applicable to their research at postgraduate level;
- Write a literature review relevant to the research proposal;
- Demonstrate an ability to critically evaluate all aspects of their research;
- Develop a research proposal for a research project and develop a plan to complete the project;
- Write and present a research proposal.

The module is continuously assessed. The final outcome of the module, weighted most heavily for (summative) assessment, is a student-written research project proposal; in this proposal, it is

expected that the research questions would be identified, the literature review developed, the research methodology made clear and the significance of the study established.

Modules with similar learning outcomes are now common on taught engineering postgraduate programmes in Ireland (e.g. TCD, 2008; UCC, 2009; UCD 2009; DCU, 2010; WIT, 2010) and internationally (e.g. Oregon State University, 2009). Most modules focus on skills development in topics such as information literacy and dissertation writing, though some cover other topics, such as statistical analysis techniques (e.g. DCU, 2010). Increasingly, interesting papers are appearing on aspects of this work (e.g. Hill, 2006; Holles, 2007; Antonesa and McAvinia, 2008; Willison, 2008), though experiences remain underreported, particularly in the Irish context.

At DIT, it was decided to run the Research Methods module in Semester 1, to prepare students for the engineering project which could start in Semester 2 for full-time students; part-time students have a more flexible date to start project activity. A team-based approach was taken by instructors in designing the learning activities for the module. The author was responsible for running a series of student workshops, in which students worked in teams, in a brainstorming environment, to solidify project topics and ideas. Student work was underpinned by workshops, delivered by the author's colleagues, on information literacy, technical writing, critical thinking, the research funding process, and intellectual property and patenting issues.

2. EXPERIENCES 2008-9

The module was first run in the 2008-9 academic year, and 17 full-time and part-time students, drawn mainly from the Mechanical Engineering stream, took the module. The learning schedule is outlined in Table 1.

Week	Topic	Lecturer
1	Research methods module outline. The research project. Overview of current research activity in the Faculty of Engineering. Criteria for research proposal assessment. Proposal planner.	A. O'Dwyer
2	'Brainstorming': Student presentation of thoughts on their research topic.	A. O'Dwyer
3	Feedback of results of brainstorming session. Research methodologies.	A. O'Dwyer
4	An introduction to literature reviewing. Using library resources.	J. de Foubert
5	Devising search strategies. Identifying and using relevant e-resources.	J. de Foubert
6	Review Week	
7	Current awareness services for research. Plagiarism issues. Review search strategies and literature review progress.	J. de Foubert
8	*Formative assessment: Student presentation of a short literature review of their chosen research topic, plus a reflection.*	Team
9	Critical thinking, CoRT (Cognitive Research Trust) thinking techniques.	D. Gordon
10	Technical writing.	T. Burke
11	The funding process, sources of funding, how to apply for funding, how to manage a funded project.	M. Rebow
12	IP and patenting issues.	M. Rebow
13	*Student presentations on research proposal. Tutor marking. 30% of mark.*	Team
	Week 16: Submit 4000 word research proposal report. 70% of mark.	Team

Table 1 Learning schedule for module: 2008-9.

Overall, the research proposals produced were of a satisfactory standard. Upon reflection at the end of the module, examining student feedback, and after discussions with the course directors of the engineering streams, the following actions for improving the module experience were identified:

- A rebalancing of the assessment, so that it occurs more evenly throughout the module;
- The production of clear assessment criteria for students, with student involvement in assessment;
- The greater use of workshops;
- Encouraging a better link between the research proposal and the research project;
- Submission of research proposal reports electronically, allowing the use of anti-plagiarism software as an option;
- Clearer academic responsibility for the module, with closer co-ordination of module activities.

3. EXPERIENCES 2009-10

The module was run for the second time this academic year and was completed by 59 students, 30 students on the Mechanical stream, 17 students on the Sustainable Electrical Energy stream and 12 students on the Pharmaceutical Process Control and Automation stream. Of these 59 students, 50 were following their programme on a full time basis. The increase in student number and diversity, coupled with the lessons learned from the module experience in the previous academic year, prompted the development of the learning schedule summarised in Table 2.

Week	Topic	Lecturer
1	Workshop 1: Research methods module outline. The research project. Overview of current research activity in the Faculty of Engineering. Criteria for research proposal assessment. Proposal planner.	A. O'Dwyer
2	Library resources, search strategies, current awareness services for research. Plagiarism issues in academic writing.	J. de Foubert
3-4	Workshop 2: 'Brainstorming': Student presentation of thoughts on their research topic.	A. O'Dwyer
	Technical writing.	T. Burke
5	Workshop 3: Feedback of results of brainstorming session. Research methodologies.	A. O'Dwyer
6	Review Week	
7	*Research proposal planner submission (on WebCourses). 10% of mark.*	A. O'Dwyer
	Critical thinking, CoRT (Cognitive Research Trust) thinking techniques.	D. Gordon
8	Workshop 4. Small group brainstorming regarding proposal ideas and progress to date (including literature review).	A. O'Dwyer
9	The funding process, sources of funding, how to apply for funding, how to manage a funded project, IP, patents.	M. Rebow
10-13	*Student presentations on research proposal. Peer and tutor marking. 20% of mark.*	A. O'Dwyer
	Week 16: Submit 2000 word research proposal report (on Webcourses). 70% of mark.	Team

Table 2 Learning schedule for module: 2009-10.

Academic responsibility for the module was devolved to the author. The final research proposal report was shortened to 2000 words, partly because of the larger student numbers, but also because it was considered that report quality and length were not necessarily linked. Assessment was spread more evenly through the module, and the assessment strategy was refined. Firstly, a two-page research proposal planner, which provided a framework to develop and refine the research proposal, was submitted by students in Week 7; the proposal planner template was

provided to the students in Week 1. This was followed by peer and tutor assessment based on short individual student presentations, scheduled over four weeks towards the end of the module. The author has significant experience of managing peer assessment (O'Dwyer, 2010), and this is discussed further in Section 4. All assessment criteria were detailed, and involved student consultation in their development; as an example, the assessment criteria for the research proposal report are given in Table 3.

	1+	1	2(1)	2(2)	P	F	
Introduction developed							Introduction not developed
Literature reviewed [1]							Literature not reviewed
Research questions identified [2]							Research questions not identified
Research methodology clear [3]							Research methodology unclear
Significance of study established [4]							Significance of study not established

Table 3 Assessment criteria for the research proposal report. [5]

Overall, the production of a research proposal planner was beneficial to the quality of the research proposal report. Figure 1 shows that there is a statistically significant positive linear relationship between the assessment results (for each student) for the research proposal report and the research proposal planner ($p = 0.0079$). In this data, $n = 54$ as five students taking the module decided not to submit a proposal planner. The research proposal planner was assessed wholly by the author; complete assessment time was approximately 8 hours, or approximately 9 minutes per research proposal.

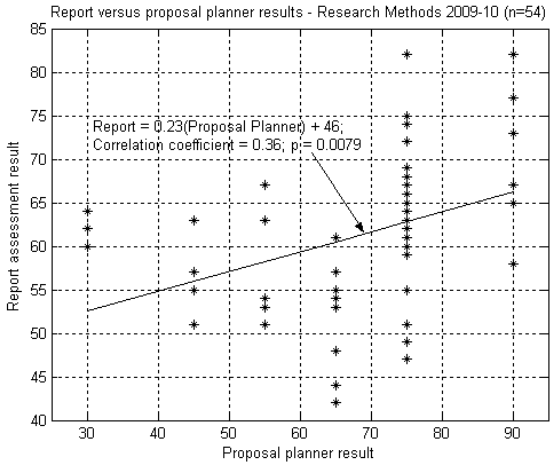

Figure 1 Relationship between report and planner assessment results

[1] Includes, as relevant, if the theoretical framework established/not established, if references are/are not to standard expected.

[2] Includes, as relevant, if the purpose of the study is clear/unclear, hypothesis developed/not developed.

[3] Includes, as relevant, if the research design is established/not established, if sampling issues are clear/unclear, if instruments are established/not established, if data collection issues are clear/unclear, if data analysis issues are clear/unclear.

[4] Includes, as relevant, if limitations have been considered/not considered, if ethical issues have been considered/not considered, if IP/patenting issues have been considered/not considered.

[5] A tick in the extreme left hand box means that the statement on the left is true and is of 1+ (90%) quality. The boxes from left to right are abbreviated by 1+ (90% - outstanding), 1 (75% - very good), 2(1) (65% - good), 2(2) (55% - adequate), P (for Pass – 45% - poor) and F (for Fail – 30% - very poor). In addition, space was provided for assessors comments.

4. PEER ASSESSMENT

A significant literature exists on peer assessment issues. For example, Falchikov (1995) provides an interesting and comprehensive literature review on peer assessment issues; other authors (e.g. Magin and Helmore, 2001) focus on the validity of peer and tutor assessment of the oral presentations skills of (engineering) students. Some authors give more specific advice on how to structure the peer assessment process (e.g. Falchikov, 1986), suggesting that the provision of explicit assessment criteria to the peer assessors is important. The contribution closest to the approach adopted in the Research Methods module (both from an assessment methodology and presentation procedure) is that of MacAlpine (1999).

The use of peer assessment (in this case of student oral presentations) is recognised as enhancing student communication skills and further develops student ability to work effectively, particularly as individuals. More generally, the method is learner-centered, motivates independent learning, caters to a diverse student background, raises awareness of ethics, unlocks student work and learning experiences to the benefit of all learners and provides case-study material that may be used on other programmes (O'Dwyer, 2010). The assessment template developed, after consultation with the students, has two parts: a 'presentation' part, and a 'contribution' part. The template provided to the students is now given; the presentation part is peer and tutor assessed, and the contribution part is tutor assessed only.

Presentation [maximum assessment mark: 72]

Content and presentation are assessed, following the structured guideline below. You are asked to 'tick' the appropriate box. A tick in the extreme left hand box means that the statement on the left is true and is of 1+ (90%) quality. The boxes from left to right are abbreviated by 1+ (90% - outstanding), 1 (75% - very good), 2(1) (65% - good), 2(2) (55% - adequate), P (for Pass – 45% - poor) and F (for Fail – 30% - very poor).

	1+	1	2(1)	2(2)	P	F	
Content	//						**Content**
Research question(s) identified							Research question(s) not identified
Literature review developed							Literature review not developed
Research methodology clear							Research methodology unclear
Accurate presentation of factors							Much questionable/inaccurate issues
Significance of study established							Significance of study not established
Presentation	//						**Presentation**
Attention-grabbing introduction							Uninspiring introduction
Convincingly argued							Argument lacks credibility
Clear and effective use of PowerPoint (inc. figures/tables)							PowerPoint use unclear and ineffective
Reasonable length							Too long/short
Animated tone							Flat or stilted or nervous tone

Contribution [maximum assessment mark: 28]

You can make brief helpful contributions and feedback about the presentation of each person. Each helpful contribution will receive either 1 or 2 marks (as a broad guide, 2 marks will be awarded for helpful feedback about the project content). Since there are 14 people presenting (excluding yourself), you can score a maximum of 28 marks from this part of the assessment.

Overall, Figure 2 shows a statistically significant positive linear relationship between the assessment results (for each student) for the research proposal report and the presentation ($p = 0.0109$). Other work shows that there is an average increase in the module mark for persons who collected their peer assessment feedback (collection was voluntary), suggesting that such peer feedback adds value to subsequent student work. The collation of assessment results was done wholly by the author and took approximately 25 hours or approximately 25 minutes per presentation.

Finally, the author requested student feedback, though a questionnaire, on the peer learning and assessment experience. Though the response rate to the questionnaire was disappointing, some excellent feedback was obtained. This will be discussed further at the conference.

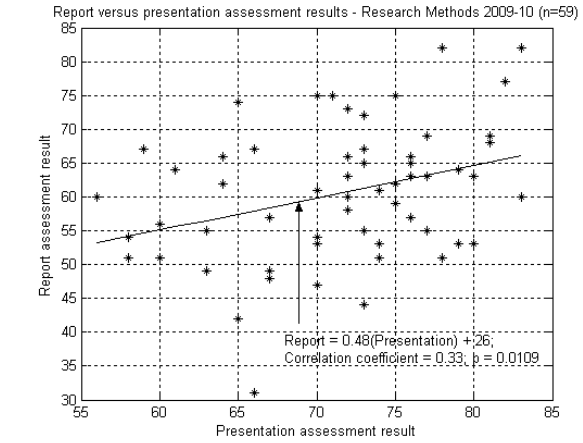

Figure 2 Relationship between report and presentation assessment results

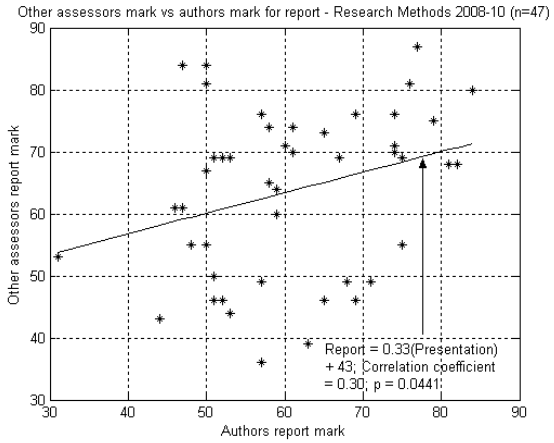

Figure 3 Relationship between other assessors report mark and authors report mark

5. REFLECTION ON MODULE

5.1 Assessment of research proposal reports

The research proposal reports prepared by students on the Pharmaceutical Process Control and Automation stream, and the Sustainable Electrical Energy Systems stream, were assessed by the author and one of three other assessors, in both academic years, using the assessment criteria detailed in Table 3. Figure 3 shows that there is a borderline statistically significant positive linear relationship between the other assessors mark and the authors mark for each student ($p = 0.0441$). This suggests that the assessment criteria may need to be more transparent. The assessment of the proposals, which take approximately 30 minutes each, is time consuming; however, the author recommends that, resources permitting, proposals should continue to be marked by at least two assessors, and that this assessment regime should also apply to proposals developed by students on the Mechanical Engineering stream.

5.2 Student feedback on the module

At DIT, student feedback on a module is obtained using a standard student survey questionnaire, in which students are asked to answer 32 questions, on a 4-point Likert scale, by ticking boxes, followed by a 'General evaluation and suggestions' section, which requests feedback on the good

features and weaknesses of the module, and suggestions for module improvement. Student feedback was requested by e-mail. Though the response rate to the questionnaire was disappointing (at 36%), many interesting comments were made. An issue that exercised some of the students who completed the feedback was the difficulty they experienced in proposing and developing a research topic. One comment, from a student on the Pharmaceutical Process Control and Automation stream, is revealing: *Asking me what project I intend to do at the beginning of a course of study is pointless; I would have liked some guidance on a suitable project (or a methodology for finding one). Spending a considerable amount of time writing a research proposal on an idea that probably will not be pursued is a waste of time. I wanted this module to help me define a useful research topic, and how to carry it out. It may have achieved something with respect to carrying out a research project, but it completely failed to assist me in defining an area of research, which is for me a far greater difficulty*. As mentioned in Section 1, the Research Methods module was run in Semester 1 to prepare students for the engineering project which could start in Semester 2 for full-time students. None of the nine full-time students on the Pharmaceutical Process Control and Automation stream subsequently started the engineering project in Semester 2, though twelve of the seventeen full-time students on the Sustainable Electrical Energy stream did so. The course team concluded that more support is needed to help students, particularly on the former stream, to identify a research topic. In the future, an early meeting between all research active staff and students will be organised, perhaps on a 'speed dating' model, to allow the seeding of research ideas to occur.

5.3 Other reflections

- The first workshop will be modified to discuss the purpose of the module in more detail, in response to some student suggestions that this was not sufficiently clear.
- Though peer assessment is broadly supported by students who gave feedback, it is proposed to make more explicit the elements that are being examined in the 'Content' section of the peer assessment form. It is also proposed to examine the use of audience response systems ('clickers') to automate part of this assessment.
- Student feedback will be obtained in the classroom in future to maximise participation.
- Many students did not include a project schedule chart or treat intellectual property issues sufficiently in their research proposal reports. More generally, many project proposals were too ambitious for the project timescale. These pitfalls will be discussed in more detail the next time the module runs.
- Finally, though the author used Webcourses to store all resource material for the module, and for submission of assignments, students only used the platform for 5.5 hours, on average. The author is currently exploring the use of a wiki, on an MSc programme, as a collaborative learning tool to assist in the development of individual student research proposals; experiences gained will inform further developments for the Research Methods module on the ME programme.

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