

Establishing and supporting educational research in engineering from a local and national perspective

Arlett, C.

Higher Education Academy Engineering Subject Centre, Loughborough, UK
Carol@engsc.ac.uk

Crawford, A.R.

engCETL, Loughborough University, UK
a.r.crawford@lboro.ac.uk

Moron-Garcia, S.

Centre for the Study of Higher Education, Coventry University, UK
aa4458@coventry.ac.uk

Willis, L.

Higher Education Academy Engineering Subject Centre, Loughborough, UK
Liz@engsc.ac.uk

***Abstract:** This paper describes an action research approach to supporting an improvement in the educational research skills of engineering academics in the UK. Two engineering education centres based at Loughborough University (the engCETL which is funded to support academics based at the university and the Engineering Subject Centre which has a national remit) have worked collaboratively to develop resources, including guides, workshops and other events and have started to disseminate this work internationally. In response to an identified need to develop understanding and to facilitate collaborative opportunities, a Special Interest Group has been established that will promote high quality educational research and provide the UK voice for international research communities. This is work in progress and there will be further evaluation undertaken of the impact of these developments. The aim is to establish a self-sustaining community of researchers as there is limited funding for engineering education research in the UK.*

Introduction

Loughborough University is one of the largest providers of engineering degrees in the UK, all of its engineering teaching has been rated as excellent in quality assurance audits and it has more postgraduate students completing engineering education research than any other university in the UK. The University hosts the national UK Higher Education Academy Engineering Subject Centre (EngSC) which has a mission to “work in partnership with the UK engineering community to provide the best possible higher education learning experience for all students and contribute to the long term health of the engineering profession” (HEA Engineering Subject Centre, 2009). Its strategic aims include promoting engineering education research and sharing effective practice. In 2005 Loughborough University was also awarded the Engineering Centre for Excellence in Teaching and Learning (engCETL) for a five year period to reward and support excellent engineering education within the university (Crawford and Dickens, 2008). The engCETL mission is to be recognised as a centre for excellence in the research, development and provision of engineering education through an active involvement with industry. The engCETL also aims for a cultural change that supports a reflective and evidence-based approach to teaching. This is achieved through the provision of support for academics at Loughborough who wish to investigate their teaching and their students' learning,

plus targeted education research through six PhD studentships, the aim being to showcase and transfer effective practice firstly across the subject areas involved and then more widely. Over 30 staff work across the two centres to support engineering education and due to an overlap in aims and the co-location at Loughborough, staff work collaboratively to produce resources, including guides, workshops and other events which are offered nationally to engineering academics.

Until recent years only a small number of engineering education research publications have been published demonstrating limited expertise and interest in the UK in pedagogic research within engineering. Arlett, Smith and Tolley (2007) found views from engineering academics that “educational research and engineering are not always comfortable bed fellows” and Canning (2007) recognises that conducting pedagogic research can be culturally difficult for academics who are not used to social science methods. Engineering academics are observed to have a tendency to rely quite heavily on quantitative measures and a distrust of the qualitative, as well as a not too surprising unfamiliarity with the educational literature (Borrego, 2007). In the UK it has been difficult to secure significant sustained funding for educational research and although pedagogic research is accepted for submission to the Research Assessment Exercise (RAE) there is a reluctance to submit engineering education research to the panels.

We have also been aware of the rise of engineering education research as a global discipline (de Graaff & Lohmann 2008) and our intention is to draw on this work to enhance engineering educational research in the UK.

In 2006 the two centres decided to offer a workshop to provide academics with a better understanding of pedagogic research, to introduce them to the use of more qualitative approaches and to give them the confidence to try these to examine their practice. We were surprised by the amount of interest generated and the speed of registration: 40 bookings were received within 24 hours of the event being advertised. Since this time, the Centres have continued to develop, evaluate and refine a programme of support for research in engineering education. In the absence of significant funding for research, and to ensure sustainability, there is a need to develop a self-supporting community of practice (Borrego, 2007; Wenger, 1999; Case 2008). The Engineering Subject Centre has recently established a Special Interest Group to develop understanding and to facilitate collaborative opportunities with the aim of promoting high quality educational research and providing the UK voice into European, American and Australian research communities, amongst others.

The engCETL funding is currently supporting six PhD studentships covering the following topics: The impact of work placements on transferable skills; The impact of industrial sponsorship on students, academia and industry; enhancing teaching and learning through virtual and remote experiments Appraising the Benefits of Project-Based Learning in Engineering Design; A Curriculum Investigation into the Study of Digital Industrial Design; and Applying technology to improve understanding in the Teaching of Electrical Machine Theory. It was recognised that these students would need additional support to that offered by their supervisors and this is provided through a Research Associate, also funded by the engCETL, with an education research background.

Research questions

The primary research question was 'how can activities to support engineering educational researchers, provided at a local and national level, lead to an increase in the capacity, esteem and recognition of educational research in engineering?' The starting point was to address the question, how can we facilitate the conduct of educational research by engineering academics rooted in their own disciplinary practice?

Theoretical framework

This paper describes action research (Cousin 2008) that has been undertaken by staff in the two centres to enhance understanding of the needs of engineering academics and PhD students involved with pedagogical research, and to develop and refine a package of support.

The centres' approach mirrors what Roche (2003) in “*being an agent of change*”, identifies as a framework for inquiry and key to informative change:

Inquiry 1: Stakeholder analysis stage 1 – Who are the people?

Inquiry 2: Stakeholder analysis – what are stakeholder values, aspirations and needs and what is the fit between expectations and the current situation?

Inquiry 3: What do people interpret as the development issues requiring attention and what is their vision for the future?

Inquiry 4: Where is the leverage for change?

Inquiry 5: What has been learnt for programme design and/or change direction from the exploration?

We know from Becher and Trowler's work on Academic Tribes and Territories (2001) and Neumann et al (2002) that disciplinary context is important in terms of the way research is conducted. In the context of our work, the academics are our 'learners' and it is important that we adopt a 'student-centred approach' and need to be aware of their starting point and disciplinary background.

The concept of building a community of practice is central to the sustainability of the work being undertaken and this has been started by the setting up of a special interest group. The two centres are facilitating the process (Wenger, 1999) and acting as a network animator (Jones, 2004).

It should be noted that the researchers have adopted an action research approach to develop and sustain educational research whilst at the same time encouraging academics to undertake (and to recognise) this form of self-reflective enquiry in order to improve their own practices (Carr and Kemmis, 1986: 162). This is a challenge for us all involved with this work as we would still see ourselves as learners who need to develop our own knowledge and skills and at the same time we are trying to ensure that we lead by example!

Methodology

A stakeholder analysis involved identifying who was currently doing or interested in undertaking educational research. At a local level, it was an easy process to discuss the immediate needs of the researchers based within the engCETL, including PhD students and staff involved with their supervision and support.

The Engineering Subject Centre was able to make an assessment of professional development needs at a national level through its network of contacts in engineering departments across the UK and we were also aware of the levers for change as interest in pedagogic research was increasing. We were aware of the need to build capacity and quality of papers for the centre's newly launched Journal as early submissions were clearly lacking in objective evidence that students had learnt more or had better understanding from the developments described. Experience from peer reviewing applications for small funding grants offered by the centre also showed an inadequate knowledge of evaluation.

Additional data to provide information about the training needs has been collected from the international literature on the development of engineering education research. We have also drawn on previous work on the drivers and barriers to promoting engineering education research and from data collected for evaluation reports for the Engineering Subject Centre.

However, the key people who are able to contribute to the answer to the research questions were participants in a programme of professional development run by the two centres. Workshops were held “to increase pedagogic understanding and equip engineering academics with tools to enable them to reflect on and research their own practice and the impact this has on student learning” (Moron-Garcia and Willis, 2007). Data has been collected from delegates who attended workshops on pedagogic research that have been held regularly over a two year period through a variety of questions.

Pre-workshop: Delegates were asked *How might engineering students benefit if their lecturers know about and do some pedagogical research?*

During the workshop as delegates are asked to consider: What does “enhancing the student learning experience” mean to you? and in reflecting on writing for publication consider why you might want to publish.

End of event feedback form questions include: What did you hope to achieve by attending the event?, What were the most interesting/useful aspects?,

How do you think the event will have an impact on your teaching/work?

After event Postcard follow up - each delegate was asked to make notes on a postcard of the key ideas they are going to take away from the workshop and their next action. These are collected and posted back to the delegates 3 months after the workshop.

An online survey of workshop attendees is conducted six months after attendance at a workshop to investigate the impact of the event.

All the data collected is analysed and the outcomes from the workshops have fed in to the development of a tool-kit aimed at engineering academics. This toolkit has now been published as a loose leaf folder to be issued to delegates at future workshops and will continue to be developed through an online version that will encourage feedback from users. (Morón-García, Willis & Case, 2009)

Findings and conclusions

The UK Research Assessment Exercise

The Research Assessment Exercise (RAE) is very influential in the UK and therefore this was identified as a potential driver for engagement with educational research. Many engineering academics have already submitted technical research under the same exercise and it became clear that education research methods would gain credibility if awareness was raised of the acceptance by the RAE, which would then lead to recognition by senior colleagues. The RAE guidance for pedagogic research is very clear that “Pedagogic research in HE will be assessed where it meets the definition of research for the RAE. It is research which enhances theoretical and/or conceptual understanding of: teaching and learning processes in HE, teacher and learner experiences in HE, the environment or contexts in which teaching and learning in HE take place, teaching and learning outcomes in HE, and the relationships between these processes, outcomes and contexts.

Reports of studies providing descriptive and anecdotal accounts of teaching developments and evaluations do not constitute pedagogic research. Pedagogic research is firmly situated in its relevant literature, and high quality pedagogic research makes a substantial contribution to that literature.” (HEFCE, 2006, p. 14).

One of the key indicators of research performance within the RAE is the number of successful completions of research student degrees. There is very limited funding available nationally for PhD studentships in engineering education, but the funding of the engCETL enabled the appointment of 4 fully funded and 2 part funded research students. A call for engineering pedagogy research studentship topics was sent out to all engineering related departments at Loughborough University, with demand greater than availability. Studentships were selected through the interviewing of each proposing academic by a research advisory panel. The panel was chaired by a professor of engineering education and included specialist pedagogic input from an external consultant and the engCETL research associate. This approach ensured that the aims could be adapted to ensure the focus was pedagogic research (rather than resource development) and that there was buy-in from the academics. By appointing six PhD students and through regular joint activities such as poster sessions and reports on progress, we have been able to develop a small research community. We are very conscious of meeting the professional development needs of these students as there is currently no guaranteed career path on completion of their doctorates. As a result all of the students are required to undertake at least ten days of personal and professional development each year which also meets the expectations of the UK government regarding employability of researchers, detailed in the Roberts Review (2004). Where possible generic skills are developed which also link to their research for example the research students are now organising a Symposium on Science, Technology, Engineering and Mathematics Pedagogy Research Methods in Higher Education which is open to all pedagogic researchers (STEM PRM, 2009).

Other actions that were taken

It was identified that more opportunities for publishing papers and presenting at conferences were needed. Engineering Education - the Journal of the Higher Education Academy Engineering Subject Centre, was launched in 2006 to provide an opportunity for engineering academics to publish. It is a peer-reviewed, international journal that aims to promote, enhance and disseminate research, good practice and innovation in all aspects of engineering education (www.engsc.ac.uk/journal). Papers are not limited to pedagogic research (they may also include case studies, critical reviews and evaluations, investigations of new methods, the results of action research, policy matters and the changing context of engineering education). However the vision for the Journal is that it will see an increase in research rigour and papers reflecting a wider variety of methodologies.

An Engineering Education Conference is now held in the UK every two years. The most recent conference EE2008 - the international conference on innovation, good practice and research in engineering education - was run by the Engineering Subject Centre. This conference was dedicated to enhancing the quality of higher education in all engineering disciplines. It served as a forum for the sharing of innovation and good practice and provided delegates with the opportunity to critically and creatively engage with new ideas and research that might help them develop their own approach to learning, teaching and assessment. All papers presented went through a rigorous review process and time was committed to providing constructive feedback to contributors which was generally well received by the authors who saw this as a useful developmental process.

What did we learn from the workshops attendees?

In response to needs identified by workshop delegates, the toolkit provides information about other relevant journals; Top tips on Writing for Publication (a list compiled by engineering academics who attended workshops); and a bibliography to provide a starting point for new researchers.

Participants in the workshop highlighted the need for a network to be facilitated with a view to establishing a community of practice, with quotes "... if students are to benefit, we as a group need to be aware of best practice and the most appropriate method of delivery. For this to become a reality we must all have at least a working knowledge of current pedagogical opinion and be able to draw upon the innovation of our colleagues and peers." "Gained knowledge, inspiration and contacts from the event. Discussions raised many of the issues concerned with pedagogic engineering research that had been worrying me and putting me off proposing new projects and publishing work". To this end the EngSC has provided funding for an Engineering Education Research Special Interest Group. The funding will allow colleagues to meet face to face to establish the new network and access to a variety of web tools to support on-going discussion and collaboration.

What was the impact of the support?

Attendees at pedagogic research workshops were asked "How might engineering students benefit if their lecturers know about and do some pedagogical research?" They responded that this would enable them to:

1. make informed judgements about the best ways to present material to encourage student learning;
2. respond appropriately if students have problems in learning;
3. teach more effectively;
4. evaluate and adopt, where appropriate, new teaching methods.

(Moran-Garcia & Willis 2007)

Six months after attending a workshop we asked attendees from one of the workshops to fill in an on-line questionnaire to tell us about how the event had influenced teaching and learning. Four out of the six respondents indicated that they had 'discussed all aspects of learning and teaching raised at the event with colleagues', two reported that they had introduced or planned to introduce 'a change in teaching practice' and one indicated that they were "progressing their pedagogic research agenda within their School and Faculty". There were some indications that positive action would result as one participant stated that he had been encouraged to 'Make specific plans for publication... and to apply for School funding for my own small scale research project'.

Another participant concluded that, “The act of carrying out any pedagogical research inevitably leads to a focus on the students and how they react, perform and develop in response to the various aspects of a planned programme of study. Knowledge gained from such research when shared with students can assist their understanding of the principles and processes allowing them to cooperate more effectively in their own development.”

Future Plans

This paper describes work in progress and it is too early to be able to measure any significant outcomes. There is significant scope for further development work and research, but it is anticipated that it will be increasingly difficult to fund these activities.

The issues identified from the work to date are:

- Sustainability of research particularly as engCETL funding comes to an end.
- We need a more rigorous longitudinal study of the impact of activities to date through: in-depth interviews; event follow-up surveys; and on-line feedback on the Toolkit.
- How to expand contacts? We have just started to build up a community of practice in the UK and we are starting to explore mechanisms to link to European networks through the SEFI working group and further afield.
- How to ensure that engineering educational research is included in the next Research Assessment Exercise? We are starting to see a change in the rigour of engineering education research in the UK, but we need more clarity about how we can measure quality, establish credibility and secure funding.

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