

Engineering Education Research – Creating an Environment for Action

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***Abstract:** This paper sets out to explore the engagement of university engineering staff in the area of engineering education research. In studying the engineering education research literature, much of the work reported has a student or policy focus. Few papers explore the engagement of faculty in education research, in particular the drivers that may stimulate activity in the field. To truly develop understanding of engineering education, it would seem reasonable to have engineering faculty researching in the area. This exploratory study presents some initial data leading to a conceptual model for the university environment. This foundation is seen as the starting point for promoting innovative and impactful pedagogical development, insightful policy development and the development of future graduates ready to embrace the challenges of an ever changing world. In proactively addressing these ‘development’ objectives, this paper will describe the model for learning and teaching research activity currently being implemented at a UK university.*

Introduction

With the increasing difficulty in recruiting students to engineering programmes across the globe (HESA, 2008), it becomes important for engineering academics to better understand the pedagogical aspects of their discipline. In 1988 Felder and Silverman produced a seminal paper that discussed the mismatch between student learning and academic teaching styles in engineering education, a feature still common in higher education today. The search for knowledge on how to develop engineering education is perhaps best illustrated by the debate presently taking place at engineering education conferences in different parts of the world (ASEE, 2008).

A particular focus has been on the subject of engineering education research. The point is frequently made that much of the work attempting to pass off as research is really practice development, often in the form of innovative teaching interventions that aim to engage students more fully in their learning (Yorke, 2000; Lohmann, 2008). Work of this type has a role to play in the broader development of engineering education, yet no amount of small scale studies attempting to answer research questions that have not been articulated is going to increase the underlying knowledge base about engineering education.

A term that has become popular in the recent literature is that of a ‘community of practice’. Fincher and Tenenberg (2006) concisely express Wenger’s original sentiments describing a community of practice as ‘mutual engagement in a joint enterprise that gives rise to a shared repertoire of knowledge, artefacts and practices’. In the broader field of education research, Tight (2003) uses the community of practice concept to break down research activity into distinct themes, one of which is academic work – that relating to the roles and development of staff. In a follow up study published in 2008, Tight suggests that two communities actually dominate, one being focused on the Higher Education organisation, its structure and operation. The second community is built around teaching and learning with a focus on courses and institutional practice. Academic work is no longer explicitly visible. Community development can be a challenge. Roxa and Martenensson’s (2008) account of change in Sweden indicates ‘a balancing act in need of cautious monitoring’.

Boyer’s treatise on scholarship from 1990 suggests “a more inclusive view of what it means to be a scholar”. To that end, the pursuance of pedagogic study alongside that which is discipline specific becomes essential for the modern day academic. A study conducted by Lueddeke in the UK using ‘Approaches Inventories’ reinforces the ‘professionalisation’ of teaching practice (Lueddeke, 2003). In

recognising the challenge of engaging teaching staff in scholarship, Lueddeke identifies development strategies, a key one being the growth of '*informed networks*' much like the 'community' suggested by Tight. Disciplinary differences are apparent, so it is not 'one approach suits all'.

On an individual level, the engineering educator must consider what 'being professional' means. Wilensky's seminal paper from 1964 suggests that professionalism is about 'autonomous expertise and the service ideal'. With Boyer's scholarship model, this would suggest a depth and breadth that may go beyond the view of many teaching engineering in universities today. The 'cycle of professional practice' proposed by Dee Fink et al (2005) captures some of the features of Wilensky's and Boyer's work, yet the depth of enquiry associated with research is not an obvious component of the cycle. This raises the question, should research be more explicit?

The literature suggests that the engagement of engineering staff in pedagogic research is not well understood. As part of the strategy to promote Science, Technology, Engineering and Maths (STEM) subjects in universities, the focus on teaching and its associated development and understanding is critical. It is against this backdrop that this study has been undertaken.

Research Questions

For the exploratory study described in this paper, the objective was to better understand faculty motivation towards and engagement in engineering education research. With this increased understanding there is then the potential to develop a strategy to promote activity in the field. Specific questions posed were:

What motivates faculty to engage in learning and teaching research?

What are the barriers to engagement in learning and teaching research?

How can opportunities for learning and teaching research be created?

The exploratory study focuses on a single university, although the study could be expanded to include other interested universities in the future.

Methodology

The model for learning and teaching research activity currently being implemented at a UK university has seen the formation of a research team charged with 'conducting and promoting pedagogical research across all parts of the university'. One school is that covering Engineering and Applied Science. The research team comprises representatives from all parts of the university, although none are from the educational field as the university has no School of Education. This eclectic mix of people has developed a strategy for three years of activity, with each year having a clear theme – Year 1 'Engagement', Year 2 'Growth' and Year 3 'Achievement'. The team's aim is to use the cross-disciplinary mix to create an environment in which action is the mantra, but which promotes rigorous research to develop understanding and the subsequent influence on policy and practice (Healey, 2000; Borrego et al, 2008).

Year 1 is focusing on engagement as this is seen as the greatest challenge to building sufficient momentum within the institution. The approach taken to exploring the research questions articulated earlier was two fold.

Firstly, following a response to an internal call for learning and teaching project funding, the submitted bids were subjected to a content analysis to explore the types and quality of the submissions not just from the School of Engineering, but from the three other Schools that make up the university – Business, Life and Health Sciences and Languages and Social Sciences.

Secondly, staff in the School of Engineering was invited to complete an on-line survey in order to capture their thoughts on learning and teaching research in the engineering discipline. The survey was administered at a point in the academic year when it was felt that the majority of staff would be aware of

its existence and would have time to complete it, namely away from the main assessment periods. The notification was sent from the central engineering office to demonstrate School support for the work, yet a decision was taken not to have the Executive Dean of the School prepare a covering letter as this may have been perceived as coercion. For this survey a nil response was as important as a completed survey since it was a reflection on the priority given to the concept of engaging in learning and teaching research.

An inductive approach was chosen for this study as there was considered to be no foundational premise on which a deductive study could be built. Theory building was deemed more worthwhile at this point as the literature was limited and much of the evidence anecdotal.

Findings

Content Analysis

An initial call for learning and teaching innovation proposals resulted in 39 bids from across the university. The bids were requested to be a maximum of 3 pages in length. Of these, only 4 bids were from the Engineering School. This provides the starting point for this study. A content analysis was conducted to explore the features of the bids from the different disciplines in terms of the areas of study, the methodological approaches proposed, how well the research question(s) were framed, the extent to which the literature had been engaged and the demonstrated proficiency for performing pedagogical research.

Starting with the number and type of bids submitted, Figure 1 shows that the School of Engineering did not demonstrate as much engagement with the call as the other schools. The Engineering, Business and Health Science schools are all of a similar size, Languages is around half the size of Engineering and IDS (Interdisciplinary Studies) is considerably smaller.

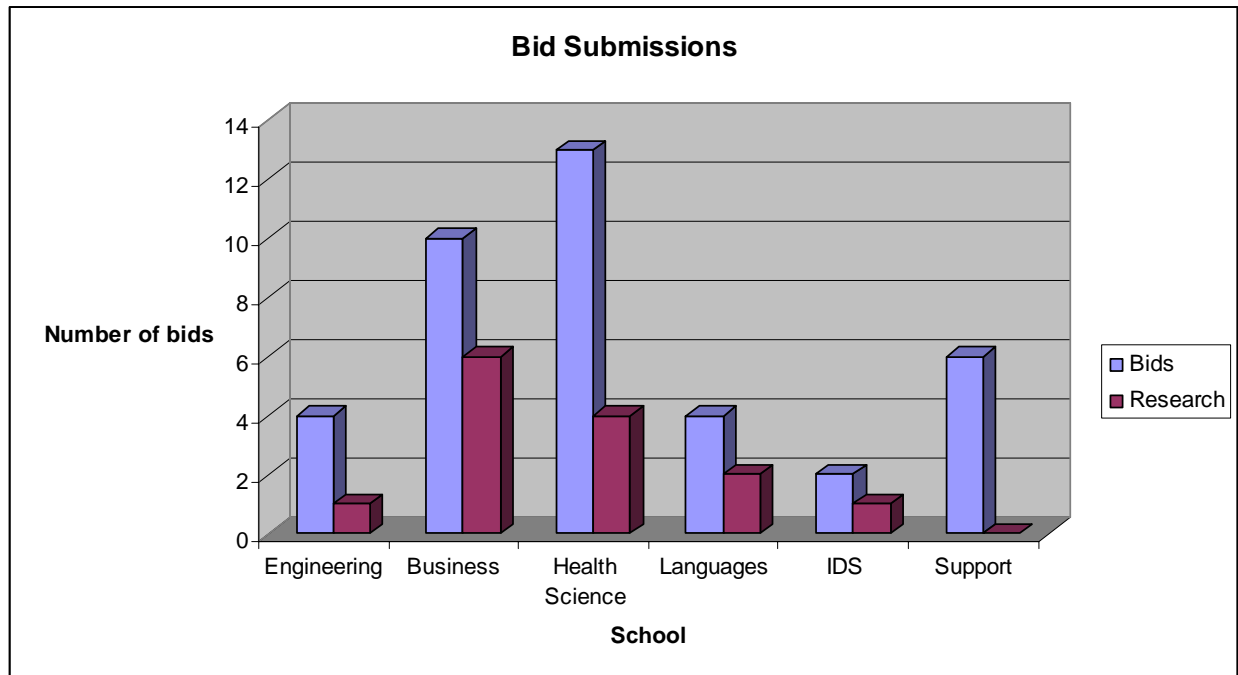


Figure 1: Bid Submissions by School (Research identified separately)

The bids were classified as being in one of 4 areas – Research, Curriculum Development, Learning Technology or a Mixed bid. 14 of the 39 bids were identified as Research and only one of these came from Engineering.

In studying the bids themselves, some interesting observations were made. Only 4 of the 14 Research bids (5 of the 39 in total) articulated a research question. In most cases the proposal launched into a description of an approach without it being clear about the focus of the bid. For the Research bids, all except one bid made reference to the literature with at least 3 references being given in each case. Journals were the dominant source of literature. Away from the Research bids, there were fewer references to the literature – 12 of 25 did include some literature, generally only one or two references.

6 of the Research bids were focused on gaining understanding, the remaining 8 evenly split between intervention and evaluation. As may be expected, those bids not classified as research were dominated by interventions (21 of the 25). Only 2 of the Research bids employed a purely quantitative approach, the preference tending to be for either a combined (quantitative and qualitative) or qualitative methodology. The inductive approach was favoured in 8 of the 14 Research bids. Of the 25 non-research bids, it was the deductive approach that dominated with a combined methodology proposed most often.

Questionnaires and focus groups were the most commonly employed tools. Interviews were a significant minority and observation was not suggested in any bid. The use of grade data, content analysis and other more numerical sources of data were only suggested in 5 of the Research bids. This characteristic was mirrored in the non-research bids. Work plans were only included in half of the Research bids and in only 8 of the 25 non-research bids.

There were no dominant areas of common interest, the diversity being encouraging. Those areas that did receive more than one mention included approaches to learning, teaching styles, employability, learning technology and cultural diversity. Reports were the first identified dissemination method followed by, in equal amounts, a conference or journal paper. For the non-research bids the focus was much more on generating new teaching materials and disseminating the work at a conference.

The data from the content analysis provides an initial ‘snapshot’ of the staff engagement from across the university in the area of learning and teaching innovation and research. With only 36% of the bids explicitly research in nature, it would indicate that most staff see the use of learning and teaching funds as a way to explore developing their practice. This agrees with the observations made in the introduction to this paper when referring to small scale local interventions tending to dominate many conferences and sections of the literature.

Within the bids themselves, the absence of explicit research questions and only a limited grounding in the literature suggests that staff is not deeply engaged with higher education pedagogy. Practices that would not be acceptable within their discipline seemed to be demonstrated in the bids submitted. Time to prepare the bid is always a factor, but should be no excuse. This observation will need further exploration to avoid ‘bad habits’ becoming part of the university culture.

The preference for a qualitative approach, with few bids seeking increased understanding and most proposing similar tools, suggests that the knowledge base on which staff are building their pedagogic research practice is quite limited. Many bids seemed to be ‘going through the same motions’ with only limited evidence of well thought out yet creative approaches to investigation. This observation, combined with those concerning the research question and literature grounding, indicate the need for much progress if the research is to meet the demands of quality and rigour expected by many journals, and increasingly conferences as well.

One helpful outcome of the bidding exercise was the opportunity to bring together people from different disciplines with similar learning and teaching interests. If performed correctly, this has the potential to develop some robust methodologies that can be transferable across disciplines and aid the generation of larger datasets for study.

Staff Survey

Having analysed the response to the call for proposals, staff in the Engineering School were surveyed to determine their reasons for engaging (or not) with the call and the broader area of learning and teaching innovation. The survey administered comprised 35 questions and was administered on-line. Of the 208 staff in the School, only 11 responded to the survey, a response rate of 5.3%. This in itself was a statement about staff engagement in the area of pedagogic innovation and research.

Despite the small number of responses, the results give much to think about. The respondents were from across the Engineering School and they had been in post for 3 years or more. Only one respondent had any form of teaching qualification (a certificate). The learning and teaching interests were evenly split between pedagogy (in particular practice), the discipline and the desire to help develop effective engineers. In terms of their practice, the respondents perceived themselves as effective and innovative teachers, motivated to develop further, yet feeling unsupported in this endeavour other than by colleagues.

Pursuing pedagogic research was not viewed as helpful in developing teaching practice. Despite some evidence of motivation to perform research (4 of the 11), the responses indicated little feeling of support for this action and no strong desire to publish in pedagogic journals. The higher education press was read by half of the respondents, yet when considering practitioner publications, books and journals, the engagement was minimal. Electronic resources were similarly not well used with only 4 of the 11 questionnaires identifying any interaction, and then only once or twice a year. Learning and teaching events, generally focused on practice rather than research, were attended by half of the respondents when held within the institution. A smaller number (3 of the 11) attended events externally. The number of events in total each person claimed to attend was generally around 2 or 3.

Only one of the respondents submitted a bid following the internal call. When asked why they hadn't submitted proposals the comments made included: 'more pressing tasks', 'lack of time' and 'I don't think it is relevant to my career progression and aspirations'. In future calls, the curriculum development area was a more common consideration than research. Again time was seen as a major barrier, although one respondent suggested they would like to see 'more interested colleagues keen to collaborate'. The areas of research interest were, much like the content analysis, diverse, although learning styles and technology were again identified by more than one person.

5 of the 11 respondents suggested they felt they had the skills to conduct learning and teaching research. The reinstatement of an Engineering School learning and teaching support group was suggested as a way to start to develop both a wider appreciation of learning and teaching innovation and research, and the critical mass needed to have a viable pedagogic research culture.

Conceptual Framework

The work conducted for this paper had support from senior management in both the university learning and teaching group and the School of Engineering. This was important as it demonstrated a mutual interest in the area. In particular, the School asked that the work consider not just faculty, but support staff working within the School as well.

In the light of the findings, a conceptual diagram has been prepared that captures the key features of the study and frames the requirements for a more exhaustive study that will be undertaken (Figure 2). The framework suggests that given the range of issues worthy of research, motivated enquiry based on the appropriate foundation of skills and knowledge (whether from an academic or support role) can develop teacher / researcher understanding and student success.

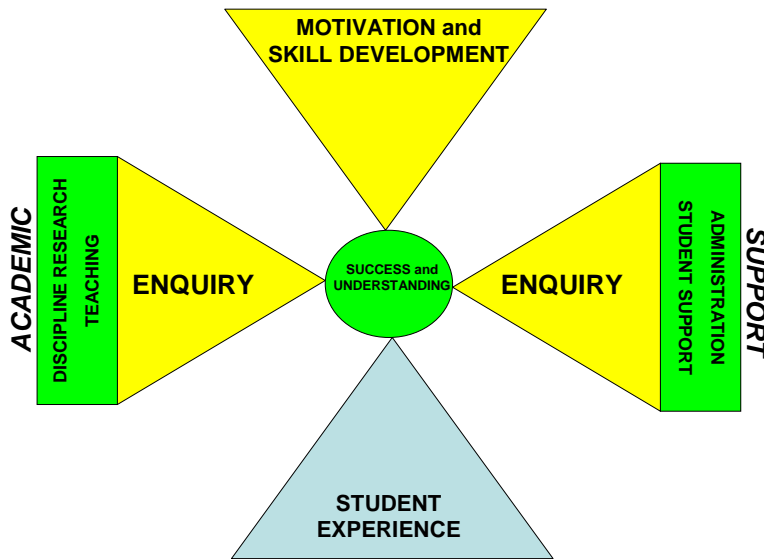


Figure 2: Conceptual Framework for Staff Engagement in Engineering Education Research

Conclusions and Recommendations

The exploratory study presented in this paper has highlighted the obvious challenges in engaging engineering staff in the process of learning and teaching research. Time, support and the question of how pedagogic research is valued all suggest that the picture is complex. The barriers have started to become clearer, yet the motivation and opportunities forming the research questions are less obvious.

A more exhaustive study framed by the conceptual model will be conducted in the next academic year. This study will explore the motivational issues as a priority. This will be helped by the fact that a small group of learning and teaching research ‘champions’ is now in place. The study of advocates, much like Tight’s ‘community of practice’ will contrast with the sceptics to suggest future developments.

In parallel, using the data obtained to this point, the team will aim to develop a programme of activity that will create an action focused environment in which engineering academics are made aware of the value of engaging in pedagogical research, in which they can be supported as they develop new research skills (Stierer and Antoniou, 2004; Case, 2008) and where people can collaborate and share across disciplines. This developmental approach will embrace change management strategies (Kotter, 1996; Asmar, 2002), as for many engineering academics, the learning and teaching research area is new and relatively unknown.

In order to better inform the planned work, the study will continue to explore the literature and approaches will be made to universities in the Midlands region of the UK to invite them to become part of the study. The work with partner universities will have two threads – an opportunity to study the approach to engaging staff in learning and teaching research followed by a wider survey and interview programme. The objective will be to address the research questions posed in this paper.

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