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Becoming and being an Engineer in an internationalised context: international students' engagement with 'real-world' enquiry at Masters' level

Catherine Montgomery (*c.montgomery@unn.ac.uk)*, Roger Penlington, John Tan and Angelina Wilson

Centre for Excellence in Teaching and Learning: Assessment for Learning
Northumbria University, UK

'It's not like bookwork… it's designed in such a manner that you have to think in your own way' (student comment)

Abstract: *This paper presents a research project that charts the complex development of engagement and professional identities in a group of international students (including British students) on an MSc course in Engineering. A detailed picture of the diversity of students' social, cultural and educational backgrounds at entry is placed against the development of students' own sense of what it means to be an Engineer in an international context. The case study was initiated by a concern for summative assessment outcomes in a number of the modules which were producing a notable bi-polar marks distribution in students' final assessments. Students were either achieving highly in the module or clearly demonstrating an inability to work with the concepts and ideas of the module. The aim of the research was to investigate the detail and the nature of this outcome following the introduction of an intensified focus on tutors' own research, amongst other innovations. Through survey, observation and interview data the case study focuses on the socio-cultural background to learning in Engineering and presents a qualitative fine-grained picture of how students build their competences and identities as professional Engineers through engagement with their tutors and their tutors' own research.*

The initial data on the backgrounds of students presented a fascinating picture of the effects of internationalisation on the composition of student groups in Higher Education. Through the student interviews a picture of students constructing both their competences and identities emerged. The research presented to them by their tutors and that they engaged in themselves as part of the course was seen to be a significant factor in their learning and one that distinguished their learning experience in the UK from their previous learning. Students also placed emphasis on the social and personal factors that both supported them in their learning and motivated them to become Engineers in the first instance. Furthermore, early analysis of students' summative assessments indicated that there was a clear impact upon the proportion of students who had made a transition between weak engagement and failure and there was a growing engagement and achievement of threshold performance.

Introduction and aims

As Engineering activities become more socio-technical in nature (Lemaitre et al, 2006), Engineering education is being required to place more emphasis on competences that enable postgraduates to operate as Engineers in an international community in the 21st Century (Borri, Gubert and Melsa, 2007). Students are thus being encouraged to develop a wider range of complex skills and competences that include an ability to engage with real world problems and the development of robust identities as Engineering professionals. This range of competences and higher order skills being required by professional bodies to achieve professional registration and for the accreditation of courses is played out against an increasingly diverse social and cultural context. There are vast differences in educational background, academic background, professional experience, age, language and culture represented in student groups (Abanteriba, 2006).

This paper relates to a research project that charts the complex development of engagement and professional identities in a group of international students (including British students) on an MSc course in Engineering. A detailed picture of the diversity of students' social, cultural and educational backgrounds at entry is placed against the development of students' skills and competences as they move towards their summative assessments. Students' awareness and development of ideas about what it means to be an Engineer in an international context are also prominent in the project. Through survey, observation and interview data, the case study focuses on the socio-cultural background to learning in Engineering. It also presents a qualitative picture of how students build their technical and higher skills, competences and identities as professional Engineers.

This research is being carried out in collaboration between the Centre for Excellence in Teaching and Learning in Assessment for Learning (CETL AfL) and the government-funded Teaching Quality Enhancement Fund (TQEF), and has received funding and support from both these sources. The CETL element of the project forms part of a wider research project that focuses upon the powerful function of different forms of assessment in student learning. The TQEF project focuses upon the link between teaching and research, aiming to build research activity into teaching and to encourage students to become actively involved in research and 'real-world' enquiry. It is intended that this project focusing on skills, competences and identities in Engineering will make links between issues of assessment and of building synergies between teaching and research.

This case study in Engineering was initiated by a concern for summative assessment outcomes in a series of modules on the MScs in Mechanical and Product Engineering that were producing a notable bi-polar marks distribution in students' final assessments. This was occurring within modules characterised by the requirement of students to work with complex, incomplete or contradictory data in unfamiliar situations and which require students to demonstrate initiative and originality in problem solving. Students were either achieving highly in the module assessments or clearly demonstrating an inability to work with the concepts and ideas of the module. The aim of the research is to investigate the detail and the nature of this outcome through consideration of students' individual and diverse social, cultural and educational backgrounds at entry. This has involved gathering detailed information about students' previous experience in maths, experimental work and the use of computer tools; and also their experience of professional contexts and different teaching and learning approaches in their previous experience in Higher Education, which was mainly within other national and cultural settings. This data is set against students' developing views of their engagement with the course, their informal learning and their views of what it meant to them to 'be an Engineer' and how they see their future career. These detailed profiles of each student are then to be considered against their achievements in their final summative assessments. The intention is thus to identify aspects of students' social, cultural and educational backgrounds that enabled them to engage successfully with learning, teaching and assessment, and also to highlight factors that appeared to be barriers to their success.

Module background and requirements

The research focuses on a series of four linked modules that examine process modeling, data uncertainty, the modeling of fluid flow and heat transfer amongst other things. The students are expected to work both in the fields of 'empirical science' and 'interpretive investigation', applying scientific principles within constraints of social, economic and ethical considerations. Thus, in order to succeed, students have to develop 'higher order skills' (Goodyear and Zenios, 2007) with which they can make the links between scientific and technological aspects, and the wider socio-economic or socio-cultural issues involved in a 'real world' context. As students move from final year undergraduate study to Masters level, the research element rapidly expands. In addition to this, the complex combinations of skills and competences involved in independent research are being demanded more frequently by professional bodies such as Engineering Council UK through their Standard for Professional Engineering Competence regulations and these skills are being increasingly valued by engineering teaching professionals (Rouvrais et al, 2006). Universities are beginning to respond to the developing requirements. These professional organisations through representation of these skills in module learning outcomes, which inherently contain elements of research material, thus requiring students to engage with enquiry and 'problem-solving' activities as part of their programmes and their assessments.

Aiming for research-linked teaching

It appears from the bi-modal marks distribution mentioned above that the students continued to struggle with modules that required them to contextualise scientific and technological aspects of what they were learning into 'problems' and 'real world' examples. Thus it was decided that in order to make the requirements more explicit, a greater emphasis would be placed on foregrounding and using research that had been carried out by the tutors themselves. In addition to this, external 'experts' from industry were called in to provide examples of 'real-world' enquiry. In personalising the research and examples in this way, it was envisaged that students would be motivated to engage more actively and deeply with the subject. It was suggested by preliminary data that encourage students to engage more with the subject was firstly to get them to engage with their tutors and their peers. From there they could move towards a more complex relationship with the subject matter. Furthermore by engaging students in this manner, the link between teaching and research could be more fully established, and it was envisaged that this would strengthen and improve the learning experience. This sort of research-oriented teaching and application in industrial-related material is also seen as a key factor in making Engineering courses attractive to a wider and more international student population.

The project: two elements

The TQEF 'Research into Teaching' element is a one-year funded project that aims to develop research-based teaching material included in the modules mentioned above. In particular, it aims to increase the use of tutors' own research material as illustrative examples in class and in assessment tasks. It is envisaged that this in turn will ensure that the modules are more research-oriented and that students are actively engaged with the research; through interacting with their tutors, asking questions and getting elaboration on the research from ‘the horse’s mouth’. Pedagogic research in Mechanical Engineering has suggested that engagement is a primary issue in improving students’ understanding and development of skills and competences (Halstead, 2003). This also ensures that the learning on the modules is research- and enquiry-led. A further way that this has been developed is that the Material Process Modelling (MPM) module and Engineering Data Analysis (EDA) module do not employ a core textbook, but rely on examples of real-world research provided by tutors. This material is used both in classroom tasks and in assessment. The project also aims to develop a departmental strategy for increasing staff research and thereby improving the visibility of students’ learning experience, thus developing recruitment, particularly in international areas.

The ‘Assessment for Learning’ element is part of a wider five-year project that aims to establish the impact of particular innovations in the field of assessment. In its broadest sense, advocating approaches that recast the emphasis of teaching and learning from summative assessment (that may encourage strategic approaches to learning), to integrated and formative approaches (that support students towards their final summative assessments) (McDowell et al, 2005). The modules under consideration in this project have had a range of Assessment for Learning approaches implemented in them, and thus the results from this research may indicate improvements in student engagement and learning that are a result of a range of approaches and innovations. This particular aspect of the project aims to show that innovations such as the sustained use of tutors’ own research in teaching can contribute to improving student learning and achievement. As mentioned above, it is hoped that this project will show an improvement in student attainment at the end of the course and some change in the bi-polar marks distribution experienced in previous years.

Methodology and data

One cohort of students was chosen to take part in the research, comprising 44 students of diverse social, cultural and educational backgrounds following a range of MSc Mechanical Engineering modules. Students were given a detailed survey to complete at the beginning of their course, in order to provide the project with contextualised knowledge of their socio-cultural and educational backgrounds. In addition to asking about their social, cultural and linguistic backgrounds, their perceived competences in maths, measurement and computing were asked for, and details of their prior learning experiences were canvassed. Class observations were undertaken over a period of two semesters, and fifteen students were interviewed using semi-structured interviews. The interviews discussed their perception of their engagement with the course, their experience of informal learning in a diverse cultural setting, the development of their understandings, and their perceived identities in relation to becoming an engineer. Students’ written work and assignments were also considered.

Findings: the survey data

The initial survey data on the backgrounds of students presented a fascinating picture of the effects of internationalisation on the composition of student groups in Higher Education. In the group of 44 students on one MSc course there were 9 different nationalities (Indian, Libyan, Nigerian, Thai, Bangladeshi, Malaysian, Greek, German and British), ranging from 21 to 44 years old. There were 15 different first languages spoken across the group, and perhaps surprisingly the vast majority of the group (95%, or 41 out of 44 students) noted that they had studied in English in their previous university, with a large percentage of students (74%, or 32 out of 44 students) having discussed academic work in English with classmates in their previous learning environment. Their experience in their subject area varied widely, particularly in terms of prior experience of computing and computer-aided design (CAD). Some students used CAD over a number of years in a professional context, while some had no experience of the main computer software that related to Engineering analysis.

Table 1

Nationality	First language	Other languages (*apart from English*)	Studied in English at university back home	Discussed work in English with classmates
Nigerian	English	Esan (Edo-State Nigeria)	Yes	Yes
	Igbo	None	Yes	Yes
Libyan	Arabic	None	No	No
	Arabic	None	Yes	No
Thai	Thai	Thai	Yes	Yes
Indian	English	Tamil	Yes	Yes
	Teluga	Hindi, Kannada	Yes	Yes
	Hindi	Konkani	Yes	Yes
	Hindi	Telugu, Punjabi	Yes	Yes
	Bengali	Hindi	Yes	Yes
	Teluga	Hindi	Yes	Yes
	Hindi	Telugu, Tamil, Kannada	Yes	Yes
	Urdu	Hindi	Yes	Yes
	Telugu	Hindi, Tamil	Yes	Yes
	Telugu	Hindi	Yes	Yes
	English	Telugu, Hindi	Yes	Yes
	English	Telugu, Hindi, Kannada	Yes	Yes
	Telugu	Hindi	Yes	Yes
	Telugu	Hindi, Urdu	Yes	Yes
	Gujurati	Hindi	Yes	Yes
	Telugu	Hindi	Yes	No
	Hindi	None	Yes	Yes
	Hindi	Punjabi	Yes	Yes
	Urdu	None	Yes	No
Bangladeshi	Bengali	None	Yes	Yes
Malaysian	Malay	None	Yes	Yes
Greek	Greek	French	Yes	Yes
German	German	None	No	No
British	English	None	N/A	N/A

Findings: the interview data

The students in the group were interviewed about their perceptions of how they engaged with the content of the course, with their tutors, with informal learning; also, how they perceived themselves as professional Engineers. Through the interviews, a picture of students constructing and developing their skills, competences and identities emerged.

The difference between current and prior learning experience

Students noted that they felt there were aspects of approaches to teaching and learning in the modules on the MSc (in the UK) that were distinctive from those in their prior learning context. In particular, students stated that the modules in question provided an opportunity to pursue chosen areas of the course in depth. One student noted that he felt that there was not a specific amount of work or a specific set of tasks that he could carry out for the work to be complete. He had a strong element of choice; it was up to him to decide what depth each subject required. Also, there was choice in what aspect of the subject he wanted to pursue:

'We can go into depth of the subject as we wish, it's not like that you have to do this amount of work and this much paperwork, it's not like that. We can select our depth and in a specific subject we can select our specific corner. In this subject, I would like to go through in this topic…That's the most interesting thing I think.'

Another student felt that the onus and responsibility for engaging in work and study was clearly with him as the student. He recognised that contact and class time on the MSc was not sufficient to cover the material on the module to develop a full understanding of the concepts. The student said:

'As an MSc student, a lot is expected from us but then yes, I think… I mean we hardly have maybe 10 or 12 weeks of classes and that's not enough to grasp the knowledge of the complete module.'

One other student explained that back home in India there was a more structured relationship with tutors where students were expected to report more regularly to tutors about specific almost 'bite-sized' aspects of their progress. In contrast, in the UK, the student noted that *'you have to do everything for yourself and that's where you learn a lot'*, suggesting that it was the tutors' 'hands-off' approach to learning that enabled students to develop an autonomous approach; a key aspect of enquiring and research skills:

'I would say that, in India it was more like, we had to go and meet tutors frequently and say 'We have done this and we have done that'. And it was more like spoon-feeding sort of a thing. But here you have to do everything yourself and that's where you learn a lot. Initially I had problems, I was like, maybe this concept was new for… It helped me because you are the one, at this level we have to put in more effort and seriously, you learn a lot when you put in more effort rather than expecting your tutor to do everything for you.'

This student's awareness of the need for autonomous learning may be a result of a combination of factors that make up the learning context in Engineering in the UK.

The importance of engagement with research in the modules

There was a strong case for developing research skills in self-reliance and 'enquiry' within these taught modules, as they are taken before the students' major independent project, their dissertation. Perhaps as a result of this, alongside the innovations introduced, students on these modules fore-grounded aspects of their course that related to research in Engineering. The research presented to them by their tutors, as the fundamental basis of the modules, and the research that they engaged in themselves as part of the course, was seen to be a significant factor in their learning. This was another factor that distinguished their learning experience in the UK from their prior learning. One student said:

'The study here concentrates on research and how to improve your ability to work on the research…to help you to solve the problems'

One other student particularly noted the importance for him of the inclusion of external examples of research from 'real' industrial contexts. This is strengthened by bringing in speakers from outside the university to talk to students about examples of research and problem solving in industrial situations. One student responded as follows:

'We had a guest seminar by an industrialist and that was really good. I think we should be having such lectures frequently.'

Another student suggested that such examples of real-world Engineering explained to them face-to-face by the person who has conducted the research or project enables them to contextualise the issues and transfer conceptual ideas into practice:

"Whatever tutors tell us, that is just bookish knowledge. I mean, we may learn just to get the grades or get score marks but then we won't get any practical knowledge with that. Unless we see things in practice, how they are happening we won't get that knowledge.'

The approaches to teaching and learning in this project appear to be fore-grounding the application of concepts and ideas into practice for the students. It also appears from the student quote above, that the Assessment for Learning approaches are inherent in students' perceptions of what is important in their learning. The student above makes a distinction between learning for summative assessment, and learning skills and competences that will be important in later life (Boud and Falchikov, 2006). The student is attributing value to the process of learning and its meaning, rather than to the acquisition of grades.

In addition to this, students noted that it was the design of the course itself that was leading them to engage with the research more closely. In fact, from what this student says there was a sense in which he feels that he had no choice but to engage with the research. It was the module structure and approach that was 'forcing' him to do this:

'The most important element of the course is the design of the course. The course is designed in such a manner that it forces research and development, it's not like bookwork or something like that, or you have to refer to this book… And it's designed like in such a manner that you have to think in your own way. That's the most important thing.'

The student notes that this engagement with research also led him to have to develop an autonomous approach to engaging with the concepts and ideas of the course.

The importance of engagement with both the tutor and the tutor's research

Davies et al (2006) canvassed engineering students' views of 'what makes a good lecturer', and found that *'uses real-world engineering examples backed up by industrial experience*' was one of the three most significant answers (2006: 545). This is echoed in this study, where students also attributed particular significance to the role of the tutor and their research in their modules. Despite the limited face-to-face student to staff contact for the module, (that is part of the gradual but sustained reduction in contact time endemic in Higher Education across the UK), the students in this study still fore-grounded the contribution of individual conversation and discussion with their tutor. Students indicated that this academic interaction with staff supported the development of their ideas, and enabled them to develop perspectives on their approach to their own research. One student notes:

'When we go and see him, he looks and then he'll tell us other areas that he thinks will be applicable to that area of study that we are doing. So that sort of broadened my scope of looking at more things and incorporating more into the report that I was doing. So it helps when people give you a different perspective on what they think will be included, and then not only do you look at that but then that'll lead you on to something else…'

Thus, engagement with the tutor is a first step towards expanding students' own ideas, developing wider perspectives on the subjects being studied, and engaging with research and enquiry in their own right. The student's use of the first person in this quote is interesting, and the labeling of his perspective on his work as *'my scope'* indicates that he feels ownership of his work. He also feels that whilst the tutor's comments are a guiding factor, he is the person driving the research he is involved in.

Engagement with the subject and development of 'higher order' skills
Goodyear and Zenios define *'higher order skills'* as the kind of learning that is involved in *'coming to understand',* and that it important for students to be able to actively engage in *'epistemic tasks'* themselves in order to develop these skills. They give the example of learning to play a game such as cricket, and note that this cannot be done by watching only, but must be done by playing the game with others who are more experienced and skilled at the game than you are (2007: 7). In the same way, students working with staff on research problems and seeing their examples, is a step towards becoming part of a knowledge-building community. This enables students to make decisions for themselves about data, and to apply these ideas to problems that they are working with.

There was evidence in the interview data that students were going beyond the numbers and data that they were dealing with, and were contextualising the results in order to understand and solve problems they were set. The students appeared to be moving towards an understanding and engaging with probabilities in their data, recognizing that they themselves have to make decisions about the interpretation of data in practice. One student talks about his data analysis experience as follows:

'Well you analyse the data and it's whatever you get out, their numbers tell you something about how the problem is and how it can be solved. Like the two curves where they overlap, they'll give you information on what's happening on the overlap, and you have to make a decision on whether you need more or less overlap, and what's happening, say, if your stresses are going to go outside that boundary. The area will tell you how likely that is and you'll need to say whether that's acceptable or not. By analysing the curves and getting numbers, you can sort of see, it tells you the likelihood and you have to make a decision on that.'

This student is reasoning through the solution to this particular problem. But he is also coming to understand the process and decisions required of him, and beginning to deal with uncertainty, a skill that is fore-grounded as important in the particular module on which he is working.

The influence of social, cultural and personal factors
There was a strong acknowledgement by students interviewed of the positive effect of both cultural and academic diversity in the group, and of its role in supporting and improving their learning. In line with research that suggests that international learning communities are significant in studying engineering (Borri, Guberti and Melsa, 2007), students expressed a desire to seek out diversity as a means of improving the quality of their learning. One student noted:

'I just want to sit with other people so I can find out their way of approaching things, so that I can learn something or I can teach something'.

At the same time, however, students were also aware of the difference in some students' skills and competencies in particular areas. This was viewed as an influencing factor on the quality of the learning of the group as a whole. This produces a more negative view of unequal distribution of peer competencies. One student identifies competency with computers as one of these areas, where students' prior knowledge of the software and technology varies considerably from student to student. The differentials in competencies such as computing influence the whole group experience, and can also affect perceptions of the course.

Goodyear and Zenios note that:

'A strong element of [the] socio-cultural view of learning is that participation in authentic knowledge-creation activities, coupled with a growing sense of oneself as a legitimate and valued member of a knowledge-building community, is essential to the development of an effective knowledge-worker' (2007: 5-6).

This view of the significance of the socio-cultural view of learning is one that is upheld by this paper. It may be the case that in the past, Engineering Education has paid too little attention to this aspect of learning (Borri, Guberti and Melsa, 2007; Abanteriba, 2006), focusing instead on the development of skills in particular areas, such as maths and physics. The increased inclusion of the use of tutors' own research as examples in teaching begins to address this, by enabling students to see the people attached to enquiry and to follow the lines of reasoning and thought explained by the tutor himself. As students become engaged with research and enquiry of their own, they begin to see themselves as part of real knowledge-generating activities. From there, they may begin to develop their own identities as Engineering professionals, part of a community of Engineers engaged in enquiry.

Students interviewed in this project appeared to fore-ground a sense of themselves as Engineers, and also placed emphasis on the social and personal factors that had contributed to them deciding to become an Engineer. Being an Engineer was termed *'a childhood dream',* and in some cases was motivated by a desire to be able to call themselves *'an Engineer'. D*espite the fact that all students held engineering qualifications on entry, there was variation in whether students felt that they could say they were Engineers at this point in their course. Students saw their experience at university as a holistic development, in which social, cultural and personal factors played a significant part in their success. When a student was asked about factors that had contributed to his success he responded:

'It was a blend. Each and every thing has contributed to it and it could be foolish on my part to say that, yes, this was the thing. It was a whole, everything as a whole came out to be the success, including my enjoyment of the nightlife here. And just going though economics, economics, economics… One needs to enjoy nightlife. Apart from university, the atmosphere here also contributed to my success.'

Findings: the analysis of students' summative assessment

Figure 1below shows an analysis of the students' summative assessment results at the end of the project compared with the results of the previous student cohort in the academic year 2006-7.

Error! Objects cannot be created from editing field codes. Figure 1: Module outcome by marks range, pre and post intervention

Although this work is ongoing it is possible to observe an early indication of the potential impact from the summative marks obtained in two of the modules taken by the cohort contributing to the current study.

The assessment strategies employed included the use of formative worksheets, technical coursework essays and in-depth investigations and evaluations of 'real world' problems, in addition to the intensified focus on tutors' own research. This differed from previous years in that both formative and summative tasks were based upon activity which attempted to mirror approaches taken within engineering research. An example would be the use of published material in tasks which required the student to practice comprehension, distillation and critical analysis of unfamiliar technical situations and problems.

The results presented in figure 1 have been obtained for three modules prior to the intervention and two post intervention. It may be observed that there is a clear impact upon the proportion of students who have made a transition between weak engagement and failure and there was a growing engagement and achievement of threshold performance. Further support for the proposition that some students were already engaged prior to the intervention may be drawn from the lack of any impact on student performance at the upper end of the marks range. We are encouraged by these results as they were obtained by students who were predominantly in their first semester (of three) and therefore we would hope to see some progression of student performance into the higher marks range as early engagement with the subject is further developed.

Conclusions

The research and analysis described in this paper is still ongoing. The results reported here are part of a work in progress. It is intended that this detailed profiling of students will enable a compilation of indicators of success, or barriers to success, from within this complex student group.

It is important to acknowledge here the authors' awareness of the fact that innovations in teaching and learning take place against a backdrop of a complex social, cultural and academic environment. The implementation of new approaches to teaching, learning and assessment such as those championed by both the 'Assessment for Learning' and the 'Research into Teaching' initiatives involves consideration of aims and principles, along with careful planning. However, in the micro-context of the 'classroom', it is an evolving activity, influenced by teacher reflection-in-action, student responses, and a wide range of contextual factors, many of which are unpredictable.

Educational research has shown that perceptions held by students, teachers and other participants in the learning context are crucial to the experience and outcomes of learning (Prosser and Trigwell, 1999). The work done undertaken in this paper so far has underlined the fact that student perceptions are being influenced. Also, students are fore-grounding research, enquiry and the process of learning as a way of developing important and life-long skills, rather than focusing on simply passing their exams. Goodyear and Zenios outline the continuing significance of students' views of what they are doing:

'Students are active interpreters of their learning environment and… variations in their understanding of learning, and in their interpretations of tasks being set for them result in differences in study behaviours that can in turn affect learning outcomes' (Goodyear and Zenios, 2007: 1).

Whilst it is the process of learning and being involved with enquiry that is significant, assessment should also *'facilitate the conduct of enquiry'* (Kahn and O'Rourke, 2007). If the approaches implemented and the exemplars of enquiry in these Engineering modules do not have an impact on student achievement, it may therefore be interesting to investigate the alignment of the assessment with the specific enquiry involved in the module itself.

References

Abanteriba, S. (2006). *Development of strategic international industry links to promote undergraduate vocational training and postgraduate research programmes.* European Journal of Engineering Education. Vol 31, No. 3, June 2006, 283-301.

Borri, C., Guberti, E. and Melsa, J. (2007). *International dimension in engineering education*. European Journal of Engineering Education. Vol 32, No. 6, December 2007, 627-637.

Boud, David and Falchikov, Nancy (2006). *Aligning assessment with long-term learning.* Assessment and Evaluation in Higher Education, Vol 31, No. 4, pp 399-413.

Davies, J., Arlett, C., Carpenter, S. Lamb, F. and Donaghy, L. (2006). *What makes a good engineering lecturer? Students put their thoughts in writing.* European Journal of Engineering Education. Vol 31, No. 5, October 2006, 543-553.

Goodyear, P. and Zenios, M. (2007). *Discussion, collaborative knowledge work and epistemic fluency. British Journal of Educational Studies*, Blackwell, Oxford. 10.111.

Halstead, A. (2003). *Engaging students with learning and personal development by using a thinking styles questionnaire.* In conference proceedings for 'Strategies for student achievement in Engineering', September 2003. University of Hull, Department of Engineering.

Kahn, P. and O'Rourke, K. (2007). *Guide to Curriculum Design: Enquiry-Based Learning. HEA,* Imaginative curriculum Network.Available at: http://www.heacademy.ac.uk/resources/detail/id359_guide_to_curriculum_design_ebl
(Accessed: 16 April 2008)

Lemaitre, D., Le Prat, R., De Graaf, E. and Bot, L. (2006). 'Focusing on competence'. *European Journal of Engineering Education,* Vol. 31, No 1, March, pp 45-53.

McDowell, Liz; Sambell, Kay; Bazin, Victoria; Penlington, Roger; Wakelin, Delia; Wickes, Howard and Smailes, Joanne (2005). *Assessment for Learning: Current Practice Exemplars from the Centre for Excellence in Teaching and Learning*. Northumbria University Red Guide, Paper 22.

Prosser, M. and K. Trigwell (1999). *Understanding Teaching and Learning*. Buckingham: SRHE and Open University Press.
Rouvrais, S., Ormrod, J., Landrac, G., Mallet, J., Gilliot, J-M., Thepaut, A. and Tremenbert, P. (2006). *'A mixed project-based learning framework: preparing and developing student competencies in a French Grande Ecole.'* European Journal of Engineering Education, Vol. 31, No. 1, March 2006, 83-93.