Students' views on their education and the future

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Abstract

Today's students are tomorrow's civil engineers. If today's pace of change continues then they will face many new challenges. How do they prepare for an uncertain future? Along with industry, the professional bodies and academia, students are important stakeholders in the provision of civil engineering degree courses in the UK. It is right that their views should be known. Research was undertaken with civil engineering students from the final and penultimate years of the University of Bolton BSc (Hons) degree course using small discussion groups and mini focus groups. The results of this small scale research are interesting and raise questions about firstly, the immense benefits of practical experience for students undertaking degree courses and secondly, the direction and management of the lifelong learning of all professional engineers (particularly in support of younger engineers). The key benefit of this work is the chance for policy makers to briefly see the world of civil engineering education through the eyes of undergraduate students from a modern university in a northern working town.

1.0 Introduction

Climate change, resource depletion, new technologies and new discoveries will change the nature of civil engineering in the unforeseeable future. Should we or even can we change the university education of civil engineers to best help to deal with the future?

The purpose of this paper is to provide a student's perspective on important questions about the future skills needs of civil engineers. What do they need to learn? How and when should they learn it? Along with industry, the professional bodies and academia, students are important stakeholders in the provision of civil engineering degree courses in the UK. It is right that their views should be known by those planning the future education of civil engineers.

Students whose views are presented in this paper do not speak for all students at all universities. All universities are not the same. Equally, the student body is not an homogenous mass. The particular views presented in this paper are offered as a snapshot to those planning the education of all civil engineers, allowing them to become acquainted with one of the many different stakeholders.

The views of the students were obtained using small discussion groups and mini focus groups. The qualitative results from this small scale research were then analysed for common ideas and issues. From the views given by the students, several themes emerged of which three are presented in this paper: practical experience, the curriculum and professional development.

2.0 Methodology

The data for this paper have been collected from the students of the University of Bolton in two different ways. Firstly, small discussion groups were used with final year students; secondly, two mini focus groups were conducted with groups of students from the final and penultimate years of the course.

2.1 Background to the research

The University of Bolton is one of the second wave of post 1992 universities. It achieved university title in 2004 and is one of the most successful universities recruiting local working class students (Davis, 2010) making higher education accessible to students with a wide variety of academic qualifications. Prior to 2004, the reputation of the civil engineering department of Bolton Institute of Higher Education rested on the sound, practical, engineering ability of its graduates. The university is continuing this tradition.

The university runs a successful HNC civil engineering course and many of the able students from the HNC progress to the BSc (Hons) civil engineering course. Consequently, a significant proportion of each cohort of undergraduate students comprises ex HNC students. All in all, the majority of the undergraduates on the civil engineering BSc (Hons) course are male part time students, working in the industry. Of those male and female students working in industry, several hold responsible positions.

2.2 Small discussion groups

The work involving the small discussion groups took place during a single session lasting around one hour. During the first fifteen minutes, the students were presented with a range of quotations from a wide variety of sources: from the Stern Review on the need to act urgently (to mitigate the effects of climate change) to the Friends of Science casting doubt

on the “facts” of climate change; from Sustrans on the need to drive less to the Daily Mirror on the current economic crisis. An attempt was made to present a range of opinions, whilst favouring those quotes likely to provoke thought and debate. Please refer to the text boxes which contain a few of the quotations and give a flavour of the way in which this research was introduced to the students.

The class comprised 44 students, of whom 35 are part time students. Two of the remaining nine students also work in industry. From this class, eleven mini discussion groups were formed. Each group took around 45 minutes to work through a four page worksheet. Each page of the worksheet was headed with the questions: *What are the future skills needs of municipal engineers? What do they need to learn? How and when should they learn it?* Responses were requested from the students under eight headings: (A) Technical competence, (B) Employability, (C) Resource management, (D) Sustainability, (E) Money, (F) CPD (flexibility and learning to learn), (G) Critical thinking and (G) Your own thoughts. No facilitators were present in the groups to direct the discussions or the written comments arising from them.

The small discussion groups engaged the students in useful thought and discussion of the subject (Figures 1 and 2). Due to time limitations and the format of the exercise, the students’ responses on the worksheets tended to be relatively limited. For some groups, the responses were just a brief agreed summary of the animated discussions that had taken place and did not represent well the diversity of opinions amongst the students. For other groups, the responses were limited to bullet points, for example, for the extensive topic of (B) Employability, Group 3’s response was restricted to just five words:

B/ Group 3 (i.e. Topic B - Employability/Group 3): Efficiency, experience, cost, qualifications, motivation.

2.3 Mini Focus Groups

Two mini focus groups were conducted. The first of these comprised four final year part time students: three men (Jim, Jack and John) and one woman (Jane). The second of these comprised five students from their penultimate year of study: three part time male students (Mike, Mark and Martin), one part time female student (Mary) and one full time female student (Martha). Pseudonyms are used in this paper.

The mini focus groups took place in one of the cafes on the campus of the university, shared by students and staff. Along with most of the staff in the civil engineering department, the author runs an open door policy and is on first name terms with the students. The author lectures in structural analysis and design and acted as facilitator in both of the mini focus groups. The students’ comments on the value of analysis and design subjects should be considered in this light.

Once the subject of the study was introduced, the role of the facilitator was kept to a minimum. The students regulated the content of the discussions apart from a small number of prepared questions from the facilitator. The mini focus groups discussed topics ranging from the personal qualities required of a graduate and employability to sustainability and professional development.

The transcripts of the mini focus groups proved to be the most useful source of data for the research. The format of the mini focus groups allowed students to develop their thinking and to articulate their ideas. Students may not be accustomed to being asked for advice in general and far less by lecturers who generally have plenty of advice of their own to give.

Finally, the collected notes from the small discussion groups were combined with the transcripts of the mini focus groups and analysed for common themes using a line by line approach. The most common themes are presented in this paper.

3.0 Practical Experience

The part time students relate their learning at university with their practical experience. They want to make good use of their studies in the workplace. This is not always possible due to the breadth of learning at university and the limited extent of a part time student's role in the workplace. Ironically, the converse is likely to be true at the end of a career in civil engineering; the breadth of work undertaken is greater than that encountered at university.

Mary: I worry about this and I work with a structural engineering company using AutoCAD and the computer. I can do structural analysis in university, but it doesn't relate to stuff in the office. I am afraid that it won't be useful.
Mark: You may be good on the course but not able to understand how things fit together on site.
Mary: You might know how but not why.

Mike: Our task is to get the thing we learn in theory into practice.

The students showed a strong preference for their learning to be directly related to the real world of civil engineering work, in other words: contextual learning. This aligns well with a constructivist approach to education. Constructivism is an educational theory that proposes that we learn by thinking about our experiences of the world and making sense of new ideas and experiences by assimilating them into the knowledge and understanding that we already have (Richardson, 1997). It requires active participation from the learner and the lecturer acts more as a facilitator rather than teacher. Jonassen (1994) proposes eight characteristics of a constructivist learning environment. The students' responses illustrate several of these characteristics, as shown below:

Jim: What's the point of learning it if you're never going to use it – like matrices?
Jack: I was pretty good at it when I did matrices, but I couldn't do it now. You shut down after the end of the semester and then move onto the next one.
Jane: Just ticking that box.
John: If you don't use it you lose it.

Constructivist learning environments emphasize authentic tasks in a meaningful context rather than abstract instruction out of context (Jonassen, 1994).

Jim: We should be taking practical situations.
Jane: Creating scenarios – as a student, you learn how to do something one way – then in the office someone calls up from site and tells you what it is like on site and it makes it harder; you have to work backwards. It really makes you think. So real life scenarios get you to understand it better.

Constructivist learning environments avoid oversimplification and represent the complexity of the real world. They make use of real-world settings or case-based learning instead of predetermined sequences of instruction (Jonassen, 1994).

From the small discussion groups, this comment illustrates the students' feelings about learning when it is divorced from context:

G/ Group 11: Students should not be joining the student ICE, they should be registering with the NEDA (National Eating Disorders Association) due to the amount of regurgitating taking place in the classroom.

Constructivist learning environments emphasize knowledge construction instead of knowledge reproduction (Jonassen, 1994).

The full time students face the difficulty of learning about civil engineering away from the context of work. From the mini focus group of final year part time students, came the following comments about full time students:

Jane: I don't think they should do the course - full timers.
Jack: I feel sorry for the full timers.
Jane: You can be the cleverest person in the world but without experience, you're useless.

From all of the above, it follows that increasing the practical experience of all students (particularly the full time students) will improve their learning experiences. This could be even more beneficial if it is accompanied by teaching approaches that relate to the practical experiences.

4.0 Curriculum for the future

The students considered the present curriculum in the light of the uncertainty of the future. What should they be learning, to what depth and when should they be learning it?

4.1 Balance of learning at university

The present curriculum for the education of civil engineers is very full and necessarily contains tensions between the teaching of technical and management skills, creating meaningful experiences for the students and helping students to develop their cultural and environmental awareness. These tensions and the debates on what to teach and how to teach it are not restricted to civil engineering. For example, in the teaching of medicine there is a tension between the time honoured objective, knowledge transmission methodology and the newer problem-based learning approach allowing knowledge to be constructed by the medical students (Hung et al, 2007).

There is no perfectly balanced curriculum to suit everyone, as each student has different experiences and needs. The research confirmed this by finding many different opinions being voiced by the students. Some students favour the subjects with a mathematical and analytical bias. They voiced their frustrations at what they called the "softer" modules such as risk management. These students do not value our course's use of presentations in the development of their communication skills.

Conversely, some students appreciated the wide range of subjects being taught; crediting their breadth of learning as an important factor in their development as rounded engineers able to adapt to the requirement of different roles in the future. Sustainability is valued on its own and its worth is also related by the part time students to the uses made of it in their

places of work. The students understand that their BSc (Hons) course cannot be all things to all people. They recognise that different parts of the course will be more or less useful depending on the role of the engineer. Listed below are four quotes from the students illustrating their diversity of opinions:

Mike: … at university, it's the hard facts. It should be based around maths and analysis. You don't need the PowerPoints and communication skills to present results to colleagues. Rather focus on hard facts and calculations.
Mark: Not deciding colours of font and background on presentations in PowerPoint.

Mary: In the Communications and IT module, in level 1, my presentation was on the history of civil engineering. In eighteen hundred and God knows what, the main things they learned were maths, algebra, structures – the core bits of it haven't changed. You still need to find a bending moment, use hydraulics and so on. These things won't change.
Martha: The fundamental aspects are going to be the same.

A/ Group 10: It depends on what area of civil engineering a graduate might end up working in. For example, if working in a structural engineering consultancy, sustainability might be irrelevant. If working for a local government transport office, sustainability could be quite relevant. We believe it is good to learn such topics because it will allow us to adapt as we might not always work in just the one area of civil engineering.

A/ Group 7: Core modules important and fundamental part of course but rounded and practical individuals need subjects that are outside the "traditional box". Health and safety is an important legal consideration in any project and sustainability is a vital change that civil engineers must invoke to safeguard the future of the planet.

Despite the variety of opinions, it is fair to say that the students generally appreciate their development as rounded engineers able to communicate and to adapt to future changes in their work.

Incidentally, while the students had mixed views on the best composition of the curriculum, there was a general consensus on the matter of computers and drawing. The significant presence and use of computers in working life is known by the part time students. Their views on the importance of computing were communicated in the mini focus groups.

John: Again, being computer literate is really important.
Jack: Same about CAD.
Jim: Everything is on CAD, Revit, BIM. You use it all the time.
John: All highway maps at the local authority are based on CAD.
Jim: Fabricators, M and E consultants – everyone uses it to communicate.
Jack: We'd be lost without CAD at work.

In the second focus group, the discussion moved beyond simply learning to use AutoCAD to the use of drawings as a means of communication. The following excerpts show an appreciation of drawing in civil engineering as a key means of communication.

Mary: Drawings are used by everyone…
Mike: AutoCAD should be part of the course because it is part of working life. There should be more drawings as part of assessments.
Mary: Hand sketching should be part of it as well
Mark: If I explain to a labourer on site, I use a quick sketch and he knows what to do

Mike: A decent drawing breaks down any language barrier.

Mary: The course should include: part AutoCAD, part hand sketching and reading drawings. You should learn how to read drawings and how to use AutoCAD.

The students believe that the use of computers and civil engineering drawing should form a larger part of the curriculum than they currently do at the university; more pressure on an already crowded curriculum.

4.2 Sequencing of learning (undergraduate, postgraduate, work)
Finally, the students commented on not just the breadth of subjects but also the matters of choosing options and specialising. There was no consensus in the timing of this, with a number of options being raised that are summarised by the two following scenarios:

- Keep undergraduate courses broad based for their full duration and then allow specialisation at MSc level or at work
- Allow early or late specialisation at undergraduate level.

Mike: The broad based approach like now is good for the full timers, but the part timers should be able to specialize because they know what they are interested in.
Mary: You should be able to pick more of your modules. There should be more of a focus on what you want to learn.
Mike: You could specialize later doing your MSc or whatever.
Mary: The broad approach is fine at lower levels of the degree course but....
Mike: More specialized is what is needed.
Martha: But there is such vast array of subjects; I still don't know what to choose for my options.
Mark: The BSc should be more general and include everything. Then in the Masters you focus on what you really need.

It appears that Mike (part time student) and Martha (full time student) agree that, coming from different backgrounds, they have very different requirements with regard to when they should be able to choose their options. Several students indicated that they expect to specialise after they graduate and their specialisation would be part of their professional development.

5.0 Professional development

The Professional Development Code produced by the Engineering Council (2009) requires that practising engineers should do three things:

- Demonstrate commitment to maintaining professional competence through self managed professional development
- Take responsibility for and manage professional development
- Support the learning and development of others

The code is simply: undertake continuing professional development (CPD) and help others in their professional development.

5.1 Learning careers
From the worksheets of the small discussion groups, the single attribute that was considered to be most important for employability is being able to adapt to change and to new

technologies. This was cited by seven of the eleven discussion groups (refer to Table 1).The students envisage a lifetime of change in civil engineering and for them, a lifetime of learning and adapting.

The concept of a learning career was used by Bloomer (1997) when describing the complex interaction of students with the learning opportunities offered to them in further education. He described how students construct their learning in further education and how their life and experiences outside college directly influences their learning careers. In order to keep up to date in a changing world, the students will be continuing their education throughout their working lives. Although different to Bloomer's original meaning, constructing a learning career seems to be a good way of describing one of the key strategies of the students to deal with future uncertainty.

From the small discussion groups, it can be seen that the students have a positive attitude to CPD and expect to go on learning during their career in industry. The following responses come from the section in the worksheet asking the students for their general thoughts on CPD, flexibility and learning to learn:

F/ Group 2: CPD is very beneficial: new technologies; methods; new codes and revisions. CPD is one of the most effective ways of keeping engineers current.

F/ Group 3: University teaches only to pass exam questions, not to understand wider knowledge of the subject area. CPD expands on this understanding in the workplace/industry…

F/ Group 7: CPD is important as it keeps knowledge current and enables new ideas to be distributed through industry.

As part of their career, the students in the first mini focus group discussed their professional education and development. It should be noted that the majority of the final year students intend to become chartered. The path ahead appears to be long and far from straightforward:

[On the issue of becoming chartered and further formal education]
Jim: You can't tell what you need to do. You speak to one person in the institution and then get a different answer from someone else next time you ask about it.
John: My employer can't afford to pay for me to carry on. Local authorities are strapped for cash – so I've got no chance of carrying on.
Jane: I want to get chartered. I want to keep learning. It's not clear what I have to do.
Jim: You might finish your MSc then have to do a top up course or something else after. Even after you're finished at university – your degree and your masters - you still have to put together a portfolio of something.
Jack: I cannot believe its three years on an MSc.

John: Getting a degree is just the start of your progression.
Jane: …and if you want a new job…
Jim: Even if you don't want to be a chartered engineer. Still the skills at communicating and maths are useful. It depends on the person – do you want respect and the challenge?

5.2 Continuing professional development of colleagues

The small discussion groups allowed the students to present their perceptions of the commitment of their more senior colleagues to undertake CPD. It appears that this is not valued so highly by all. The following three quotes are from the worksheets:

F/ Group 6: More senior work colleagues generally have a poor knowledge, especially about the environment and sustainability. More senior work colleagues also discard new technologies as they are unfamiliar.

F/ Group 10: Existing long serving engineers seem “blinkered” and avoid adopting new or changing methods.

F/ Group 11: Industry colleagues are not really adaptive to change. Their approach to education is: “I’ve done my time.”

From this snapshot, it is questionable whether all engineers are successfully undertaking CPD. In recent years, the civil engineering institutions have increased their involvement regarding each individual engineer’s duty to undertake CPD (IStructE, 2010 and ICE, n.d.). Once again, it is questionable whether this current level of involvement is sufficient.

5.3 Helping others in their professional development

Gaining practical experience of civil engineering while studying for a degree would be of immense help to all full time students (and many part time students) in their professional development. The students are at a stage in their professional development when they need the help of their senior colleagues. They value this but struggle to gain the help and support of others:

F/ Group 8: People can share knowledge at work. New graduate engineers need more experience. If you have a senior engineer who has around ten years of experience, new engineers can learn lots of information from them.

Jack: A year in the middle should be compulsory [to give full time students experience of industry].
Jim: Summer placements, if you cannot get a full year. I doubt it would happen. Get a company to accept students for a few months – you’ve got no chance!… It’s hard to get a job. It’s not fair.

Mary: Nobody is helpful… Not having experience of what goes on in design and construction - it’s massive! I kept going on at them. They said: “You can get your experience at home in your own time...” and gave me these little jobs to look at.

Martha: Every spare moment I have I spend applying to work at a [civil engineering] company. Applying, phoning – but I get nothing.

For these students, the perception is that the help from industry is not forthcoming. This is not surprising as the third duty placed on professional engineers to help others can easily be overlooked; for instance, the latest Presidential Address of the IStructE included, amongst several paragraphs on professional development: “There are two strands to the Institution’s responsibilities in this context – providing sufficient opportunities for members to benefit from good quality CPD, and demonstrating this to the outside world” (Plank, 2011). Additionally, in answer to the question: “What is CPD?” the ICE (n.d.) responds: “CPD is defined as the systematic maintenance, improvement and broadening of knowledge and skills. CPD covers technical and professional topics throughout your working life”. Many similar comments omit

to mention the third requirement of the Professional Development Code, which is to help and support others in their professional development. It could be of help to the students if the engineering institutions would make this third duty clear to their members.

5.4 Confidence

One attribute that is helpful to all practising engineers is confidence. It is important in decision making and only confident engineers can act creatively or imaginatively. It is one of the key attributes that the Joint Board of Moderators (JBM) considers should be developed at university (JBM, 2009a) yet arguably, it is something that many graduate engineers lack. It is suggested that it can be developed in working life better than at university.

Mark: You cannot teach someone confidence. You can get it from practising. On site, I was not confident but I get confidence from practicing on site. If I see a problem, then I have to know what to do. The labourers laugh at me if I don't know the details. You know the global problem but not the details.
Mary: Knowledge helps. We don't know what is expected of us in the work place. The things we are taught – will they want this in the work place?

Lee and Hogg (2009) also looked at the development of confidence amongst graduate quantity surveyors. They found a "strong relationship between confidence and frequency of use". Unsurprisingly, the tasks most regularly carried out by graduate quantity surveyors were the tasks which registered the highest feelings of competence by the same. Graduate engineers with no work related experience may therefore be expected to lack confidence. They can best gain confidence through their work and with the help of their senior colleagues.

This illustrates the point that some things are better taught outside a university education. A university education cannot provide all the answers for the development of a professional engineer. In the words of one student from the second focus group: "I don't think university can be responsible for all these things. It's got to be part of your job as well".

6.0 Discussion and conclusions

6.1 Practical experience

The part time students place a high value on their practical experience as it allows them to set their learning at university into context. The students discussed how they reflect upon new information and ideas offered in the course in relation to their own circumstances. In this way, they are continually adding to and reshaping their understanding of civil engineering as they progress towards their graduation. This description fits well with the constructivist model of education.

Kolb's (1984) experiential learning theory builds on the constructivist model and follows a cyclical four stage process of: (i) concrete experience; (ii) reflective observation; (iii) abstract conceptualization and (iv) active experimentation. All four stages are required for high quality learning to take place and if one stage is missing the cycle is broken and the learning is affected. So, in Kolb's model, the best and most meaningful learning takes place when experiences are transformed into knowledge through critical reflection. This new knowledge is then used in further learning.

For part time students, the concrete experience gained outside the university therefore needs to be complemented by the other stages in Kolb's learning cycle to maximise its attendant benefits. In short, part time students should be encouraged to reflect on their

experiences outside the classroom in relation to the abstract concepts being taught within the classroom. They will then be in a strong position to plan and test their newly constructed understanding in the real world and thus begin their next cycle of learning. It is the activities of reflecting and planning and testing that help to transform the students' experiences into learning (Kreber, 2001).

For full time students, the concrete experiences could possibly be provided in the form of work experience / placement, field trips, case studies, laboratory experiments, model making and testing. Unfortunately, it is not possible for university contrived experiences to match the real world ones in terms of context, complexity and layers of meaning. However, help from industry in supplying useful and up to date case studies would be well received and in any case, engaging and useful learning could take place using the experiences described above.

The above discussion highlights the difficulties that full time students face when trying to understand and appreciate the practical aspects of their own civil engineering education. Some practical experience of industry for full time students would appear to be very useful, if not essential, for them to benefit to the full from their undergraduate education.

6.2 Curriculum for the future

When considering what subjects should be in the curriculum, the students did not agree on the extent to which subjects such as sustainability, risk management and health and safety should be taught. Some considered them to be inappropriate at undergraduate level; others considered them to be essential to allow their graduation as rounded engineers, able to adapt in the future. Equally, there was little agreement on the timing of specialisation (or choice of options) on the degree course. Some favoured early specialisation and others favoured maintaining a breadth of learning at undergraduate level, allowing specialisation later.

No students suggested that the current curriculum should be drastically changed in preparation for an uncertain future (including the effects of climate change and resource depletion). Instead, they value the use of CPD as a means of coping with future changes.

The civil engineering curriculum at the University of Bolton is accredited by the JBM, whose purpose, in its own words, is "…to ensure that educational programmes are in place to develop professional engineers…" (JBM, 2011). Through the JBM, the civil engineering institutions expend a substantial effort in monitoring and controlling the university education of civil engineers. Far less effort is expended by the civil engineering institutions on the lifelong professional development of the same engineers. It is questionable if this balance is right; in the words of the current IStructE President, Roger Plank (2011): "It is quite alarming to look back at what I learned at university and realise just how much is no longer relevant, and how many current topics and techniques were not covered."

Civil Engineering students are not alone with this problem of trying to prepare for the future. David Sackett (n.d.) (Professor Emeritus of McMaster University), sums up the problem for medical students neatly: "Half of what you'll learn in medical school will be shown to be either dead wrong or out of date within five years of your graduation: the trouble is that nobody can tell you which half – so the most important thing to learn is how to learn on your own."

This year's civil engineering graduates will begin a lifetime of learning on their own, which will cover new topics and techniques that are presently unknown and unforeseeable.

Therefore, time spent at university developing the skills needed for self-directed learning will be time well spent.

Another constructivist model of teaching and learning that addresses this issue is problem-based learning (PBL). This is a technique originally developed for the teaching of medicine at McMaster University (Ontario, Canada) in the 1970s (Hung et al, 2007). From there, its use has spread to many other universities and fields of study. Perrenet et al (2000, p. 346) list the three key educational objectives of PBL as acquiring (i) professional knowledge, (ii) skills in problem solving and (iii) skills in self directed learning. Self directed learning is elaborated on by Savery and Duffy (2001, p.14) who note that students are expected "…to monitor their own understanding i.e. function at a metacognitive level." That is, the students are expected to identify information needed and then find it; to plan and set their own goals; to sustain, monitor and manage their work (self regulation). These are skills that are an excellent preparation for lifelong learning career.

6.3 Professional development

The students prize the idea of CPD and they expect to continue their education throughout their working lives. They see this as a way of keeping up to date and adapting to changes in the future. The part time students exemplify this belief as they are already in work and are continuing their education at university.

The part time students are at a stage in their careers when help from senior colleagues is particularly useful. The full time students have an even greater need of help from practising engineers. They could benefit enormously from summer placements, short tem contracts, internships or even a job. The students are aware of the current economic recession and the difficulties companies and local authorities are facing. On a personal level, they are even more aware of the lack of help that they are receiving from industry. This is despite the duty of all chartered engineers to support the learning and development of others (Engineering Council, 2009).

The degree is one step along a lifelong commitment to learning for professional engineers. It is arguable that the lifelong learning of an engineer is even more important than the undergraduate learning. Yet more attention is given to the latter than to the former as noted above, in Section 6.2, and further illustrated by a simple comparison of the number and size of documents on the Engineering Council website relating to university education compared to those relating to professional development. Concentrating so much attention onto the university education of a civil engineer (over say three years) runs the risk of overlooking the very important learning that takes place elsewhere (over say forty years).

This imbalance is compounded by a further imbalance in the development of civil engineers. The wide range of subjects taught to students at university is necessarily taught at a relatively basic level (when compared to the level of understanding of an experienced professional engineer). A deeper technical understanding can be gained through working in a particular field and this is shown by the skills and knowledge of many chartered engineers. However, the most senior civil engineers in the profession must develop beyond this. Their role should be to help shape the society in which we live. This crucial role requires a depth of understanding and breadth of vision that relies on experiences gained and lessons learned after leaving university.

The professional development of a more typical civil engineer may suffer from two of the key drawbacks that affect the PBL approach (Mills and Treagust, 2003 and Perrenet et al, 2000) discussed in Section 6.2 above. Firstly, the acquisition of new knowledge builds upon prior

knowledge that may be wrong or incomplete. The second drawback is the potentially unstructured way in which knowledge is acquired. Engineering has a hierarchical knowledge structure requiring a specific order of learning. If a topic is missed now, it may make it impossible to understand a related concept later. So it is quite possible that a civil engineer's professional development could be far from satisfactory.

The skill of self evaluation (one of the skills of self directed learning) is important in managing the impact of these two potential drawbacks on professional development. A possible indication of the limited extent to which this skill is currently mastered by young structural engineers is the low pass rate of the IStructE CM exam (IStructE, 2010). In 2010, 61.7% of UK candidates (who presumably believed that they were ready to take the exam) failed. It is not just young structural engineers who struggle with self evaluation. A study of the self assessment skills of General Practitioners (Tracey and Arroll, 1997) concluded that "general practitioners cannot accurately assess their own level of knowledge on a given topic, professional development programmes that rely on the doctors' self perceptions to assess their needs are likely to be seriously flawed".

All of the above points taken together raise significant doubts as to the efficacy of the current system of CPD operated by the engineering institutions.

6.4 Summary and future research

This is small scale research. Nevertheless, the results are interesting and raise questions about firstly, the use of practical experience in the design of degree courses and secondly, the direction and management of the lifelong learning of all professional engineers (particularly in support of younger engineers).

The practical experience of the part time students reading civil engineering at the University of Bolton is a key factor in the high quality of their learning. Full time students do not have this resource and their learning experience is the poorer for that. However, their lot could be greatly improved by local companies and local authorities providing more help and support (possibly in the form of case studies and visiting lecturers). This is a duty placed upon all chartered civil engineers; however (from the students' comments) this does not appear to be happening.

The future is uncertain. No-one knows what skills civil engineers will need in the future. This need cannot be satisfied once and for all by the gaining of a degree in civil engineering. This need can only be met during the learning careers of the students graduating today. All students should therefore graduate having learned to learn (i.e. with the skills of self directed learning). Their professional development will allow them to adapt and manage all of the changes that are coming in the future and hopefully, they will still have time to help and support their younger colleagues. More research into the efficacy of the current system of CPD operated by the engineering institutions could help to improve civil engineers' professional development in the future.

The key benefit of this work is the chance for policy makers to briefly see the world of civil engineering through the eyes of undergraduate students from a modern university in a northern working town. Whilst it may not be possible to generalise from this research, it is hoped that others will be able to relate to it (Bassey, 1981) and it is hoped that those planning the future education of civil engineers will be able to make direct use of it. Students are one of the stakeholders in the provision of university education; however, the literature search indicated very little research into the views of students undertaking civil engineering

degree courses. If students' views were to be sought (for example to inform policy making) then there is scope for much further work.

So finally, what do students need to learn for the future? The answer is that they cannot learn everything that they need during a short spell at university. Rather, their ongoing professional education and development will sustain them throughout their working lives. If they need to learn anything to cope with the future, it is how to develop professionally. From their remarks, it appears that they are learning this. As one student noted, the degree should be seen "as a springboard to a successful and rewarding career".

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8.0 Tables

Table 1

What makes you employable and keeps you employable? Most common attributes from the 11 small discussion groups	Number of times cited
Being able to adapt to change and new technologies	7
Experience	5
Qualifications	5
Being able to work in a team	5
CPD	4

9.0 Text Boxes used with the small discussion groups to prompt thought

Text Box 1

Fluffy modules

"There has been an explosion of "fluffy" modules .... Graduates should be aware of the needs for 'Health and Safety' and 'Sustainability' for example but ... undergraduates don't know enough ... to make a whole module on each of these subjects of value.

The most important 'Health and Safety' knowledge I require from graduates is the ability to model and design a structure that doesn't collapse. The biggest contribution they can make to 'Sustainability' is not wasting the materials and embedded energy in the over design of structures ..."

(Nolan, 2009)

Development is not sustainable unless it is socially just. How to do this?

"79% of people in the least deprived areas in the UK enjoy where they live compared with 46% in the most deprived areas. ...The gap in male life expectancy at birth between Manchester and East Dorset is nearly eight and a half years."

(Defra, 2005)

Text Box 2

The government sponsored Stern Review

Both mitigation and adaptation must commence as soon as possible. *"There is still time to avoid the worst impacts of climate change, if we take strong action now. ...the evidence gathered by the Review leads to a simple conclusion: the benefits of strong and early action far outweigh the economic costs of not acting."*

(Stern, 2007)

Economic crisis

In March 2009, the website of the Daily Mirror puts it starkly. *"The construction industry is facing its worst crisis in nearly 90 years and thousands more jobs are set to go. That was the grim prediction yesterday as Bovis became the latest big building firm to crash into the red."*

(Manning, 2009)

Text Box 3

The job of the civil engineer may change in the future

"No-one can predict the 21st century counterparts of quantum theory, the double helix and the internet, but advances in science and technology will continue to transform our lives, create new industries and enable us to tackle presently intractable problems."

(The Royal Society, 2010)

CPD

"...experience can become idealized and too readily accepted as providing answers appropriate to later circumstances."

(Mumford, 1996)

Text Box 4

Deep vs. shallow understanding

"Are we teaching the right things? Should the current curriculum be reviewed?" - comment from delegates: *"We therefore need a fundamental shift in teaching practice so that we teach students how to think rather than showing them how to following procedure in processing calculations."*

(IStructE, 2009)

Hard sums are good for developing engineers

"The teaching of mathematics both as an identifiable discipline as well as its use in developing engineering theory is important and should run for at least two years of the programme. Elements involving calculation, experiment, observation and deduction, must form a significant part of the programme"

(JBM, 2009a)

10.0 Photographs of the students in the small discussion groups

Figure 1 (Photo 1)
Title: Photograph of the students in a small discussion group

Figure 2 (Photo 2)
Title: Photograph of the students in a small discussion group