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Online teaching and learning: 21st century professional competencies for both academics and students?

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ABSTRACT

The paper describes the development of a successful online engineering course that has been developed over seven years and compares the presentation with that of a traditional lecture course. The techniques that are used to support the student learning include:

- *online equivalents to traditional methods in which knowledge is "pushed" to students using hard scaffolding techniques such as e-lectures, video clips and animations,*
- *interactive, Web 2.0 ("reciprocal scaffolding") techniques such as e-tivities and discussion boards in which students work online in groups to discover the context of the course,*
- *informal learning ("soft scaffolding") such as podcasts, and*
- *self-motivated learning, in which students "pull" knowledge, from website links and background reading and formative quizzes ("technical scaffolding").*

The paper attempts to show how such techniques can interact constructively to motivate students and it makes some recommendations for future developments. It is further suggested that engineering students should develop online learning skills, especially for group working, as a key professional competency for the 21st Century.

Keywords: *online learning, podcasts, e-tivities, scaffolding*

BACKGROUND

Learning in traditional university Engineering and Physical Science departments tends to have a higher number of lecture hours than in other disciplines, at least in the UK (e.g. National Union of Students, 2008). Whilst engineering students gain considerable practical experience through laboratories, engineering design, project work, etc., they nevertheless still spend a lot of time in lecture courses "learning things." In the arts and social sciences, the emphasis in learning tends to be on "constructing knowledge" whilst knowledge in physical sciences is either based on facts, which it may be considered desirable to learn, or it may be discovered through experiment or other research. Sparkes (1999) has long argued for considering Engineering education in terms of knowledge, skills and understanding (and later "know-how"), which may prompt a discussion on whether engineers really mean the same when referring to "knowledge" as some educationalists. There have been various initiatives to ensure that Engineering education is related to the real-world professional engineering. This includes the CDIO initiative which "is based on a commonly shared premise that engineering graduates should be able to Conceive – Design — Implement — Operate complex value-added engineering systems in a modern team-based engineering environment to create systems and products." (Worldwide CDIO Initiative, 2010) However, there will still be a role for more theoretical courses, for example on physical principles, within Engineering degree programs In such courses, a more constructivist approach may be useful in which students learn by assimilating new understanding and knowledge into their own experience. If the subject is entirely new, which it may well be, then this may involve having a better understanding of the real-world context of the subject.

Therefore, one could argue that, in Engineering degree courses, there is too much emphasis on knowledge delivery rather than on discovery and that, even in more theoretical courses, it must be possible for students to discover the context of their studies. It was with these considerations in mind that a new course was developed on Optical Fiber Communication Systems in which students would understand how the development of important practical systems (the infrastructure for internet transmissions) relied on knowledge and understanding of fundamental concepts (the materials science underpinning the components of such systems.) This would concur with another of Sparkes' contentions that "in order to maintain motivation, it is best to relate physics concepts to engineering creations that depend on them, rather than to physics experiments and bench-top demonstrations." (Sparkes, 1993) (Incidentally, this 1993 paper is also interesting in terms of supporting CDIO principles, differentiating, as it does, the goals of teaching science from those of teaching engineering.) It may not have been necessary to present this course online, however, the tutor (JCF) had undertaken the duties of Pro-Vice-Chancellor (which equates to Vice-President in some countries) responsible for Learning and Teaching. This made it virtually impossible to schedule regular lectures and so, making an opportunity to lead developments in e-learning out of the threat of not being able to teach in a conventional manner, it was felt that on-line techniques could be used to break away from the traditional pushing out of knowledge.

Such a development would also enable engineering students to develop their on-line group skills, which may be a somewhat overlooked, Engineering competency (Winterman, 2006.) A report (Independent Committee of Inquiry into the impact on higher education of students’ widespread use of Web 2.0 technologies, 2009) concluded that young people inhabit the social web space with ease and have a disposition to share and participate. This is generally at odds with the world that they encounter in higher education, in which outputs tend to be carefully referenced, precise, individually owned and guarded. However, there was recognition that young people are not usually good at finding and critically evaluating information, whether on the web or elsewhere, and that they may not be good at collaborating in groups online. Conversely, it was also recognized that academics should continue to reflect on research into learning so that they are able to make fully informed choices about their teaching and assessment methods in the light of the new technologies that are available.

e-LECTURES AND COURSE ORGANISATION

In considering how to organize the course, it might seem surprising, given what has been said about lectures, that it was decided to present the core knowledge to be acquired in mini on-line lectures, referred to as e-lectures (Edirisingha and Fothergill, 2009). However, it was felt that engineering students would naturally relate to this format, rather than, for example, providing them with reading lists of material to study. These e-lectures were not video recordings of lectures but PowerPoint presentations with narrative and some interactivity converted into a low bandwidth format using products such as Impatica and Adobe Presenter. The lectures could be watched whenever students wanted as many times as they liked. They could be paused, rewound, etc. and they had a rolling transcript, which was particularly popular with overseas students. The talking head was felt by the students to be the least important part of the presentation; an interesting comment as many recorded lectures are only talking heads. A screen capture from a typical lecture is shown in Figure 1.

Such e-lectures, together with video clips, website links, animations, background reading, a list of desired learning outcomes, and formative quizzes, were compiled into learning units, the building blocks of sections of the course. In this context, a learning unit may be considered as the ‘smallest self-contained learning lesson, providing at least one learning outcome’. (Han, 2006) The learning units were organized into the four sections of the module and each section was concluded with a summative assignment – usually an on-line computer-marked test taken under examination conditions in a computer suite. This is shown diagrammatically in Figure 2.

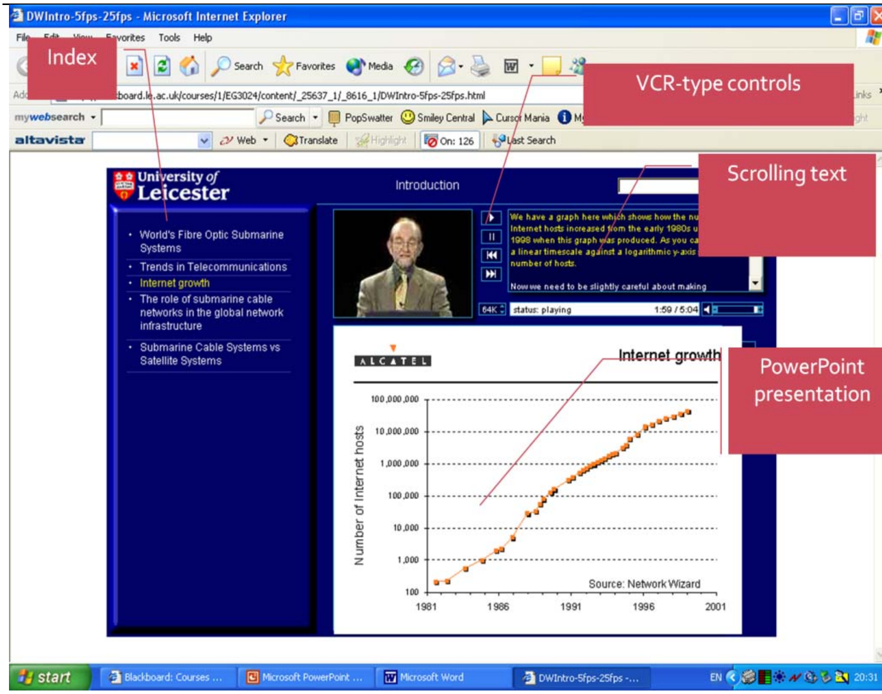

Figure 1: Screen capture of a typical e-lecture highlighting key features.

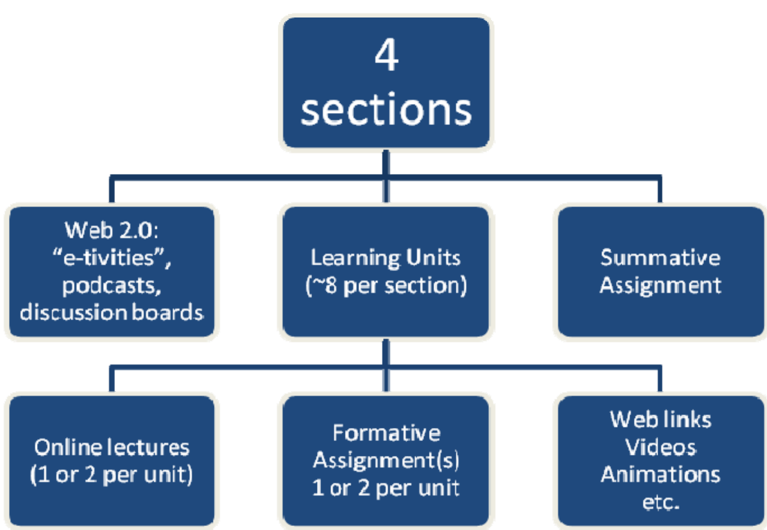

Figure 2: Organization of the Course showing the roles of "sections" and "learning units".

e-TIVITIES

In the first two of years of presentation of this course, whilst the students did well, there was little interaction with the tutor other than on the general discussion board which was busy, with students mainly wanting advice from the tutor on academic problems and some early problems with the technology. Furthermore, there was little interaction between the students themselves. Despite these limitations, the students commented to an external reviewer of the course (Barker, 2005) that they found learning online to be "very flexible, you can learn how you want to learn" and perhaps surprisingly both the students and the tutor remarked that they had better access to each other. Through access to the discussion board, the students commented that it "does seem like you get slightly more interaction with him". During this initial period, the discussion board was anonymised and archived each year and used as a basis for the subsequent frequently asked questions (FAQ) section. Whilst the students found the FAQ section useful, it gave them even less reason to interact with the tutor. To the tutor, at least, the course felt a bit dead. This may not have been the perception of the students (they have not made this comment) as they were coming to it fresh, but there was a feeling that the course could be improved by allowing the students to interact with other humans (other members of their cohort, the tutor and sometimes other academic moderators) as well as a machine.

Running alongside the course, weekly podcasts were introduced in 2006 with a series of four "e-tivities." The term e-tivities was coined by Salmon (2002) to describe frameworks for online active and interactive learning. Following these ideas, considerable activity (and interactivity) can be generated on the online discussion boards. Salmon recommends an approach to e-tivities, in which the interactivity between students becomes stronger over five stages, shown schematically in Figure 3.

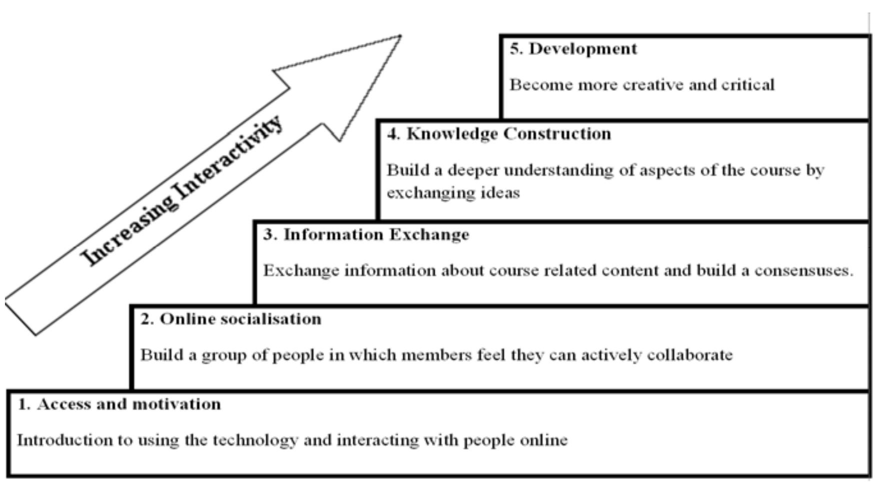

Figure 3: Salmon's Five-Stage model of e-tivities, (adapted from Salmon, 2002).

Such e-tivities were originally developed for distance learning students and required some modification for campus based students. Firstly, the students mostly already knew each other quite well so one could argue that the first two steps of the e-tivities were less important. However, this is not totally true: it was still found that the students were challenged by having to form consensuses on-line and indeed were still somewhat shy about introducing themselves. Whilst it is true that young people are generally not reticent about publishing on line (Independent Committee of Inquiry, 2009), it is not so clear that they are used to working together constructively in this way. It is also possible that the students do not know each other as well as one might assume. Secondly, the students do not really have to work on-line. They appeared to do so for at least the first three e-tivities. The fourth and last e-tivity, which is discussed more below, was more substantive both in scope and credit and it is not perhaps surprising that, whilst they still usually collated their contributions on-line, they found it easier to physically meet to organize their work. One should also notice that this module is quite short; it only counts for 5 ECTS (10 CATS) credits, about a twelfth of their total workload in a given year. The e-tivities are not a major part of the module, but they are valuable and, if the module were to be rewritten it would be appropriate to change the balance away from e-lectures towards a more Web 2.0 interactive style.

The first e-tivity effectively amalgamated the first two steps that Salmon suggests, for the reasons expounded in the previous paragraph. In the first e-tivity, it was important to explain what these e-tivities are about – and why students should join in. For this reason, the first e-tivity was not dependent upon understanding the course – it was about breaking the ice: easing the initial restraint or awkwardness in the virtual meeting space. The students were split into groups (about 5 students each) for the e-tivities. Interestingly, because the course was on-line, it was possible to accommodate two cohorts of students studying different degrees at different levels by giving them slightly different pathways and assessments through the course. Although there could have been some beneficial reciprocal scaffolding (Holton and Clark, 2006) in combining members from each cohort in a group, it was felt that this would have been detrimental for the more advanced students and perhaps more difficult to assess fairly. This first e-tivity started soon after the course began when the cohort settled down.

The second e-tivity was more to do with information exchange. The groups were asked to find the longest continuous optical fiber communication link using information from the internet. This was followed up with a supplementary question towards the end of the e-tivity asking them what limited the length. This is not difficult, but it did demonstrate how poor the on-line searching skills of many students are. By giving the students feedback, through the podcasts, some competition was engendered to find the longest fiber. (It is currently over 7000 km by the way!) The third e-tivity at first sight was similar: the students were asked what limited the speed (bit-rate) of information down a fiber. Actually, this is much more difficult and it meant that not only did they have to discover new information on the internet; they also had to construct an understanding of the contribution of the various factors that might limit the speed. The final e-tivity formed a mini-project. This year, students were asked to write an e-lecture for next year's cohort on an aspect of the subject that was only covered in a passing way. This formed the summative assessment for the final section of the course.

PODCASTS

As well as the e-tivities giving more collaboration and interaction between the student and the tutor and, indeed, the other students, podcasts were introduced. There was no educational model for these (although there are models now, e.g. Salmon and Edirisingha, 2008), but what has evolved is a model in which podcasts complement the e-lectures. The e-lectures are relatively difficult to prepare and update and indeed this has only been done where the subject has evolved and left them inaccurate. The podcasts ("profcasts" as Salmon has christened them) needed to provide context and to be perceived as being *of the moment*. The technical quality was not too worrying, indeed, if they were not highly refined, they would sound more spontaneous. A podcast might commence with a comment on the weather, or the current performance of the local football team, indicating that the podcast was fresh – perhaps making the students realize that it had been specially recorded for them. Something contemporary would then be discussed for a few minutes. Often this was a development in internet technology, perhaps a news item. A sub-sea breakage in an optical fiber internet cable that cut off much of India for a few weeks was a great opportunity for students to realize the importance of the technology. Interestingly, it also enabled them to talk to their (non-engineering) friends about what is otherwise a rather abstract subject. The next part of the podcasts would give them some feedback on their performance or/and make suggestions about what they should be doing in the coming week. Usually this would link the podcasts and the e-tivities at this point. It was useful to be able to give hints on the e-tivities – partly to give more reason for the students to listen to the podcasts, but also to stop them following dead ends in their investigations. It was also possible to fuel that competition between the groups, saying, for example, "Group 4 had found an optical link that was twice as long as that discovered by Group 2." To end the profcast, an injection of humor was appreciated. Indeed a "rap" for this purpose gave these podcasts some fame, making an appearance in the (UK) Times Higher Education and on local television, (Impala in the News, 2006.) It was hoped that the students might listen to the end (rather like the "... and finally" items at the end of News broadcasts) if there was something enjoyable to look forward to. The podcasts were therefore informal, some would say unnecessary, but they gave life to a course and motivation to the students.

The podcasts can therefore be seen as a natural complement to virtual lectures. Both types of lectures provide the function of "core knowledge acquisition." However live lectures can enthuse and entertain students, provide a sense of belonging to a course, and facilitate communications between students and the academic. They can provide a current context to the lecture material. The podcast, in considering current events, providing students with feedback and planning and some humor, provide the ingredients that are missing from virtual lectures, Figure 4.

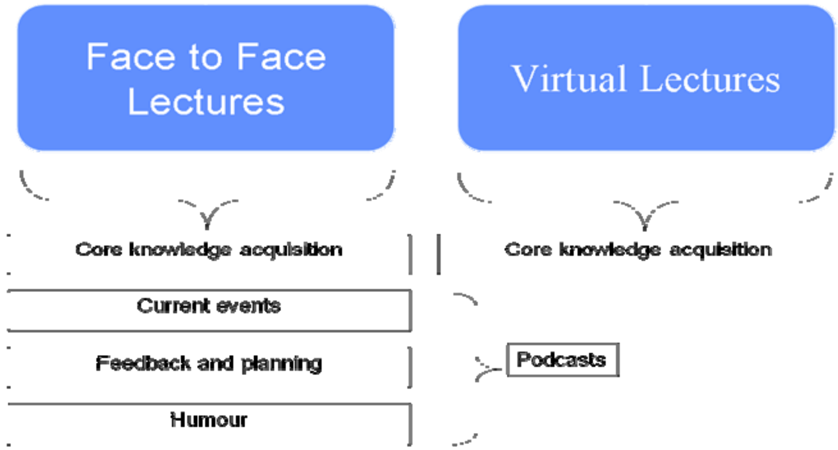

Figure 4: Podcasts complementing virtual lectures.

SCAFFOLDING

The ideas of Vygotsky (1978) have led to the concepts of "scaffolding learning" – i.e. providing support and help for the students' learning. In this context, almost all aspects of the course may be included as types of scaffolding; this is not particularly remarkable as the course was designed for the students to study largely unaided by a tutor. Engineering academics may often consider the "push" technology of lectures without the "pull" components of self-motivated learning. In the types of scaffolding that have been introduced, it is interesting to consider how e-tivities and podcasts may fit into this spectrum from push to pull. A possible analysis is shown in Table 1.

Table 1: The notion of different parts of the course a being different types of scaffolding to aid student learning.

PUSH (conventional teaching) - hard scaffolding	e-lectures video clips and animations
Interactive - mainly reciprocal scaffolding	e-tivities and discussion boards
Soft scaffolding	podcasts
PULL – self motivated learning	website links, background reading formative quizzes lists of desired learning outcomes

FEEDBACK AND PERFORMANCE

There has been very positive feedback to the introduction of the various facets of this online course. Overall the marks have improved markedly, Figure 5. It can be seen that the median mark (i.e. the 50th percentile mark) has increased from around 60% to more than 70%. The proportion of students failing the course first time (i.e. with a mark less than 40%) has dropped from around 15% to zero in most years. Obviously, the format of the assessments has changed, it would be a wasted opportunity if they had not, but the tutor feels that the level of competence assessed is broadly similar and that students have engaged with the course to a far greater extent.

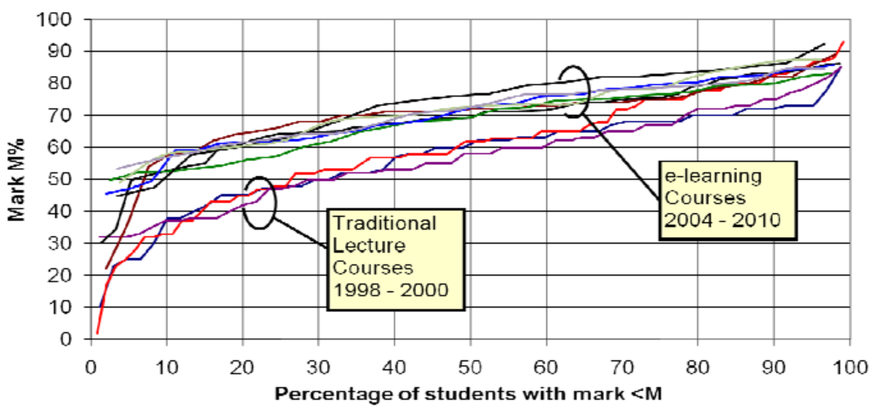

Figure 5: Cumulative plot showing mark distributions for traditional and e-learning presentation of the course.

The e-lectures were popular. Comments included: "I am able to actually listen to a lecture, and just pausing it if there is something you don't understand …", "We can ask him directly through the discussion board …", "I think that the online lectures are better, because I can do it anytime and any place", "I need 1½ hours to study that 15 minute lecture because I need to take notes …". The last comment is quite important. There were about forty 10-minute e-lectures in the course, but students spent considerably longer (45 – 90 minutes was reported) on studying each lecture.

Comments from focus groups on the podcasts were similarly positive: "The good thing about podcasts is you can sit in your room and play and listen to them. … It is good to listen to them", "It is really good when he relates information in the lecture to real life. It helps you to understand things", "It makes people interested in the module", "It is quite useful, it is just general feedback. He points out where students make mistakes …".

The use of e-tivities as a framework for interactions with and between students has been successful. The group discussion boards have been very active with all students taking part (admittedly after some initial cajoling.) It is unlikely that online discussion boards will be well used without some framework such as e-tivities.

FINAL COMMENTS

With the success of the e-tivities in promoting a deeper understanding of the course, and the podcasts interacting with the e-tivities to provide feedback and motivation, it is felt that that it would be beneficial to give these a greater involvement when developing future courses of this kind. The use of online courses should not be confined to those fortunate enough to study by distance learning. By considering which aspects of the course fall into the different types of educational scaffolding a balanced course can be constructed which gives meaning to constructivism applied to more theoretical courses in Engineering degree programs.

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