

E-learning: roles in distance and traditional postgraduate engineering courses

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Abstract

E-learning has been receiving increased attention since the advent of the Internet, following the hype of "online everything": from administration, to communication to business to education. The promise of e-learning has, however, fallen short of statements like those of J. Chambers (CEO of CISCO Systems) that said in 1998 that "the biggest growth in the Internet, and the area that will prove to be one of the biggest agents of change, will be e-learning" (Rosenberg, 2006). This is not to say that e-learning should be abandoned as a concept. It appears however that a new level of seriousness in understanding and exploiting its particular strengths is required. The future of learning technology may be promising, but its evolution is unclear. This paper investigates the role and potential of e-learning in both instructor-led (synchronous) and online (asynchronous) course delivery as well as blended variants within the context of new engineering postgraduate degrees in the EU. The discussion draws on a series of case studies, primarily focusing on the EDUCATE! multi-institution, EU project, which is developing an Environmental Engineering MSc based on e-learning.

Keywords: asynchronous, blended learning, computer-based, education, e-learning, online

Introduction

e-Learning has been attracting, over the past decades, a lot of interest from different stakeholders within the education and training sectors and many generations of e-Learning have been announced. Impressive predictions have been made on the future of e-Learning, ranging from the most optimistic views to the most sceptical views, including statements like those of J. Chambers (CEO of CISCO Systems) that said in 1998 that "the biggest growth in the Internet, and the area that will prove to be one of the biggest agents of change, will be e-learning" (Rosenberg, 2006). Arguably, the growing relevance of the use of ICT in education and the increasing acceptance of the potential of new technologies to affect learning systems have brought attention to the contrasting nature of the two components of the "e-Learning mix": ICT, as one of the fastest changing components of society and education, a slower adopter of change (Carneiro and Nascimbeni, 2007). European ambitions to become a competitive knowledge-based society arguably depend however, on adjusting its education to dynamically changing environments, in terms of:

- **Technology:** The Internet Revolution, as an original idea may be a thing of the past, but has been, most importantly replaced by the Internet as a everyday fact of life, similar to water and energy.
- **Nature:** Environmental Change concerns are an excellent example of global problems requiring (common) global understanding and equally global and far reaching solutions. This presupposes, as so often quoted, an added burden on education, but is educating the few that can physically attend a university enough to ensure the global audience required?
- **Education** itself: The Bologna process is an attempt to standardise a highly fragmented education sector. This is first and foremost targeted on mobility (by ensure exchangeability of programmes, modules and degrees). The question that leads on from this realisation is one of the extents of that mobility and the extent to which barriers between physical and virtual mobility are real or virtual.
- **Politics:** The focus on integration within the European political project relies heavily on creating and propagating a common (or at least a compatible) understanding of technical, political, economic, social and environmental realities and their interplay. The project is thus heavily reliant on an education system that allows for such an underlying common understanding to be reached by opening, as it were, lecture theatres to all audiences, across the continent.

- **Data-Information-Knowledge flow:** the speed with which advances in science change (sometimes radically) the underlying realities of the scientific process (from the environmental sciences to the human genome project) require new faster mediums of knowledge propagation. The need for the careful and slow process of distilling knowledge from the cutting edge of research into the textbooks is still undeniably there, but students need to get exposed to new ideas and changing scientific realities. This is all the more true since a series of other relevant components are catching up with the realities of the information age, including for example, data, information and knowledge with education lagging behind (Carneiro and Nascimbeni, 2007).

The aim of this paper is to investigate the role of e-learning in both instructor-led (synchronous) and online (asynchronous) course delivery as well as blended delivery modes within the context set above. The emphasis of the work is in e-learning as a tool in delivering postgraduate (rather than undergraduate) course in the EU, particularly since experience has shown that postgraduate and undergraduate audiences are different in their approach towards e-learning (Barr, 2007). The work draws from published literature as well as a series of case studies, including the ongoing MSc in Sustainable Development in the School of Geography of the University of Exeter and the EDUCATE, multi-institution, e-learning programme, led by the School of Civil Engineering of the National Technical University of Athens, which is developing an Environmental Engineering MSc for the Balkans.

Online vs face-to-face lectures: Differences and Issues

We start by asking how the e-learning paradigm transforms the core teaching mechanism within a traditional learning framework: the lecture itself. In a typical lecture (Chung, 2006) explanations and comments using voice is a dominant part of the lecture. The orally delivered part of the information will be termed a "script". Slides and software demonstration are used as part of the visual support of the "script". Writing on the board, in addition to prepared slides is also possible. From the students' point of view, these four lecture "components" are part of a larger learning process, which includes activities taking place before, during, and after the class, in the traditional classroom setting. Clearly this is not always the case, nor is traditional classroom always perceived as a success. It could however be argued that without a proper mechanism to compensate for any missing lecture components (particularly during class), distance learning classes could result in serious compromise (Chung, 2006). There are broadly two major paradigms of what can be used to "replace" the "during class" element of the student experience:

1. The first paradigm is to deliver the script in textual form, for example by annotating presentation slides as much as possible or by including the lecture scripts as part of the file (e.g. as notes). The most common way however is to emulate the concept of the textbook. Figure 1 provides an example of such an approach used in the Vicaire Project¹ where the script is enriched by actual slides used as figures.
2. The second paradigm is to deliver the slides as the main textual medium of the lecture but enrich them via recording the voice of the lecturer together with the slides (voice-over) and allowing for the (still) slides to become, for example, streaming video. This can act as an emulation of a classroom lecture, in which the sound element undertakes the function of slides explanation and the lecturer is allowed to control (actually predefine) to some extent the pace of the lecture. Figure 2 presents this alternative as part of another module of the same MSc in Sustainable Development of the School of Geography, University of Exeter. The user can however pause or replay the video, or indeed move backwards/forward to listen to previous (or following) slide/videos. Thus the actual pace of the lecture is "negotiated" between the predefined pace of the lecturers recording and the actual play of the lecture by the student. There is an obvious overhead implication for the lecturer who is in this case in need to predefine and record script and explanations (Barr, 2007). The concept can be extended to include software demonstrations using screen capture software and voice over, where such a software or tool demonstration is part of the intended learning process (e.g. Figure 3)

¹ <http://hydram.epfl.ch/pages/projets.htm>

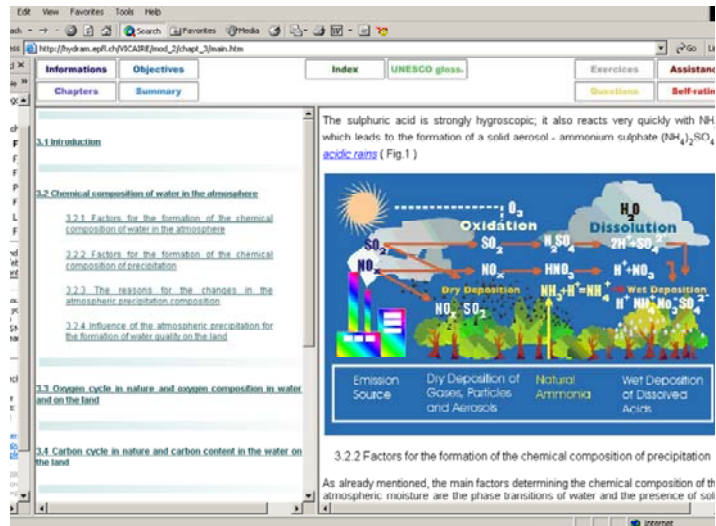


Figure 1: An example of a script-based approach to on-line lectures: the VICAIRE project

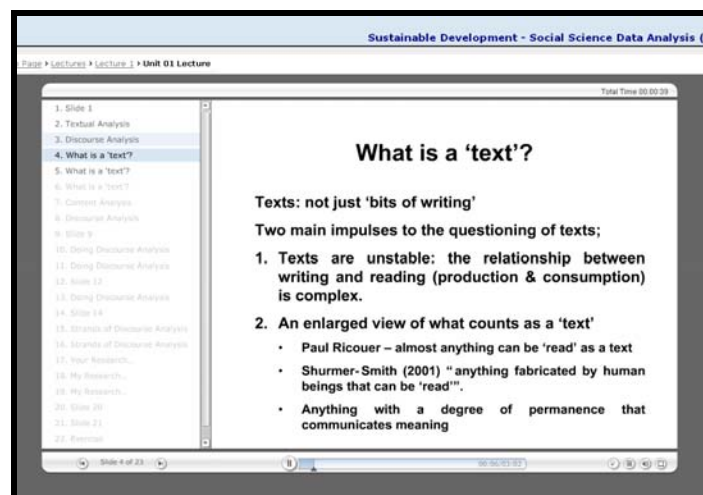


Figure 2: An example of a slide-based approach to on-line lectures: The MSc Sustainable Development at Exeter University.

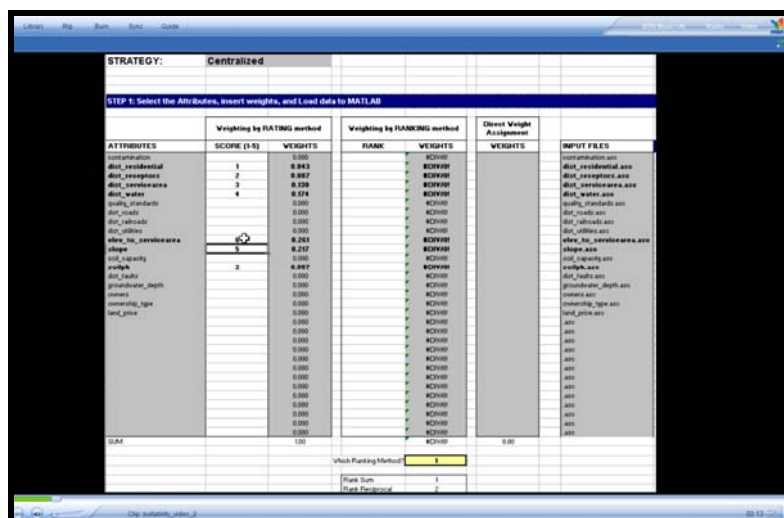


Figure 3: An example of a video demonstrating a software: The water technologies multi-criteria suitability evaluation tool developed by Makropoulos et al. (2007).

Both paradigms (and their hybrids) offer a series of advantages over traditional lecture delivery in the face-to-face context as suggested by Chung (2006) whose study suggests that students believe that on-line lectures were as effective as, or sometimes even more effective than, in-class lectures due to:

- Ability to pace oneself listening to the lecture
- Ability to replay parts of the lecture
- Finding the most effective time to listen to the lecture for better concentration

Various concerns have been raised, in particular targeted towards internet connection reliability and for specific individuals, an affinity to more natural communication. From the point of view of the lecturer, however, a most important remark is made by Cantoni et al., (2004) who suggest that, apart from the issue of communicating the content of the lecture to the students, a face-to-face, classroom teacher can rely on a number of visual cues from their audience: The lecturer can see who is taking notes, trying to understand a difficult concept, or preparing to make a comment. The (attentive and interested) teacher receives and analyzes these visual cues and adjusts the delivery to meet the needs of the class during the lesson. The distant teacher has no visual cues. Some of the role of this feedback is necessarily passed on to other e-learning-specific features.

Blended Learning

To learn and teach in a blended way has been and continues to be an way of conforming to different teaching/learning needs. Blended approaches could potentially allow encouraging and facilitating the communication and exchange of ideas between teacher and students beyond the traditional contact time (but in an asynchronous mode which takes into account the instructors' necessary time allocation to non-teaching activities); making possible for students to have an active role in the whole pedagogical process so that their interest for the course's content is sharpened, group work and interaction are promoted and their autonomy and responsibility towards developing and finalizing their work is strengthened. Chung (2006) for example, reports that most students desired to have an access to the online lectures in the archive whether they were from a distance lecture or in-class lecture. The study echoes the experience of Barr (2007) in running the MSc for Sustainable Development in Exeter University, in both a fully online and a blended format. Students enlisted for the face-to-face course are allowed full access to the online material, including the lectures (e.g. slides with voice over as suggested earlier). This has changed the way in which the students interact with the face-to-face lecture in that they now treat the lecture more as an opportunity to interact with the instructor and participate in discussions and less as an information uptake point. The fact has prompted some lecturers to change the form of the face-to-face lecturer to support this new student approach, by turning them, in some cases into discussion/thought-provoking sessions to provide the context for the lecture material online.

A Case Study: The Educate E-learning Course

The last 30 years have seen a rapid development of environmental education in Europe and internationally. This development has been most significant in the countries which had sufficient resources and appropriate long term Higher Education policies. These trends have largely bypassed the countries in South East Europe to the effect that Environmental Education in these countries leaves much to be desired and urgent action is needed. Furthermore the environment of SE Europe and Western Balkans has been subjected to unprecedented pressures over the years, requiring enormous effort to remedy the situation. The capacity of the region to undertake this work is limited by the lack of trained professional with the knowledge and transnational perspective required. In view of the ambition for unified regional development and associated environmental protection policy (e.g. the WFD) that is required, this imbalance needs to be urgently addressed. The EDUCATE! postgraduate course has been set up to assist the regional transnational cooperation on Water Resources and Environmental Management. The course is supported by five Engineering Schools coming from four leading national academic institutions, (1) the School of Civil Engineering, National Technical University of Athens; (2) the School of Chemical Engineering, National Technical University of Athens; (3) the Faculty of Civil Engineering, University of Belgrade; (4) the Faculty of Civil and Geodetic Engineering, UL FGG University of Ljubljana; and (5) the Faculty of Hydrotechnics, Technical University of Civil Engineering, Bucharest. A main innovative element of the postgraduate course relates to its e-learning component. The course is delivered to the students through a Moodle web-based platform.

Roles and Structure of the Educate E-learning Platform

The overall course structure can be seen in Figure 4, while the further breakdown into modules and lessons can be seen in Figure 5 and Figure 6 respectively.

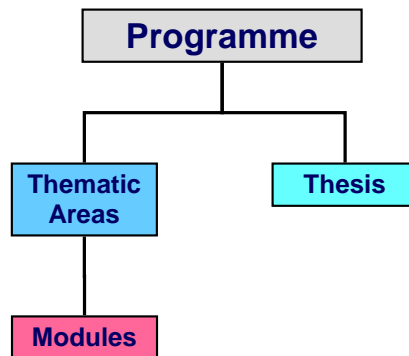
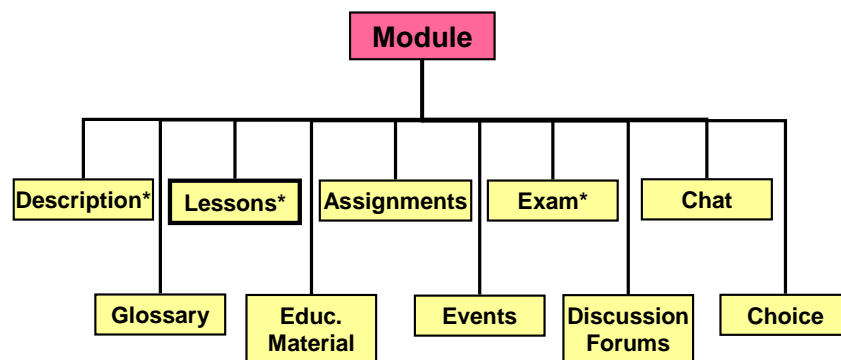
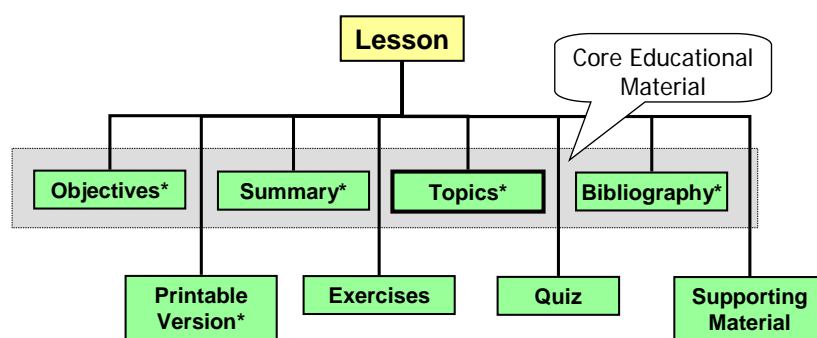


Figure 4: The Educate! course structure



* Required

Figure 5: Module components



* Required

Figure 6: Lesson components

Assessing the Course Development in view of UK's Professional Standards Framework for Education.

The Educate! course material preparation has recently been completed and its kick-off occurred on the December 2007. In view of this, a preliminary reflective assessment of the course is undertaken next, using as a framework the key areas of the UK's HE Academy Professional Standards Framework (HEA, 2006). This is a flexible

framework which uses a descriptor-based approach to professional standards for education, developed by the Academy on behalf of Universities UK, the Higher Education Guild and the four UK Higher Education funding councils after extensive consultation with the higher education sector. The assessment is broken down into the **areas of activities** that the framework specifies, namely:

- i. Design and planning of learning activities and/or programmes of study
- ii. Teaching and/or supporting student learning
- iii. Assessment and giving feedback to learners
- iv. Developing effective environments and student support and guidance
- v. Integration of scholarship, research and professional activities with teaching and supporting learning
- vi. Evaluation of practice and continuing professional development.

i. Design and planning of learning activities and/or programmes of study

The design of a new postgraduate course, such as the Educate programme is both challenging and presents an intriguing opportunity. The challenge is obvious and lies in the fact that everything needs to be specified from scratch: From identified thematic areas, to the modules contained within each thematic area, to choices between compulsory and electives, streams and core. The opportunity can be understood by comparing this *tabula rasa* process to “usual practice” in curricula development. The usual approach in development of curricula in courses that have been operating for years, is one of incremental changes, usually triggered by non-pedagogical issues. At the module level, new academic staff “inherit” module descriptions from retiring staff, which they are then forced to change to fit their own competences rather than what is required by the students (of which the older module descriptions were not necessarily an accurate representation anyway). At the level of a programme, additional modules are added, more often than not, to account for the presence of new academic staff, rather than academic staff being added to the faculty to address new teaching needs. In the case of Educate, the curriculum was defined a priori, within the general area of expertise of the participating Universities (which was extensive) and without any significant consideration on who would develop and teach the modules in question. The teaching material itself is an early product of trans-national collaboration between academic staff: An internal “bidding process” was undertaken to identify experts within the boundaries of the consortium (and beyond) in the module subject matter, which led to collaborations across university boundaries. It has to be stated however that the process of multi-institutional collaboration for material development was difficult and based, to a large extent, on good interpersonal relationships between academic staff working together.

ii. Teaching and/or supporting student learning

Clearly the Educate Programme is one of both teaching *per se* and supporting student learning. The boundaries between the two, in view of the specific e-learning delivery mode and indeed course design and organisation are difficult to distinguish. The “lecture” is given in the form of either a basic text (“script”) in suitable html format (Figure 8) or power point presentation with voice over, but in fact the students are expected to undertake a much more proactive approach to learning, by utilising additional bibliographic material and references, self-assessment exercises, assessment tests and assignments also provided in each lecture (Figure 7). In that second sense much more of the programme is focusing on supporting student learning than supporting teaching. It should be noted however that this change from “teaching” to “supporting learning” is an important shift in the lecturer’s priorities, which is allowed by the e-learning framework. Freed from their own problem-in-context (to fill-in one or more hours of teaching!), the lecturer is able (in principle) to concentrate on the real objective: assisting the students to learn. Past student assignments or projects, can organically be added to the resources available to the student, supporting to some extent the social constructionist claim advocated by Moodle.

9 **Lecture 9: Precipitation**

Topics

- Theory

Exercises

- Rainfall exercise 1
- Rainfall exercise 2
- Rainfall Assignment
- Solved Problem on exercise 1
- GIS DATA (for exercise 2)
- Instructions on exercise 2

Self assessment units

- Rainfall Multiple Choice (1)
- Rainfall Multiple Choice (2)
- Rainfall True/False
- Rainfall Quiz
- anketa

Figure 7: Examples of material available to the student for a given lecture

The screenshot shows a Moodle lecture page titled 'Precipitation Physical Context'. The page is part of a 'Postgraduate Course in Water Resources and Environmental Management' at 'DUCATE!'. The main content area is titled 'Precipitation Physical Context' and discusses the dynamics of the atmosphere, listing variables like density, pressure, temperature, and velocity components. It also mentions 'Atmospheric Moisture' and 'Dew point'. A graph (Figure 2.1) plots 'Water vapour pressure, e (hPa)' against 'Temperature, T (K)'. The graph shows two curves: a solid blue line for saturation vapour pressure and a dashed red line for actual vapour pressure. Key points on the graph are labeled: 'Dew point' at approximately 10°C, 'Intermittent rain' at approximately 20°C, and 'Saturation' at approximately 30°C. The graph also shows the relationship between water vapour pressure, saturation temperature, relative humidity, and dew point.

Figure 8: An example of a lecture (item: theory from Figure 7)

iii. Assessment and giving feedback to learners

Assessment and feedback is a crucial point in terms of both formative and summative assessment – as well as in terms of “experiencing” the results of the learning process. The formative assessment aspect is dealt with through a series of self-assessment quizzes, mostly, but not restricted to the multiple choice variety. The strategy adopted is that of a pool of questions, from which the system picks a specified number randomly, thus allowing for a dynamically changing challenge every time the student re-enters the system to attend the same lecture. The Moodle system allows for a series of assessment methods (actual points given, allowing multiple attempts to complete a quiz with penalties, non evaluated quizzes with helpful comments and indications of additional reading etc). A suggestion that is currently investigated is whether the quizzes at the end of each lecture could allow for a more interactive, customised, specification of the module material: ie using the quizzes not only as a formative “assessment” tool but rather as a diagnostic tool modifying the formative process itself. An indication, by the results of the quiz, that specific students have gaps in their understanding of statistics within a module on hydrology, could lead to an alternative route through the module to be suggested to the student, revealing more support material on statistics for each new lecture for the specific students.

The summative assessment process adopted is a combination of by-project assessment, in which students have to write an assignment for which they get a mark and actual, face-to-face exams in Regional Exam Centres. This latter, was not motivated by a pedagogical imperative, but rather one of accreditation. This is partly due to the inexperience of project partners in e-learning and the need to guarantee quality of learning the “old fashioned way”.

On the point of students “experiencing” the results of the learning process, *adaptive media*² such as the online simulation models used in the Educate teaching material portfolio have the ability to provide feedback to the students in view of a direct (intrinsic) experience of the development of understanding: *Intrinsic* feedback is defined as “feedback internal to the action that cannot be helped once the action occurs”. *Extrinsic* feedback is external to the action and may occur as a commentary. This latter type is more associated, within the Educate Project, with automated feedback to quizzes, as discussed above. The former is much harder to achieve in a class, but the focus on hydroinformatics (Abbott, 1993) that the course adopted enables the use of simulation tools, tutorial simulations and virtual environments which facilitate “direct” experiences. For example, a simulation model of a water distribution network, allows the student to “play” with different system configurations and observe whether the impact of pressure to water demand is what the theory in the lecture suggested. Although clearly this is a proxy for a real system, the engineer is able to see the results of changing pressures in the system in real time – an experience at least as real as that of the actual network operator, who changes the pressures within the confines of a control room in a Water Company – with the possible exception of telephone calls with customer complaints that are bound to follow!

iv. Developing effective environments and student support and guidance

It would be tempting to say that this e-learning programme is all about developing effective environments for student support and guidance. In fact this element – taken here to mean mostly a way of communicating with the student beyond the lecture delivery is a crucial and a difficult one for distance-learning programmes of the e-learning variety. This is due to the absence of personal physical contact between teacher and student – due to time and geographic displacement. Communicative media (Laurillard, 2002) including chat rooms, discussion forums and web-conferencing are available for synchronous and a-synchronous collaboration. The extent to which these are going to be used in practice will have to be monitored. Early experience suggests that they are indeed used by students – sometimes more frequently and with less forethought than one would have expected. There is also, still, significant uncertainty as to the exact time demands teaching of these modules will require of instructors. Early experience however suggest that although time investment is significant, the flexibility of when this time needs to be “spent” fits better into the emerging culture of flexible timetables, high mobility and always-online modes of working, favoured by younger academics.

v. Integration of scholarship, research and professional activities with teaching and supporting learning

The link between teaching and research has long been advocated as paramount but its actual implementation is subject to a series of non-pedagogical issues, such as, *inter alia*, proximity of the subjects the instructor teaches to his/her own research, flexibility of teaching curriculum to adapt to changes in understanding due to recent research, as well as receptivity of the student. It could be argued that, at least theoretically, all of the above are better served by a flexible, knowledge-driven, proactive approach to learning, supported by e-learning courses. In the case of Educate! professional activities are at the core of the stated aims of the programme – in view of its vision of influencing professional and indeed economic development in a very specific geographic area. Research is stated as a key element of the studies in the programme collaboration agreement, both through MSc theses, and indeed through course material. Most of the case studies and tools available as educational material in the modules were developed by the researchers/instructors and have been published in peer-reviewed Journals. The pro-active approach to knowledge discovery favoured by the Educate programme, prompts the instructors to include more research findings, rather than less, which would have been the case should the aim had been “deliver yet another lecture”.

vi. Evaluation of practice and continuing professional development.

Further than what was suggested above, in terms of the link between practice and the educational process, the programme attempts an even more explicit link between higher education and CPD. A series of 3-5 day short courses on additional specialised topics, based on the same delivery mode and core material, will be available in each country to professionals from Government and Industry. This is an attempt to ensure two things: (a) that professionals who are not able to attend a full course benefit from the link with current research and thinking and (b) that issues that are identified as crucial within the professional environment – based on feedback from the short courses – will be informing the core education programme, making the graduates more aware of and relevant to industry and practice. The short courses were designed through a series of initial workshops with the

² Computer media capable of altering their state in response to user actions (Laurillard, 2002).

industry (ie the beneficiaries), to reflect their needs better. This existence of a reasonably well-defined stakeholder group prior to the start of the course is an advantage in CPD course development, missing in graduate and postgraduate course development, where such a group is not available to be consulted with in the first place. Clearly this is not the only link to practice since the academic staff, participating in the course, have their own track record of involvement with practice. This is more so, in the context of Eastern Europe as the non-existence of large highly specialised consultancies creates a niche for academics as “special problem-solvers”. The uptake of this role by the academics in Eastern (and Southern Europe) is further necessitated by the insufficiency of research funding by national or international bodies.

vii. Overall Quality Assessment – an important overarching point

There is clearly a need to monitor, evaluate, assess and reflect on the material, course development and delivery and student feedback and assessment. The very aspects of e-learning suggested as positive characteristics here (including the link to research, the organic, flexible development possibilities and the customised navigation of the student through course material) could potentially be problematic. To address these concerns, both internal and external Quality Assurance teams have been set up to undertake evaluations at regular intervals. These teams will also take into account student feedback – particularly, but not restricted to the pilot phase (years 1 and 2). The formation of these teams relates directly to methods for evaluating the effectiveness of teaching and implications of quality assurance and enhancement for professional practice. Extended feedback sought from the students will be an input to both this QA process, but also to a continuous re-assessment process at the module level. The link between the course and practice (through the short courses) will also be a control point in terms of quality of the educational process and its relevance to current issues.

Other considerations

To date, however, the single most difficult process in the development of this MSc is accreditation. This is further complicated by the Bologna process and its requirements as well as the significant variability in the policy of European academic institutions towards it. There are also significant differences in the policies of partner institutions towards tuition fees and finally policies on Education and degrees in the partner Member States. Although these issues are outside the scope of this work, it is important to note that although e-learning, multi-institutional MScs, Bologna and ECTS credits are all attempting to increase the transferability, modularity and ultimately flexibility of Education in Europe, this is still very much a period of transition and thus far from ideal. Thinking and practice are moving but the inertia embedded in this process should not be underestimated.

A (Tentative) Conclusion

Moore, in his Editorial in *The American Journal of Distance Education* (1989), suggested four dimensions of interaction related to learning: (1) interaction with the content, (2) interaction with the instructor, (3) interaction with the students, and an additional fourth dimension particular to e-learning, that of the interaction with the system. Some of these interactions and the issues they imply for creating and running distance-learning online courses have been discussed in this work under the prism of the authors’ own experiences. The authors of this paper are academics within the engineering discipline and not experts in education per se. This dichotomy (between the de facto role of educator and the lack of formal education on education), which is particularly evident in all academic disciplines of the physical and engineering domains, naturally results in a more “experiential” approach to the question of e-learning and its handling within our work. Although formal theoretical treatment (from an Education Theory perspective) of much of the discussion in this paper is perhaps wanting, it is hoped that the hands-on experiences (of the learning-by-doing type) that it brings on the table, are still wanted.

In conclusion it is suggested that, in agreement with Bouhnik and Marcus (2006), the real question is not “to ‘e’ or not to ‘e’,” since “e” learning is already an essential factor of a contemporary learning environment and its significance can only increase in both its purely online and blended learning variant. The question is how to “e”, based on an evolving understanding of what e-learning is, what makes it different from the types of learning we are accustomed to in the traditional learning environment and how these differences can be turned to strengths for education and its practitioners.

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