E-LEARNING IN CONTINUOUS PROFESSIONAL DEVELOPMENT ACROSS THE GLOBE

An Experience in Water Engineering

J. Izquierdo, P. A. López, V. S. Fuertes
Centro Multidisciplinar de Modelación de Fluidos, Polytechnic University of Valencia, Cno. de Vera, s/n, Valencia, Spain

F. J. Izquierdo
Área de Sistemas de Información y Comunicaciones (ASIC), Polytechnic University of Valencia, Cno. de Vera, s/n Valencia, Spain

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Abstract: Based on our wide experience in continuous professional development (CPD) through traditional activities and hands-on experience on several commonly used Learning Management Systems, we have integrated both concepts and developed a simple, yet effective e-learning approach to help professionals in the water field to fill the gap between their sometimes not updated background and the new features that characterize the water field in the present days. We argue that this task can make use of the same approach that is essential to the knowledge discovery process, to which the e-learning process boils down to. In this contribution we present the work performed at the Polytechnic University of Valencia, within the Multidisciplinary Team of Fluid Modelling, on web systems to support technology enhanced learning specifically addressed to professionals in the Water field. Our approach hinges on the joint use of the online as well as the offline characteristics of the e-learning process and puts to work together in a synergic way both traditional and technology-based learning know-how. As a result, a number of distance courses have been produced that are used for Engineering CPD across the globe, since many professionals worldwide, mainly from Spanish speaking countries, have followed our courses. We present the evolution of our system and the results obtained from testing and evaluating the prototype during the last three years. We have identified issues significant to users in order to better manage the system and changes required to adapt our system to organizational processes and context. Feedback received from trainees indicates both the validity of our approach and the feasibility of implementing e-learning materials to contribute to CPD in the water field in particular and in any field in general, since the methodology herein presented can be exported in a straightforward manner.

1 INTRODUCTION

The final aim of Continuing Professional Development (CPD) is to update the knowledge required by professionals to improve their performance, allowing them to find valid solutions to the new problems they have to face every day. Virtually without exception, all knowledge areas have to undergo dramatic changes frequently developed at vertiginous speed. The Water Field is far from being an exception. In effect, the traditional background of the Hydraulic Engineer of the last century, driven by the universal and generalised water policy exerted from the offer side, has been oriented to Civil Engineering, neglecting and even ignoring technical aspects that have proved to be strongly demanded by the current labour market (Cabrera et al. 1999). Emphasis is placed on keeping on exploiting and taking advantage of the natural resources of the Planet, but under the command that development do not compromise the future, that is, to be sustainable. The concept of sustainability of a natural resource has triggered the updating of a number of aspects closely related to the water field, completely ignored a few decades ago. It is now ten years since the task force of American Society of

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civil Engineering (ASCE) regarding Environmental Hydraulic towards de 21st century was issued. According to the ASCE Task Force Committee on Hydraulic Engineering Research Advocacy (ASCE, 1996)

- education and research have not been articulated in a suitable way;
- researchers do not connect adequately with social needs underlined by politicians;
- education programmes in Hydraulics are not tailored to the real labour market needs;
- hydraulic engineers should develop wider and more visionary thinking.

Nevertheless, it is a real fact that the level of knowledge on water management from the demand side (sustainable water management) is by far lower than that of classical management (water development). University (academia) has shown strong inertia in the subject, due to its novelty and to the lack of tradition, to accommodate rapidly to the Society demand. In addition, it is frequently difficult to find educational publications of quality. As a result, most professionals in the water field have to face the new perspective with a clear lack of suitable training to cope with it.

On the other hand, the fact that technology within the water industry is under continuous development incorporating new tools every day, the lack of training and education in this field, despite the great job demand, and the future consolidation of this trend with new crises due to lack of water resources and/or loss of water quality, make it clear that wide possibilities are open to applied research tending to develop more efficient techniques of management from the demand side. Logically, research would be worthless without result dissemination through CPD activities reaching the professionals in charge of implementing them in practice. Academy, in substantial debt within this subject, has to undergo the process of courageously assuming the guidelines given by the ASCE Task Force in 1996.

These circumstances, under the author's point of view, give outstanding importance to subjects closely related to efficient use of water from the perspective of both R+D and the shear transmission of knowledge, that is, CPD. Nevertheless, high demand orientation, even though it shows necessary to achieve a good response within the labour market, does not guarantee success. It is of paramount importance to perfectly balance fundamentals and applications for the professionals to be able to assess the different alternatives. This task is far from being easy and demands a continuous dialog between education sender and receiver.

Unfortunately, this dialog between water professionals and university personnel is not straightforward. A number of obvious reasons make it difficult to create the right framework for the necessary knowledge transmission.

On the other hand, it becomes more and more clear that the use of telematic tools by online learning communities, through the true involvement of all the participants, allows the necessary share of information through suitable net learning models. These models, when adequately designed, may constitute a suitable framework to fulfil the task of CPD. Technological evolution has made the use of virtual learning tools more and more of an option in distance learning; these tools have become an indispensable support for the achievement of educational aims in learning institutions, namely through the provision of means for the interaction between participants.

This paper aims at describing the work developed within the Multidisciplinary Team of Fluid Modelling at the Polytechnic University of Valencia, in the field of CPD by using distance learning materials addressed to professionals in the water field. Our activity in CPD, including the participation in international forums and projects (see Cabrera et al., 1998 and Cabrera et al., 1999), is a fundamental feature of the Team. Based on this experience through traditional activities (quoting just a short sample of recent references, see Iglesias et al., 1999; Fuertes et al., 2003; Izquierdo et al., 2004; Díaz et al., 2004a; Fuertes et al., 2004; López et al., 2005; Izquierdo et al., 2006a) and hands-on experience on several commonly used Learning Management Systems (see, among others, Izquierdo et al., 1997; Izquierdo et al., 2003; Díaz et al., 2004b; Izquierdo et al. 2006b), we have integrated both concepts and developed a simple, yet effective e-learning approach that has materialized in a set of telematic courses with the aim of helping professionals in the water field to fill the gap between their sometimes not updated background and the new features that, taking into account the changes experienced within the water philosophy and needs, characterize the water field in the present days. We also describe the benefits and difficulties that were found and add some reflections on solutions for the improvement of this model. We present the evolution of our system and the results obtained from testing and evaluating the prototype, during the last three years. We have identified issues significant to users in order to better manage the

system and changes required to adapt our system to organizational processes and context. Feedback received from trainees indicates both the validity of our approach and the feasibility of implementing e-learning materials to contribute to CPD in the water field in particular and in any field in general since the methodology herein presented can be exported in a straightforward manner. The structure of this paper is as follows: first we describe the long and iterative way of materials production; then, our model is presented focussing on a number of dimensions that characterize modern telematic tools and distance learning; finally, we report both positive and negative facts about the experience to conclude with its really positive assessment.

2 MATERIALS DEVELOPMENT

The process leading through the production of each unit is iterative: there are different feedbacks from the first draft to the computer implementation. In a compact way, the steps are the following:

- Content proposal made by the responsible of the unit. According to his or her knowledge of the subject, his or her expertise in the field and other considerations (own points of view involving a variable degree of difficulty) the responsible delineates the basic scenario, settings, aspects and one or more lines of work from them. Also, other materials, such as exercises, questions or even tests susceptible of being directly used can be proposed at this stage.
- Collection and understanding of the material by the writer of the linear writing. The first materialization of the work can be called linear writing (screenplay in cinematographic terms). It is the backbone of the unit. All the contents to be developed in the unit appear in the linear writing in its final order. Also their characteristics, such as extension and other worth mentioning details (like conflicting points to be underscored) and also the way in which they are going to be presented (like would-be illustrations and specific ideas about animations, video, etc.) are then described in full. Guidelines to embody the linear writing can be:
  - Materials selection to fulfil the objectives.
  - Material structuring.
  - Thinking in interactivity and motivation. Selection of graphics, pictures, audios, videos, animations, interactive elements, simulations, internet links, etc.
  - Making sure that the units are self-contained.
  - Deciding which materials are essential and which additional.
  - Indication of what information and/or crossed references should be available from hyperlinks.
  - Etc.
- First revision (feedback). The writer of the linear writing agrees with the unit responsible the corrections, amendments, modifications, alternative approaches, etc. The importance of their communication, which should be maintained during the whole process, allows the creation of a dynamic and accessible final product. Note that both roles can be assumed by the same physical person.
- Storyboard development. The linear writing cannot directly be implemented in the computer. Although the contents, the order in which they will appear and the entire auxiliary means to be used are already decided at this stage, the attempt to directly type on the keyboard or to develop blindly animations or illustrations turns to be inefficient most of the times. It comes from the fact that edition cannot be improvised if the final aim is a really interactive and attractive product. As a consequence, in this fourth phase the equivalent to a cinematographic storyboard is developed. The storyboard consists of a remake of the linear script in which contents are divided into pages and screens. Now several questions should be posed: which part will be audio and which text?; how the concepts will be introduced?; how animations, videos, series of pictures will be presented?; how equations or their parts will be enhanced?; how superimpositions will be developed?; etc. For example, audios should be used to link concepts and not to introduce complex concepts; the text in one screen should be short, concise and avoiding abuse of descriptive materials; the use of moving diagrams could help the trainee understanding, perhaps with the help of a suitable audio; a plethora of ideas should be added here, only limited by the storyboard writer's own imagination.
- Computer implementation. It is probably the most mechanistic but, in a certain sense, the most exciting and rewarding phase of the

process, since the outcome of the previous phases makes its appearance at the end. It is 'the most mechanistic' because starting from the storyboard it seems to reduce to the most immediate action of copy and paste. Nevertheless, it is a creative 'copy and paste', since it does not boil down to directly translate facts to series of screens through the used author language. On the contrary, this phase involves user interaction design, picture and video recording, graphics and charts design, animation rendering, etc. Now, it becomes clear that words like 'copy and paste' and 'mechanistic' are not at all suitable.

- Full revision of the final product. The complete unit is evaluated by persons both related and not related to the work, in order to check if the proposed objectives have been fulfilled. Inner analysts check the formal outcome and outer appraisers evaluate the most important aspect: if it eventually meets the didactic and educational functionality to which it was intended to.

3 THE MODEL

Even though interactive learning can be observed from the static (personal, mono-user) point of view, such as the one provided by an interactive book with self-links or the well-known linked documents in pdf format, the true potential of e-learning resides currently in the communication capacity offered by several new technologies and, specially, by the Internet. A pioneering author in the field of e-learning, Badrul H. Khan, editor of several monographic works (Khan, 1997, 2001), has proposed a model to identify different levels of discourse regarding training through the Internet. In this paragraph we present our implementation regarding seven of the dimensions considered by Khan. Only ethical considerations have been left out of this work.

3.1 Pedagogy

From a pedagogical point of view, one can consider the so-called Social-Constructivism, which emphasizes the importance of culture and context in understanding what occurs in society, and constructs knowledge based on this understanding (Derry, 1999; McMahon, 1997). This perspective is closely associated with many contemporary theories, most notably the developmental theories of Vygotsky and Bruner, and Bandura's social cognitive theory (Shunk, 2000). Social Constructivism Education exhibits a philosophy based in four basic pillars. The Constructivist one, according to which the learning capacity of an individual becomes more efficient by interacting with the neighbourhood (Piaget, 1977); the Constructionist one, which spans the previous idea by considering that, when building something, learning is reinforced by the fact of showing the others the object that is built (Papert and Harel, 1991); the Social Constructivist one complements the others with the idea of devising group learning mechanisms to show things to other groups (Rogoff, 1993). And, finally, it is the concept of 'being connected', which reflects the capacity of being in permanent contact with the neighbourhood, what transcends the subjective vision of concepts that is typical of separated (unconnected) learning (Moodle, 2006, Connected and Separate section). As explained below, all those four pillars have been used to erect our structure.

3.2 Platforms

Based on these pedagogical ideas, a number of on-line platforms have been created during the last years. Some of them are of commercial use (like WebCT, but others are open-source (like SAKAI, and MOODLE).

Those platforms are mainly oriented to be used through the Internet by means of web browsers, what provides the trainees with full access from any computer with Internet connexion, as long as they have an access account to the course.

On the other hand, the hardware requirements are easily satisfied even by the most affordable configurations.

3.3 Management

From the computer implementation point of view, the requirements for the web administrator are not too demanding, since those platforms are distributed within packages that are easy to install and not requiring a too complex backend. As an example, MOODLE, the platform used in the application herein described, needs a LAMP (Linux, Apache, MySQL and PHP) environment, which turns to be of very easy administration.

From the point of view of the trainer/administrator these platforms allow very versatile configurations due to the fact that a wide variety of modules can be easily added, what constitutes the true attractiveness of on-line courses.

Also, security systems, access logins and passwords, student monitoring, announcements, tutoring, communications, guides for the student, etc., are easily managed.

3.4 Tools

Not only content presentation in the traditional manner by means of lesson-like modules are possible, but also so-called SCORM (Sharable Content Object Reference Model) (Redbird Software Corp., 2006, Content Packages and Resources section) modules that, besides being interchangeable with other courses, allow the use of diverse materials, such as videos, flash presentations, links to other web sites, etc. Using the same characteristics of content presentation it is possible to create Glossaries of terms that, suitably linked from the presented materials, will be of great help for the student to get concepts. These objects can be configured as collaborative, in the sense that both students and trainers are able to enlarge each term in the Glossary with their own ideas and/or examples.

Going further into the field of collaboration, an electronic learning platform allows the inclusion of Wiki modules and the building of Blogs, with the intention of luring students to participate in its construction, by following certain guidelines or basic rules established by the trainer with the aim that the own trainee be able to complete or enlarge the subject under study.

3.5 Tutoring

Well within this interactivity we would like to enhance that, without doubt, communication between trainer and trainee is of paramount importance. We are speaking about tutoring. This communication can be carried out by means of Forums and Chats, which are well known amongst internet users and can be created within these platforms. Also Queries, in the sense of fast opinion surveys launched by the trainer to get specific pieces of information from the student that would allow him or her to modify the progress of training or other strategies, can be considered.

3.6 Evaluation

Learning involves, of course, measurement of the training level reached by the trainee. To accomplish this task a wide variety of modules are at trainer's disposal: self-evaluation modules, such as questionnaires with multi-choice answer and automatic self-assessment on completion, or the so-called Hot Potatoes (Half-Baked software Inc., 2006, What is Hot Patatoes? section), sometimes more attractive for some students, since they allows a huge variety of exercises, such as crosswords, associations, multiple selection, short answers, filling of gaps, etc. All these exercises will be evaluated at the end of the exercise. As a result, the trainer is able to provide the student with a set of evidential proofs allowing the later to build an idea on his or her learning level. The final assessment, from the trainer point of view, will be performed from Task modules, which are short and theoretical works, and Workshops, which are longer projects that will be eventually sent to the trainer as an independent document in any of the customary electronic formats.

The list of all the abovementioned resources, which far from constitutes an exhaustive one, allows a wide variety of combinations, including the nesting of one into another. For example, one unit may end with a self-assessment exercise forcing the student to pass it before getting into the next.

3.7 The Interface

From the student/client point of view, the visualization of an on-line course must be attractive, simple, intuitive and useful. As a consequence, modification of the general presentation of the different modules should be allowed both for the teacher and the student. The administrator will place the blocks in the main page where he or she considers necessary, and will give different permissions to the users (students and teachers) for their re-distribution, elimination (in the case they are not necessary) and/or inclusion of new ones (if they are considered as interesting). The trainer will be in charge of maintaining the order within his or her course, but the student will be allowed to customize the general appearance of the interface so that he or she feels more comfortable.

3.8 Final Considerations

All in all, electronic learning exhibits great potentiality since, despite there is no teacher present during the process, it allows, as has been explained before, a wide variety of both instant and asynchronous communication possibilities, of content presentation in different formats, text, hypertext, links to other own or alien sources, videos, flash presentations, static or animated graphics, etc. In addition, it can be done in a

hierarchical and perfectly ordered way due to the capacity of organization into directories, labelling of contents and organized presentation of configurable blocks that endow these interfaces with a powerful potentiality as learning tools. On the other hand, it provides all the involved actors with suitable communication devices. Students are able to share information at ease both with the tutor and other colleagues, and trainers are able to track much better students' progress. These characteristics help to meet the requirements urged by modern telematic trends and, above all, make distance learning effective.

4 FEEDBACK AND RESULTS

Distance learning in Spanish in the World of Hydraulic and Environmental Engineering has been herein considered as a pilot experience. To the knowledge of the authors, there are no previous experiences in distance learning in Spanish for this pool of professionals, and the activities developed within the CMMF must be considered pioneering. In this section we describe our team personal experience in the subject. It is made up of different pros and cons, but it should be eventually assessed as very fruitful.

Development of so a specific type of materials with the aim of rendering them into telematic training units is really time consuming and not straightforward at all. As a rough estimate, a course with available written documentation (see linear writing in paragraph 2), which has been devised as a fifty hour course for a student, takes a whole month full time work of preparation by an expert university lecturer prior to be issued through the telematic tool we use. Preparing self-contained didactic units with suitable length, devising all the multimedia needs, such as images, animated videos, graphics, links to other related pages, glossaries linked to selected words, references in the Internet, foldable examples, tests and interactive workshops, etc. (see more details in paragraph 2), takes most of the time.

Nevertheless, during the two academic courses in which the activity has been developed, the impact, taking into account the specificity of the subject, can be assessed as more than acceptable.

Fifty five people have taken the courses, forty one out of them have been Spaniards, eight from Mexico, two from Colombia, four from the Dominican Republic, two from Peru and one from Chile.

Most of the students were professionals working in companies, either public or private, devoted to water management. Nevertheless, all of them had close relationship with water supply operation, either with technical management, thus showing especial interest in the course about pumping stations and the one about hydraulic transients, or with building installations and more basic tasks within the water supply activity, thus exhibiting higher interest for our course related to foundations and basics of Hydraulic Engineering applied to fluid transport.

On the other hand, a specific agreement has been signed with the Universidad Michoacana (Mexico), for the participation of university lecturers from this institution with original education as Civil Engineers, whose background on hydraulic machinery and small hydraulic systems was considered as incomplete.

The response and level of participation of the registered students must be evaluated as very positive, according to the feedback received both by their communications and by the automatic control of connexions exerted by the system. For one thing, the students had to perform on-line evaluations with regard to the contents of the specific subject they were working on. We have to say at this point that, as expected, almost all the evaluations have been excellent. For another thing, the quality of the written materials, which were sent electronically, regarding the different workshops, reached, in most instances, really high levels. Most of these communications were directly related with those workshops, which posed questions and problems requiring some time to be solved and aimed at the student's acquaintance with the main objectives and skills, thus requiring more time and attention from the student. Over 65 per cent of the workshops have been performed perfectly, thus deserving the highest mark. Those students that were not given a top-mark evaluation for the workshops, -25 per cent-, were able, with only little iteration, to get positive assessment. Only 10 per cent of the registered students gave in.

On the other hand, the relationships established through this tool, taking into account the specificity of the subject, have triggered a number of discussions going further and rising aspects different than the concrete contents under study, but focussing on the professional tasks performed by certain students. Since we, the trainers in charge of these distance courses, are specialists in pumping stations and hydraulic engineering, this platform has provided our students with the possibility of rising questions (especially technical ones) about, for

example, specific characteristics regarding water supply systems or about the determination of the characteristics, selection of pumps and regulation of pumping stations. These aspects require high standard skills in the subject and, as a consequence, are not included in more basic courses. Anyway, this feedback, under our point of view, should qualify as a high quality one since it is fruitful for trainees and for trainers too. In effect, some of the aspects raised by the students have been incorporated to the next edition of one course or are in process of being incorporated.

Tutoring has been one of the most interesting aspects in our experience. Not only personal tutoring, which has been the most abundant and fruitful, but also discussion in the specific forum implemented in the tool has become a really enriching experience. Students have shared fluently specific problems taken from their respective companies. In some cases, questions raised were common to many of them. But, in a good number of instances (bigger than expected), the personal experiences disclosed in the forum motivated interesting exchanges of information, which were considered by other students, thus greatly revalorising the expected objectives. Under our point of view, this enhances the suitability of the tool. Nevertheless, it has to be said that the main drawback has consisted in the bigger effort that both trainer and administrator have been forced to do, since this kind of activity is really very demanding one.

As said before, the tool we are describing here allows the realisation of on-line surveys. Although technically the resource has worked perfectly, it is necessary to add that their evaluation may be considered not completely reliable, since most students were not familiarized at all with distance learning, what made some of the surveys really heterogeneous. It has to be pointed out here that the best evaluated aspects were the attention given by the trainer (tutoring and forums), the specific contents of the different themes and their applicability for the students' working field. As a consequence, our assessment, which can be given in the own terms used by most students, is that the 'course has been very useful'. Eventually, it should be said that it has been really rewarding for the full team of people who have worked to prepare these kinds of distance learning resources.

We are currently developing and intend to develop new telematic courses in the water field that will be able to coexist with the three courses already developed. In fact, registration is open at the moment of typing this paper and keeps on growing on a daily basis.

The decision about the subjects to be considered in the new interactive courses is determined by two really important aspects. On one hand, the responsible of the course contents must be an expert in the subject: it is absolutely necessary that materials are interesting and well chosen; thus, performing a good tracking of them seems to reveal an urgent necessity. But, on the other hand, we should think which is the society demand regarding distance learning within our fields of interest. The objective is to aim with maximum accuracy at the biggest work stock markets. In this regards it seem plausible that next trends will aim, amongst others, at plumbing installations of different fluids, where the new legislation implies wide changes from the Engineering and Architecture points of view and European and international directives are propelling a series of movements to save water by making a more rational use of it within the consumers collectives. Future initiatives will certainly point in those directions.

5 CONCLUSIONS

Distance learning in Spanish in the World of Hydraulic and Environmental Engineering has been herein considered as a Continuous Professional Development pilot experience. To the knowledge of the authors, no telematic tools of this nature have been developed in Spanish for this pool of professionals so far. Our experiences both in traditional courses and in multimedia materials development have been put to work together in order to produce a series of distance learning courses aimed at providing professionals in the water field with updated information that could help them to bridge the gap between their education at the origin and the new features that current environmental trends stubbornly seem to point at. We claim that the developed materials together with the platform used to implement them meet the requirements urged by modern telematic theories since it provides all the involved actors with suitable devices to perform their own tasks. Students are able to share information at ease both with the tutor and other colleagues, and trainers are able to track much better students' progress. The courses have been followed by students throughout the world, mainly from Spain and Latin America and the results can be definitely considered very satisfactory.

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