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Design and Development of a Blended Learning Module Template for On-Campus and Distance Learning in Civil Engineering

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Abstract: - A considerable amount of the e-learning materials produced initially was mostly technology-centred. Consequently, less attention was paid to the learners' cognitive and social activities in the learning process. This paper describes a blended learning module template, based on WebCT Vista, which is to be used for on-campus and distance learning programmes, in Civil Engineering, at the University of Surrey (UniS), UK. The learning environment designed aims to facilitate the emergence of an active Community of Inquiry leading to deep and meaningful learning. The authors assert that making the course available for both on-campus and distance learners simultaneously will trigger collaborative learning activities through using online discussion forums and chat rooms, which will enhance the depth and scope of the learning of both groups. The modular design of the template takes into account the loaded schedules of busy engineering lecturers and it allows them to improve course materials and to develop new learning scenarios to fit the learners' needs, in an easy and flexible way. The authors note that e-learning tools are but one of the means of providing a successful learning experience. Other influential parameters in the learning environment (e.g. teaching and facilitating skills) should be adapted to the demands of blended learning. Finally, the authors recommend adopting broad and inclusive views that take into account both users' and developers' needs and perspectives. This should be related to the development, the improvement and the adaptation of templates and to the actual use of the template for teaching and learning, to the benefit of everyone (faculty, lecturers, e-learning developers and learners).

Key-Words: - E-learning, Blended Learning, Community of Inquiry, Pedagogy, Virtual Learning Environment (VLE), Engineering Education, Implementation, Technology, Change

1 Introduction

Early research in e-learning was mostly technology-centred [11]. Researchers point out that e-learning research should not only study e-learning systems as technological innovations, but also the psychological phenomena associated with the use of information and communication technology (ICT) in learning [30]. They emphasise the need to research psychological factors, processes and mechanisms involved in e-learning so that 'the e-learning practice can move from a technology-centred implementation to human-centred effective learning processes' [30, p.287].

The nature of learning environments is likely to affect students' learning effectiveness and their psychological well being during the learning process. It is therefore important to design the learning environment based on reliable learning theories or a combination of

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them, and in a way that will facilitate learning and the social inclusion of the whole student online learning community registered in the course. Moreover, it is important to take into account the lecturers' perspective and the impact that the technology may have on them. These challenges require not only a sound and broad knowledge of e-learning pedagogy that enables the developer to see the problems from a variety of perspectives [29], but also e-learning implementation strategies that developers should be aware of when designing solutions [8, 9, 10].

A large body of evidence shows that the use of Virtual Learning Environments (VLEs) can improve the learning process [2, 6, 7, 15, 16, 18, 19, 27]. In addition to e-learning, many universities have introduced hybrid forms of learning, such as blended learning (see for example: [14]). This combines both conventional face-to-face learning and e-learning. Others universities introduced VLEs in its distance education programmes [19, 25, 22]. This new technology opens up a way to develop new forms of flexible learning to the benefit of the learning community.

Research suggests that blended learning can be more effective than conventional on-campus learning [14]. However, there is no coherent theory on the design of effective learning environments to support blended learning [11]. Moreover, many lecturers lack the time, e-learning pedagogical skills, technical expertise, incentives, and flexibility to use e-learning platforms more effectively [11].

The purpose of this paper is to describe the development of a learning environment for blended learning modules in Civil Engineering, from two perspectives. The first one is pedagogical and it consists of the application of learning theories to design the template. The second perspective is techno-social and it focuses on the requirements for a successful integration of learning technologies and methodologies into engineering lecturers' everyday teaching practices, taking into consideration the constraints of their heavily loaded schedules.

1.1 Design of Learning Environments

'Research on learning does not provide a recipe for designing effective learning environments, but it does support the value of asking certain kinds of questions about the design of learning environments.' [4, p. 153]. Four perspectives should be considered in the design of learning environments [4]. These aspects define the level of centeredness of the learning environment - the degree to which they are learner-centred, assessment-centred, knowledge-centred or community-centred. These four aspects should be aligned in the learning environment as they overlap and mutually influence one another [4].

Learning theories and approaches are as diverse as the focus of the learning process (technical knowledge, thinking skills, problem-solving or other skills). Moreover, many of these theories are overlapping. It is therefore necessary to understand the characteristics of the learning phenomena that are likely to take place in the context of the environment to be designed. The suitable learning theory, or set of theories, on which the learning environment should be based, can then be selected to support the learning processes intended.

It is considered that both cognitive and social aspects should be taken into consideration in analysing the learning likely to take place in blended learning environments [26]. One of the models that satisfies this requirement is the Community of Inquiry model [12], which is a theoretical perspective that views learning as an activity determined by cognitive activity and social interactions facilitated by the teachers' presence [12, 13, 14]. From this perspective, knowledge is acquired through cognitive activity (e.g. interaction with content and tasks) and social interaction (e.g. dialogue and group work) that takes place within the learning environment.

The role of the teacher is crucial in the process as he/she designs the educational environment and sets the social environmental conditions within it during the learning process. The pedagogical requirements of the model have to be embedded in the learning environment designed. This can be done through applying a set of well established cognitive and information-processing theories which should be used to design the structure, materials and screen layouts. This may include for example; the rule of seven [20], cognitive load theory [24], message and screen design principle [5] and guidelines on the learning environment structure [5].

1.2 Successful Implementation of e-Learning

The second important perspective to consider in e-learning is the implementation of the technology and its dissemination amongst engineering lecturers. Eight conditions for the success of implementation of learning technologies in organisations have been identified [10]. Others enumerated a number of variables that affect the implementations of learning technologies, many of which are managerial in their nature [8].

More recently researchers found that out of the eight variables suggested [10], four of them seem to have the greatest impact on the implementation of learning technologies [9]. In addition, the barriers were classified into three categories [21]: personal, attitudinal and organisational. It is notable that much of the research in this field focused on managerial aspects [8, 9, 10]. Although, they might be relevant, it is believed that a suitable implementation should start from understanding the problem from the users' perspective in the context

where the educational technology is implemented. The relevant barriers to our situation are [21]:

- Time necessary to learn new learning technology.
- Lack of training and technical support.
- Increased time required to develop, monitor and update e-learning materials.

It is notable that different barriers will become significant at different stages in the implementation process [21]. Thus, a flexible strategy is necessary to overcome these barriers.

2 The Blended Learning Template

The University of Surrey (UniS) has recently introduced WebCT Vista as its VLE system. The system is now widely used across the University. The UniS e-learning team promotes the use and development of e-learning at the University. DEBSCE[2] is an initiative of the centre within the Civil Engineering discipline, in the School of Engineering, which aims to expand the development and dissemination of e-learning in Civil Engineering at Masters level. A number of the intended blended modules, which are currently delivered as paper and CDROM-based distance learning modules, are being developed for online learning. The aim is to trigger further development of e-learning in Civil Engineering at UniS.

There are currently six modules using a common template as a basis for the development of the e-learning materials. These are: Space Structures, Long-Span Bridges, Durability of Bridges and Structures, Prestressed Concrete Bridge Design, Bridge Deck Loading and Analysis, and Earthquake Engineering. The template has been designed in order to facilitate the adoption and development of the materials. The project aims to develop high quality e-learning and to disseminate good e-learning practice among engineering lecturers within the University and beyond.

2.1 The Pedagogical Aspect of the Template

The template structure is based upon the guidelines for learning environments suggested in the research [4, 12]. It also relies on well established cognitive psychology principles [1, 3], and some aspects of social learning theories [12, 17, 28]. The template will first be described, and then a discussion about its design, uses and update will be presented in the discussion section.

[2] Development of E-learning delivery for post-graduate distance learning modules in Bridge, Structural, and Civil Engineering.

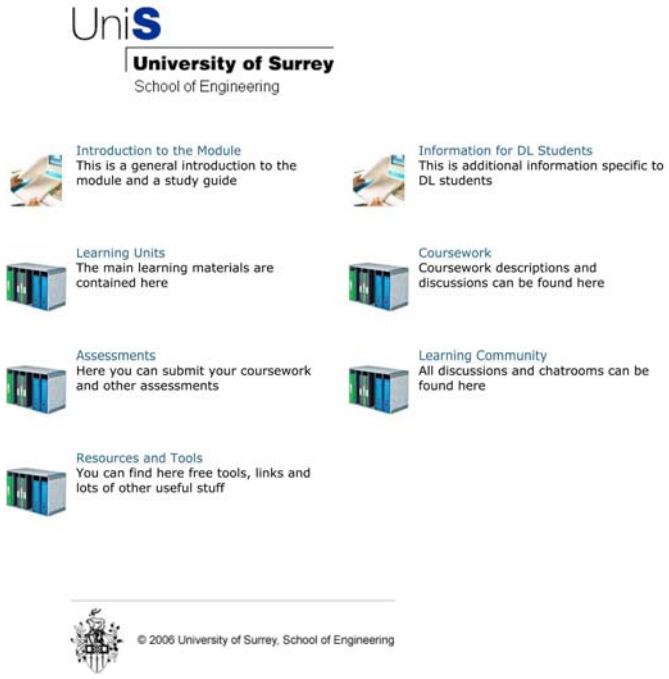

Fig.1 The home page

Fig.1 shows the main page which consist of 7 elements. Two of them contain basic information about the module and the other five folders contain learning materials and tools. The folders are Learning Units, Coursework, Assessment, Learning Community and Resources.

2.1.1 Learning Units

Fig.2 shows the content learning unit folder. As shown, this folder contains a number of units (typically 7 to 10). In addition, the folder contains an introduction to the units, guidelines for discussions and a link to a discussion forum about learning materials. This is the second level.

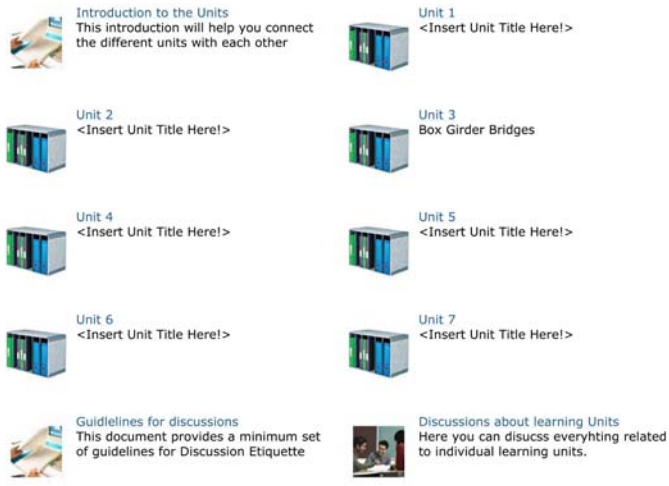

Fig.2 Learning materials (Units)

The third level of the learning material folder contains sections which are subdivisions of the learning units. Each learning Unit contains between 1 to 5 sections depending on the length and complexity of the unit. Fig.3 shows three sections, an introduction to the unit, discussion guidelines and a discussion forum about the unit.

Fig.3 Section within a Learning Unit

2.1.2 Learning Community

In addition to the learning forums, there are also two chat and whiteboard rooms. This folder is meant as a meeting point for any student who would like to ask questions or discuss topics related to all aspects of the module (see Fig.4). Chat rooms are synchronous systems that can be used for instantaneous communication. The whiteboard can be used to write, show images, figures etc. Collaboration through this system can be difficult to establish without planned chat meetings organised and guided by the lecturer. In order for this form of collaboration to succeed, it might be necessary to included it in the module time and it should be graded. This would require a decision at the Civil Engineering Board of Studies. Discussion forums are different since they are asynchronous, which means that the discussion is not taking place simultaneously. The participants in this discussion can reply to messages at a later time. Thus the lecturers have more flexibility to manage these forums.

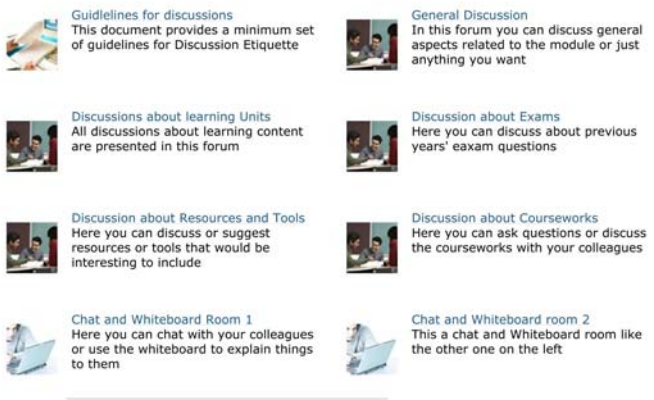

Fig.4 Learning Community

1. **Introduction to the Module:** ***(Level 1)***
2. **Information for Distance Learning Students:**
3. **Learning Units:**
   - Introduction to the Units ***(Level 2)***
   - Units 1-10:
     + Introduction to the Unit ***(Level 3)***
     + Section 1-5
     + Discussion about the Unit
   - Discussion about Learning Materials
4. **Coursework:**
   - Description of Coursework 1-2
   - Discussion about coursework 1-2
5. **Assessments:**
   - Submit Assessment
   - Quizzes
   - Discussion about Exams
6. **Learning Community:**
   - General Discussion
   - Discussion about Learning Materials
   - Discussion about coursework 1 & 2
   - Discussion about Exams

Table 1 The Structure of the Template.

WebCT allows a number of tools to be shown on the toolbar located on the right hand side of the screen. As shown on Fig.5, all of the four icons are communication tools.

Fig.5 The Toolbar

The "Who's Online" icon allows logged in users to see other fellow students who are online at the same time and who they could then contact using the chat facility. The reason for showing this icon in the centre is to trigger possible online discussions (chat) and to help reduce feelings of 'cyber loneliness'. It is believed that this tool will increase possibilities and chances of interaction between fellow students particularly as the second icon "Chat and Whiteborad" is shown beside it. The third tool "Discussions" is a link to the asynchronous discussion forums. This tool has been chosen for similar reasons as the "Who's Online" tool. The "Mail" tool allows students to communicate via the WebCT internal e-mail system.

Table 1 shows all the discussion forums. There are four forum categories; discussion about learning materials, discussion about coursework, discussion about Exams and General discussions about tools and resources. With the exception of the discussion about learning units and coursework that require regular academic input, the other forums are made available to students registered on that module to use them to interact with each other. The triggering cause is the joint interest in learning, solving exam questions or having a general discussion or chat.

2.2 Technical Aspects of the Template

2.2.1 Modular Design

The modular design of the template allows materials to be updated simply and easily. Complicated WebCT tools that may require advanced knowledge of the VLE systems have been avoided and replaced by a combination of simpler tools and solutions. This design also allows modifications and adaptation of the template. However, this requires knowledge in both e-learning pedagogy and WebCT.

2.2.2 Formatting of the Materials

The learning materials were originally in hard copy format supported by some materials on CDROM and downloads from a free bulletin board system 'UltraBoard'. Many of them contain advanced organisers, study objectives, self-learning activities etc. Thus, they are suitable for self-learning. However, due to their relative length further work is required to adapt them for online learning.

The formatting of the materials was done using the commercial software courseGenie which can convert Microsoft Word (Word) documents into WebCT learning modules. This software combination has a number of benefits. Firstly, all of the lecturers are familiar with Word and have used it to develop the distance learning materials. Secondly, courseGenie is fully compatible with WebCT and the SCORM standard. Thirdly, it continues to allow the lecturers to update their materials in the familiar environment of Word.

2.3 Implementation Aspects

2.3.1 Staff Development Courses

The UniS e-learning team offers a range of staff development courses in WebCT and e-learning and will develop a special training course for the Civil Engineering lecturers who will be using the template. The aim is to provide a course that is tailored to their specific context. This will help the lecturers by providing a focused course concentrating on those aspects of WebCT used in the template. The training planned will include the different aspects related to the template and in particular e-learning pedagogy, e-moderation and the technical aspects associated with the development and update of the modules.

2.3.2 Development of Guidelines

Guidelines on how to develop the e-learning materials to be used with the template and instruction on how to modify the template will be available for lecturers and future developers. This will include information on how the template is built and how it can be used in teaching. The guidelines will be used as a complement and reference for the training course.

3 Discussion

The Engineering profession requires the specific mastery of certain cognitive processes such as problem-solving and reasoning. Therefore cognitive theories of learning are relevant to this educational environment. Moreover, since most engineering projects are conducted in teams with a high level of interaction, social learning theories and particularly Communities of Practice are also highly relevant [28]. In addition, engineers must engage in life-long learning, as a requirement of the professional bodies to which they belong, in order or keep their knowledge up to date and to maintain their chartered status. Therefore, the learning materials have to take into account these aspects in the pedagogy used. The e-learning environment in which engineers are trained must also foster these important skills through translating the pedagogies into e-learning.

The Community of Inquiry model is one the models that suits best the above requirements. The model assumes that 'learning occurs within the Community of Inquiry through the interaction of three core elements' [12, p. 88]. Table 2 shows these three elements; cognitive presence, teaching presence and social presence.

Elements	*Categories*
Cognitive Presence	Triggering Event
	Exploration
	Integration
	Resolution
Social Presence	Emotional Expression
	Open Communication
	Group Cohesion
Teaching Presence	Instructional Management
	Building Understanding
	Direct Instruction

Table 2 Community of Inquiry (Adapted from [12])

The inquiry usually starts from a triggering event that can be one of a number of different types. As an example, an engineering design problem can lead to advanced cognitive and problem-solving activity. As the students confront the difficulty of applying design principles and procedures to solve the given problem they investigate a variety of solutions, which triggers further activity. The suggested solutions are then integrated and the problem is resolved. Throughout this process, students will evaluate and apply their theoretical knowledge and will learn from problem-solving techniques thus deepening their understanding and at the same time derive new knowledge.

This inquiry activity will be enhanced if it is carried out in a group setting. This would require open communication and will lead to more cohesive groups and better performance as the task in being carried out. Such a collaborative process is likely to be enhanced by the presence of a facilitator or a lecturer in a variety of ways. This will also avoid negative group dynamics that could waste time and energy and thus decrease the effectiveness of the learning activity. Moreover, trivial solutions will be avoided through this guided instruction, which will lead to a narrower focus and deeper learning.

The template has been designed to support these high level cognitive and social processes. Research evidence has shown that discussion forums can greatly enhance learning in virtual learning environments (see for example: [2, 6, 7, 15, 16, 18, 19, 27]).

As can be seen in Table 1, there is at least one discussion forum linked to each folder. The triggering cause of discussions can vary from one situation to another. In the case of Coursework, which is usually a design project, discussions can start from a problem faced by a student during the design work. It is believed that the presence of so many discussion forums will, on the one hand, accelerate the development of group feeling among course participants. On the other hand, it will enhance the learning activity and the depth as many students will contribute with a variety of perspectives and solutions. However, once again it is highly recommended that a facilitator should guide the discussions towards possible solutions and away from incorrect routes while avoiding the drawbacks that may develop in highly active groups (e.g. groupthink).

Incentives could be used to drive the discussion process. An example of this would be to include these discussions into the summative assessments. Students could be required to submit a portfolio of discussion posts that they have contributed to.

The participation of distance learning students is particularly relevant to the discussion process. Whilst they do not experience the classroom environment, many of them have been practising engineers in industry for a number of years. Bringing this experience to the discussion forum not only benefit the classroom students, but also brings into the review process different approaches to the problem from different company and/or national perspectives.

4 Conclusion

In this paper the design and development of a blended learning template has been described. It has been argued that the learning environment must support the learning phenomena likely to take place in a blended learning setting. This can be achieved through selecting a combination of learning theories suitable for blended learning (e.g. a combination of cognitive and social theories, Community of Inquiry, etc.). In addition, the e-learning pedagogy adopted must be translated into technological solution (i.e. structure, navigation and screen design) that reflects and support the pedagogical model chosen.

It has also been argued that, in order to avoid the emergence of implementation barriers, a simple and effective design, should be used. This can not be achieved without taking into consideration students' perspectives and lecturers' constraints. It is also recommended to use technologies that the target users are already familiar with.

The success of blended learning requires minor institutional changes related to educational issues, such as the introduction of new forms of assessment and/or the introduction of lecturer-supervised online-chat sessions.

The preconditions for the success of a holistic approach such as the one described in this paper requires:

- starting from a sound understanding of the needs and constraints of all the users involved in the learning transaction,

- applying a sound e-learning pedagogy,
- building a simple and effective learning environment
- providing development and support during the whole process.

It is believed that this template is likely to support the emergence of a Community of Inquiry in the blended learning modules. However, the template is but a tool and will not enhance the learning alone. The teachers' presence is a key factor in the learning process, since it is their facilitation skills that will trigger, sustain and direct the inquiry. At this stage of the project, all of the lecturers have welcomed the use of the template in their modules. It is believed that with the specific development course from the e-learning team all of the lecturing staff involved in Distance Learning will become familiar with the pedagogy behind the template and will use it in their modules. Additionally, it is hoped that the reminder of the engineering community in the School of Engineering will see the benefit of the learning environment and will wish to use it or adapt it for their own courses.

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