A Web Based Environment For Construction Planning Courses

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***Abstract** - We have developed a World Wide Web (Web-) based Construction Planning and Control (WEBPCO) educational environment for graduate students and building construction practitioners. WEBPCO represents an information constructed environment (Web site). This environment consists of lectures material, tutorials, additional material (articles, texts, bibliography, etc.), discussion pages, homework assignments, on-line interactive exercises, multiple choice short examinations, and a building scheduling game which last for all the course period. This environment supplements conventional methods of presentation by providing all the needed material linked to examples, exercises, tutorials and an e-mail way of communication between students and the teacher and supervisors. All the communication are done directly into the Web pages on a particular discussion page related to one subject. We describe the implementation of the WEBPCO environment. An experiment is being running with about twenty participants.*

Introduction

Although computer-based educational systems appeared several decades ago [1], they are still not widespread.; many universities do not have a specially equipped electronic classroom [2]. Most developers aim their efforts towards creating a distributed learning environment using World Wide Web (WWW) or simply Web. The Web is expanding at phenomenal rate. The availability of good quality hardware and software has resulted in an explosion in growth of teachers and student computer usage [3]. The integration of the Web technology and quality graphical Web browsers provides the potential for a large scale implementation of computer-based teaching materials as a significant contribution to the cost effective delivery of teaching to a larger number of students. Many initiatives are being developed offering distance learning material and interactive learning via the Web. A great amount of gigabytes of materials, including text, high quality images and video, are now available over the Web. However, an aspect still not well resolved of is the use of interactive teaching materials. The common usage of interactions with the student include multiple choice questions, student text submission facilities, interactive tutorials and electronic communication.

Interactive Web-based courseware represents a move towards active learning, i.e. student self-guided teaching. It is intended that the Web-based course will be used as a constantly available and updated learning resource for students. Moreover, computer-assisted learning (CAL) provides perhaps the best opportunity for student self-guided learning [4]. It is self-paced and self-planned with the students themselves choosing their own paths through the mass of information encompassed by the courseware. Successful use of such courseware will not only increase students' knowledge, but will require them to develop other important skills, including self assessment and planning of studies, information technology skills, creativity and self-motivation (Russell and Cohen, 1997). A flexible and interactive course may be extensively used by undergraduate students at all levels as well by engineers under a continued education program and is proving to be a popular additional source of detailed factual and updated information [5].

This paper presents a Web-based courseware developed as an initial step towards these concepts and applied to civil engineers and graduate students on the subject of building construction planning and scheduling. The pilot course is being taken effect joint to the regular course of the Graduate Program on Industrial Engineering at the Universidade Federal de Santa Catarina (Brazil). The Web-based environment is partially developed, thus it plays as complementary material and electronic interactions for the regular class of students. Another aim of the Web-based environment is the usage of WWW facilities to make the course's material available to more people, firstly in Portuguese. This first experiment has also the objective of determining the framework necessary for a complete courseware package, the constraints with practical usage of the Web resources, and the

assessment and pedagogical processes with the virtual participants.

In the development of this experiment some key issues concerning the use of WWW are being investigated, which are [6]:

1. Information availability. Do the range of material available for the search provide a varied selection for the intended group of participants?
2. Ease of access. Do the site still need high intelligent users to navigate through it?
3. Control of access. Do the participants find it difficult to access the required information? Are there control in excess to off-topic material?
4. Group dynamics. Is the student-teacher ratio adequate? As in many other teaching and learning environments the size of the group under supervision has a direct bearing on the output. In this experiment the "virtual" group (participating only via Internet) is very reduced and follow partially the course because the Web environment is not full implemented. The supervisory team has two remote "virtual" teachers, who will be more active on the Web discussions, and two classroom part-time teachers, which will act on separate lectures and classroom works.
5. Specification. When the information from the WWW would be used to the assessment questions, it is necessary to be careful with its formulation. Small variations in the question can mean the difference between a fairly narrow and uninteresting search and one that covers the whole WWW. This experiment will not ask this kind of information, however it is intend on the future.
6. Appropriateness. If this type of search is going to be useful to both participant and teacher it must be appropriate to the needs of the participant. This will, in turn, allow the teacher to use it in subsequent teaching.
7. Teacher input. Is the amount of input required from the teacher on an adequate level? It varies among the different level of participant knowledge.

WEBPCO Overview

The environment is structured into three parts: course material, course interactions, exam questions, and the Building Scheduling game.

Course material

In the conventional lecture the teacher's presentation may be usually oral, written on a chalkboard, or using prepared visual displays. The available Web technology allow delivering of text, graphic images, animation, and sound directly by the Internet. In this first effort the WEBPCO offers on Internet the visual displays used by the teacher on his lectures, including text and graphic images. Two hyper-text tutorials was written as a support material supposed to be read by the student on his/her studying hours. These tutorials are based on some bibliographic material referred to the students. When reading the tutorials students work independently on their assignments. Some original examples was added to them defining some milestones for its submission. Some of this examples are text and graphic combined pages. Another ones configure a teaching by example text, that has some interactive questions, which must be answered on-line by the student and are immediately submitted to the teacher.

All these pages has a "Questions and Answers" link where the student may put his/her doubts in order the teachers to explaining. These explanations are made available to all of the students on a particular page according to the subject, as those familiar FAQ pages (Frequently Asked Questions).

Course interactions

The interactions between students and teachers are all made by the Internet and plays a very important role on this environment. Many remote collaboration projects have been conducted elsewhere with success [7,8]. The available Web technology allow the use of electronic mail communication, chat rooms, Web conferencing, and discussion lists or discussion groups. In this primary version of the WEBPCO environment discussion pages are implemented in a similar manner to FAQ pages. The electronic mail communication is intend, but not limited, to collaboration between students during the game playing. The course also provide a social opportunity for the participants to "meet" and communicate with peers at other part of the country. We felt the *fun* aspect of the scheduling game would provide motivation for the students.

The discussion pages are like a forum to where one participant submits his/her doubt, opinion, discussion or everything else. This is done through a special form where the participant put the text and submit it to the Web server. This text is appended to the specific discussion page and made available to all the participants. Thus any one can send a follow up or reply, which is also appended to the same page. There are discussion pages for every section of the course, homework assignments, examples included into the tutorials, and some pages for general comments about the course, such as suggestions, opinions, interface problems, and so on.

It is pointed on the literature the benefits of some kind of on-line forum, such chat rooms or Web video-conference, providing more dynamic discussions between the participants (Sloane [6]; McDonough et al. [3]). However the technical knowledge involved in this course would present some restrictions to these on-line tools. The student may want to spend more time reading the examples and doing the exercises, and only after this submit any question to the discussion group. During this experiment the discussions and electronic mail between participants will be observed towards this issue.

Exam questions

The third component of the WEBPCO environment is a collection of short interactive exam questions on the topics covered by the examples and exercises. These exams are compulsory, previously scheduled and made available to the participants by a short period of time (one or two days). After the exam, the student can review questions and see his/her score, the overview and explanations.

Building Scheduling game

This building scheduling game [9] is intend to support the practical application of the course on the activities scheduling of a multi-story building construction. The simulated construction last for thirty months, each two months being a turn on the game. The game is played in this pilot course with two participants teams, forming a building construction firm. The participants are free to choose the partners. The game, as well as the course, has two parts. In the first part teams has to submit to the supervisor a preliminary Gantt diagram for the strategic planning of the project and a tactical scheduling for the activities listed by the supervisor. All the teams work on the same project using the same initial data: activities breakdown structure, network precedence, work teams productivity and unit resources costs. The scheduling is done using the Line of Balance method [10]. In the second part of the game the teams has to apply its scheduling and make decisions replying to varying conditions which arises every month. Some information is give on return to every play, changing the original stated conditions, such as teams productivity, overall productivity, human resources available, material delivering, and many others. The winner is the team which at the end of the game will have the project concluded on time, and the least cost. In this pilot course the game simulation and supervisor decisions are not automated, but controlled by the teachers. As it is the first time building scheduling game is being applied it was done on this way to the teachers get experienced with it and validate the game software.

Assessment

The participants are assessed based on the exam questions, some discussion questions and the game performance. Each participant also grades each other on the same game team. Since this pilot course is experimental no much effort is being made on the assessment feature, in regard to the other features.

Technical Challenges

The hardest technical challenge on the Web has been keeping up with the rapid pace of changes. It is a significant challenge to: (a) take advantage of the most promising technical innovations, and (b) run well on most or all the major Web browsers. Our current design uses some codes on JavaScript which is nowadays available on the most popular browsers. The same is not true for some features such as dynamic HTML, for example. Another technical challenge is the use of higher-level tools to make the pages updating more rapid and automatic. For example, to add content more rapidly into the discussion pages.

Our implementation is based almost exclusively on some high spread scripts, Perl codes. We are exploring the convenience of using Java programs together with some database products freely licensed for academics, as mini-SQL.

The multiple choice exams may be implemented using JavaScript coding, but in this experiment it was implemented using the CASTLE toolkit from the University Leicester [11]. A rudimentary record-keeping system is under development for users to track their performance.

Fortunately there are many research academic groups and software developers working on the computational features of Web-based tools for Web course authoring. One of them which had captivate us is the AulaNet software from PUC-Rio [12]. There were no time available for this experiment to be implemented on the AulaNet software, but to the extent we had investigated it has all the desirable features for a Web-based courseware. Some restrictions to special applications (probably based on Java programs) have to be better investigated, for example, to implement interactive examples and the Building Scheduling game.

Discussion

The scope of this particular experiment has been limited by the time available - all the environment material was developed or formatted to the Web during forty days - and the amount of monitoring available for the participants usage of the Web pages. A closer logging method and navigation monitoring on the Web page access is under development.

Probably in the case of a university course or continued education program the exam questions has to be more time-constrained and a more open-ended case study has to be added. Since the Line of Balance method is poorly known by teachers and construction practitioners some time has to be spent on divulging the method, encouraging construction firms to use it, and collecting case studies in order to form a good basis (data and case base) for the course. In this also aspect this courseware plays an important role.

A Web based courseware also must take the advantages of the World Wide Web resources. The WWW holds more useful information than most university libraries and the information is in theory more up-to-date and relevant to many orientations, academics as well as everyday applicable. However the WWW usefulness is limited and there are many instances where learning through the use of more traditional resources is better. The research groups

working at the Construction Management Laboratory (GECON/UFSC) and "prof. Inaldo Ayres Vieira" Civil Engineering Studies Center (CESEC/UFPR) develop others Web projects which dispose many resource information on construction management and information technology to the construction industry. Much of this material may be added to the WEBPCO environment in a near future making more easy to the participant to solve his/her problems.

Conclusion

WEBPCO is a comprehensive on-line course that assembles four forms of content - course material (lectures outlines), course interactions (discussion pages), study guide (exam questions), and the Building Scheduling game, into a coherent environment suitable for graduate courses and continued education programs. The WEBPCO first experiment is under development at the Industrial Engineering Graduate Program of the Universidade Federal de Santa Catarina. We have seen that WWW is a very viable distribution channel for this type of content, attracting construction practitioners as well as undergraduate students.

We invite readers to visit our environment and experience WEBPCO. Guest access is always available at http://www.eps.ufsc.br/~gecon/cursos/PCO98. Construction management educators or trainers interested in exploring WEBPCO as complementary material to their courses may send an e-mail to gecon@eps.ufsc.br.

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