ESTABLISHING A VIRTUAL BUILDING & CONSTRUCTION SITE FOR EDUCATION AND TRAINING

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Abstract: Field trips, site visits and industrial placements can make an important educational contribution by bridging the theory–practice gap through the provision of vital contextual information and the promotion of insights not easily understood in the normal classroom. But, in the Building and Construction industries it is increasingly difficult to arrange actual sites visits. An alternative web site solution is described in this paper. The City University site, the *Virtual Building and Construction Environment*, is part of a much larger group of sites known as *CIVCAL*, developed by four Hong Kong universities. Access is provided to three tours, three building sites, information in a Design Office and Production Office as well as details of some outstanding construction projects in Hong Kong. The paper explains the underlying design methodology and production techniques, including features incorporated to promote learning and comprehension.

INTRODUCTION

There are a number of traditional approaches that provide "real world" experiences in education and training. Particularly in post-secondary settings, the real world is brought to the classroom through such activities as guest speaker presentations, laboratory experiments and video presentations. It could be argued that practice exercises and demonstrations serve the purpose of showing the application or real side of the learning material.

An obvious contrast to providing in-class practical experience is to take students to the 'real world'. Traditionally this is achieved through a range of activities from short-term excursion to longer-term clinical or industrial placements.

Some important factors influencing the educational effectiveness of these activities are organizational logistics, the degree of guidance and supervision, preparedness of participants and follow-up/consolidation. Obviously the participant's focused involvement is vital and preparatory talks and supplementary materials, process observation sheets and report requirements often address this issue.

Field experiences can suffer some disadvantages from uncontrollable influences such as inclement weather, increased travel costs and industrial disputes. Late changes in, for example, the production/construction schedule or safety/security arrangements can cause anything from a minor inconvenience to a complete disaster.

These activities 'in the field' *can* provide exciting contextual learning, prompting insights and sensory experiences that are difficult or even impossible to provide in the normal classroom. The advantages of good actual experiences should not be underestimated and careful consideration should be given before they are entirely removed from the curriculum. This could occur with the overzealous use of immersion Virtual Reality.

The education purpose of such reality enhancing strategies needs consideration. Overall, they provide a means to bridge theory and practice and facilitate contextual learning. Contextualised experiences encourage meaningful learning and transfer of knowledge to both problem–solving situations and real-world events. Also, the provision of multiple stimuli can arouse interest and focus attention. In particular, rich visual environment can promote pattern recognition enhancing memory and recall. This contrasts with many areas of instruction that depend on learning of lists out of context (i.e. meaningless learning).

Other "teaching strategies" aimed at enhancing reality in the classroom include various combinations of role-playing, simulation and educational games. Different media types or technologies are frequently used to support such strategies. Computer and communication technology has played an increasing role in these strategies over the past 30 years. So much so that for example, some science, manufacturing and commerce activities "in the classroom" (i.e. conducted in a "formal course") are actually part of a real-world event. This paper describes how the preceding ideas were taken into consideration and applied to creating a web site in an area of applied science.

The project described is part of a larger project, known as CIVCAL that provides a comprehensive teaching/learning environment for students in many aspects of civil engineering. CIVCAL is an inter-institutional project between four Hong Kong universities: University of Hong Kong (Coordinator), Hong Kong Polytechnic University, Hong Kong University of Science & Technology and City University of Hong Kong. The project is now in its final stage having been developed over 2 years.

A more detailed account of the conceptual and theoretical underpinnings of the web design and the anticipated cognitive outcomes is enunciated in a forthcoming paper by the authors (Wilkins and Barrett, 2000).

NEEDS AND DESIGN CONCEPT

The project evolved out of a need to provide civil engineering students in Hong Kong with current, interesting and appropriate information about local construction projects. The aim was to provide multimedia materials relating to some of the larger construction projects.

The initial proposal for delivery was a multimedia form of encyclopedia on CD-ROM. After analysis and discussion the educational concept was extended and the ideas of a 'virtual site visit' became the design metaphor. Following submission of a joint proposal, the University Grants Committee duly funded the project.

The original idea of concentrating on one or two large sites (the Chak Lap Kok airport project and/or the Hong Kong Convention & Exhibition Centre) was modified after curriculum and resource considerations. Each university concentrated on their area of specialism and following agreed guidelines, set about producing the learning materials.

Due to advances in technology, it was later agreed that the project would be web-based and that CD-ROM would be produced as a secondary form of delivery. This decision facilitated access and lowered distribution arrangements and costs. It also had technical and production implications, for

instance, the nature and quality of video that could be delivered over existing and predicted networks had to be taken into account.

The sub-set site developed at CityU is known as the "*Virtual Building and Construction Environment*". It followed the 'virtual site visit' metaphor and is specifically designed to support teaching/learning in building and construction technology. Our approach which is described in this paper and viewable on the website was the creation of multimedia displays and interactive activities in relation to construction processes of actual buildings in Hong Kong.

DEVELOPMENT

This section briefly describes the development process through the design, production and trial phases.

The 'virtual visit' metaphor provided a referential framework for content and assisted navigation and interface design. In this sub-project we focused considerable effort on capturing content. Knowledge engineering methods were used to identify and organize content. A series of work-group meetings concentrated on such teaching aspects as curriculum demands, overlap and gaps between courses and expected outcomes of the student learning experience. The practical, "reality", aspects were also considered including what kind of site visits should be included and what aspects of construction are important.

Faculty expressed many differing views while invited students made a significant contribution. But, to identify the core ideas and underlying structure of content, the Concept Mapping methodology was introduced. This technique of diagrammatically representing content by showing concrete and abstract concepts and their relationships proved invaluable in 'pinning down' a diversity of ideas (concepts) and their relative importance as expressed in terms of their contribution to a users (students) understanding of the content. Results of this process contrast with traditional topics–based structure or that based on how a lecturer may have learnt the material. The resulting map of the domain of building and constructions enabled selection of core clusters of concepts and prioritising these for development.

The above activity is part of the team–based approach to development employed at CityU (Barrett, 1999). In this model, content experts work with technical and instructional designers to produce the pre-production materials. Outcomes include the concept maps, conceptual diagrams, flow-charts, content scripts, screen designs and storyboards. A prototype was produced firstly using a commercial presentation outliner and then as a 'Powerpoint' model which enabled the overall design to be reviewed for functionality and navigation.

These design and prototype exercises provided clarifications of the key components and give directions as to how they would to be produced. It was decided that content could be grouped to show Low Rise, Medium Rise and High Rise housing in Hong Kong, highlighting the techniques applicable both across and unique to each group. Exemplars of each group were identified as respectively the Academic Exchange Building (AEB) on CityU campus and the Harmony and Concord buildings of the Hong Kong Housing Authority. The materials structured under these three areas, (and related icons) were designated the "site visit" within the Virtual Building and Construction Environment.

To further interest, contextualise and consolidate information, three time-based presentation were made. These are designated as the "Site Tours". The AEB consists of a condensed video time-line of the construction with voice-over explanations (i.e. through a virtual tour guide). The second demonstrates and explains the construction of a Harmony Block while the very latest technology is shown using stop-action photography for the Concord Block.

Two other ‘virtual buildings’ house relevant core content in the Design Office and Production Office. Material is interrelated throughout the virtual environment and additional links allow further exploration.

To enable expansion, a special link to Other Projects is produced in order to add new concepts and recent examples of innovative Building and Construction technology.

One member of the team has produced an extension photographic and descriptive review of recent outstanding projects in Hong Kong (Wong, 1998). Through arrangement with the publisher, this material has to be edited to appear on this site. Gathering and editing content and preparing media elements was a demanding task carried out by content specialists with the work of a research assistant. Pre-production activity of locating, sorting and editing of text and other media requires considerable time and dedication.

PRODUCTION

The Courseware Development Laboratory (CDL) is a dedicated facility for producing educational and training materials on CD-ROM or Websites. It houses all needed facilities and is staffed by qualified and experience personnel in order to provide programming/authoring, graphic art/animation and project design and management. Specialists in the (CDL) carry out web authoring and graphic production.

Again, within the team-based model, individuals work as a node within a specialist network of co-coordinated activity. Work-group sessions, including review activities, keep the need for reworking to a minimum. The outcome is a consistent look and feel and ease of navigation. These aspects will become evident in visiting the web-site http://civcal.media.hku.hk/.

INITIAL EVALUATION

Preliminary tests with undergraduate students of the Building & Construction Department have shown that students find the web site useful in enhancing their understanding of the concepts and techniques relating to the on-site assembly of buildings. Two tests have been run with two groups of students based on evaluation by questionnaire:

Group 1, studying construction engineering and management, evaluated the site one year ago at a very early stage in its development. This group had already been studying construction technology and engineering subjects for almost two years. The group, and its tutor, a civil engineer and full-time member of the academic staff, found the site extremely helpful in providing an overview of the construction process, even at this early stage in development:

Group 2 (over 100 students), was studying in a common first year and would eventually concentrate on construction engineering and management, quantity surveying, or building surveying. The group was first introduced to the web site by the authors and members of the CDL team during a course in Construction Communication. The site was subsequently used by one of the co-authors to teach aspects of building construction technology. Specifically it was used as a "virtual site visit" after a series of lectures and tutorials in technology subjects relating to individual components and building elements - substructure, wall construction, floor construction, roof construction, windows, and doors. An assignment was subsequently set requiring students to respond through the web site to questions posed relating to various production processes. Eventually a questionnaire evaluation was conducted to obtain feedback relating to the students' overall experience of the web site. Again there was unanimous agreement that it provided a useful learning experience, specifically in that it

enabled students to integrate the individual building elements and components studied in the previous lectures and tutorials. The site visit concept was well liked and the video, time lapse and animation sequences appeared to be particularly helpful in viewing overall construction processes, which could then be examined through more detailed visual and text material on the web site.

A comprehensive student evaluation will be conducted in the first semester of the 2000/2001 university teaching year.

SUMMARY

Practical, "work experience" activities have the advantage of contextual learning fostering integration of knowledge and promoting affective awareness. Under well-organized and well-supervised conditions, different forms of site visits have much to offer. But interruptions, interference and conflicts in purpose often diminish the learning experience to the extent of making it unproductive.

Reality enhancing procedures such as simulation, gaming and role-playing have often been added to the traditional mixture of lab experiments and projects. In addition, computer simulated environments of various kinds can be introduced to promote interest, application and transferability of knowledge for the purpose of bridging theory and practice. Taking these ideas into account, we have designed and produced a web-based environment founded on knowledge engineering techniques and employing multimedia and communication technology.

We have attempted to employ the most efficient means of development through team-based networking. Specialists using the appropriate tools in suitable facilities carry out actual production.

Also, as this material has broad delivery, only limited by web access, it is suitable for distance learning, vocational and professional continuing education. In addition, the general model could easily by extended to provide on-the-job training or act as a Decision Support System.

The content organisation and associated functionality underlying this project is in direct contrast with the random collections, or even topic-based collations, of materials frequently encountered in web course materials. Moreover, what is not immediately evident is that users (students) are exploring the information provided according a highly designed representation of declarative knowledge. This emphasizes the building of 'conceptual structures' of the knowledge base. Also, users view the material in context and sequentially (through time-based sequences in the virtual tours) which promotes development of procedural knowledge. These processes foster schema formation and consolidate understanding. The project has also makes extensive use of multimedia elements not for "entertainment" but to promote student learning through multi-sensory perception and pattern matching processes.

Developing good quality learning materials is demanding and resource consuming. It is important then, that the educational purpose, learning experience and outcomes be paramount in producing web-based educational materials. Application of design principles from Instruction and Cognitive Science is imperative if the learning experience is to become more effective. Production and implementation raise important issues relating to efficiency. The web site described in this paper, while still having room for expansion in terms of content and learning activities, demonstrates one collaborative effort that provides students with relevant, accessible and thought provoking materials.

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