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Internet-Based Interactive Package for Diagnostic Assessment on Learning of Fluid Mechanics

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Abstract. Students in civil engineering and mechanical engineering fields may find the concepts of fluid mechanics abstract and have difficulty in grasping the real phenomena. Innovative learning methodologies are necessary to help arouse their interest. Yet, many web-based learning sites have common weaknesses including information being laid out basically in a textbook format and the lack of interaction. This paper delineates the development and implementation of a web-based interactive teaching package for diagnostic assessment on learning of fluid mechanics with an expert system approach, by employing the latest knowledge-based system technology and web production software. For each scenario of prompted answer from the learner, diagnostic assessment is performed by the system to determine the most probable shortfall or misconception of the specific learner on that particular topic. The package provides an opportunity of stimulating pedagogical environment to take care of engineering students in self-directed learning through interaction, application, and reflection.

1 Introduction

Fluid mechanics is a subject involving the fundamental principles of physical science and applied mathematics. By the nature of this subject, students in civil engineering and mechanical engineering fields may find the concepts abstract and have difficulty in fully grasping the real phenomena. Some innovative teaching and learning methodologies are necessary to help arouse their interest. This is in line with the prevalent goals of most universities for teaching and learning quality enhancement through the application of the latest technology.

As a result of advancements in the fields of computer and education technology, web-based learning (WBL) has been becoming a general trend in conventional higher educational settings [1-2]. The Internet has the potential for effecting fundamental changes in the design of pedagogical processes and the instructional system. The trend to couple the Internet in teaching and learning has been gaining momentum rapidly and learning availability over the Internet is increasingly expanding. An entire new industry of WBL has emerged to compete with these conventional instructional institutions [3-4]. In order to cope with this, most educational institutions at least attempt to conduct some forms of web-based instruction. It appears that new

technology will build a new paradigm on education, with self-directed learning as a foundation strategy.

A retrospective review on the existing educational systems and the population of students under these systems demonstrates that quite a wide variety and deviation exist amongst different students. It seems to be a trend that the demand for higher education at different age groups, in particular adult age group, is escalating. It corresponds to the generally increasing expectation exerted by the society on better educational quality for the ultimate enhancement of productivity. Hence if the working adults desire to earn more money for improving their own living conditions, they have to upgrade themselves via various channels. Yet time constraints and places where they were residing usually impeded them [5]. Moreover, the traditional learning and training system is sometimes considered not effective enough since it offers little facility in tracking the progress of the student or keeping courseware up to date. It is suggested that simply to present materials to the students is not enough. It is extremely imperative to keep the records of the students to date and to monitor and record their progresses simultaneously. Monitoring should be undertaken on whether or not they have accessed the requisite information and whether or not they need to be chased at times [6]. Nowadays, novice technology has been invented, which is able to perform this student tracking activity in a convenient manner. WBL is rendering it possible for all the educators to deliver far more sophisticated and useful instructional programs.

Besides, recent advancements in artificial intelligence technology have rendered it possible for computer programs, by encoding knowledge and reasoning, to simulate human expertise in narrowly defined domains during the problem-solving process. A knowledge-based system (KBS), as a form of artificial intelligence technology, is capable to incorporate systematically the heuristic knowledge and expertise. By knowledge processing facilities, individual expert's knowledge could be stored under rule frame on a permanent basis so long as such rules are valid and update of such knowledge base whenever necessary is accomplishable over passage of time. The progress and development of KBS suggests that "machine expert" can play a vital role in decision making. It has been proven to be appropriate in furnishing solutions to domain problems that require considerable rules of thumb, judgment or expertise, in particular under the following types of classification, namely, education, diagnosis, interpretation, planning, and design. KBS has made widespread applications in a variety of domain problems and is proven to be capable of attaining a standard of performance comparable to that of a human expert [7-18]. Towards this direction, the present study indicates the necessity to go for extensive knowledge base on teaching and learning of fluid mechanics.

In this paper, the development and implementation of a prototype web-based interactive teaching package for diagnostic assessment on learning of fluid mechanics with a KBS approach, by employing the latest KBS technology and web production software, is delineated. Several up-to-date expert system shell and web production software including Visual Rule Studio, Dreamweaver, Java, JavaScript, Flash, PhotoShop and PhotoImpact, are employed. By using custom-built interactive graphical user interfaces, it is able to assist learners to acquire the much-needed knowledge in this domain area.

2 Web-Based Learning

In the present day, the society has entered into the information age, in which people strongly desire to obtain the information as soon as possible. The current technology is at such a stage that information released in the Internet is no longer restricted to text and graphics as usually presented in the traditional textbooks. The embedded material could be in a diversity of forms such as sound, animation, application, video, 3-D modeling or picture. An expanding multimedia communication system offers the advantage of furnishing diversified and enhanced delivery mechanisms of quality education. The student now has a potentially impressive myriad of study alternatives. This evolution into diverse learning opportunities has been prompted by the realization of a knowledge-based economy and associated technologies. The currently popular World Wide Web is characterized by the high speed in downloading, user-friendly graphic interface browsers and open standard, and portability between different operating systems and platforms.

It is generally acknowledged that effective instruction with technology must be driven by sound pedagogical principles, involve critical thinking, and provide a real community to students. Advocates of the use of new instructional technologies have asserted that these criteria can be, and have been, generally realized in an online environment. With the increasing quality and availability of technology, online learning has become rapid, effective, flexible, and convenient. In addition, technology has furnished the immediacy and range of interaction comparable with face-to-face learning. The proponent may confidently describe WBL as a viable alternative to conventional teaching at tertiary education sector. The flexibility and open infrastructure of Internet have been demonstrated to be able to act as a medium for developing learning application. For those individuals who would not have the chance or afford to further their education in a normal manner, WBL is able to furnish a cost-effective and flexible way and alternative opportunity of path to acquire lifelong education. It is apparent that the groups best served by WBL are individuals who have special demands, have family responsibilities, and work and reside in remote areas. WBL has a distant advantage that may render commute distance and time constraints of little or no consequence to students.

It should be aware that higher education is often shaped by debate among student, academics, politicians, and industrialists. In recent years, tight financial restrictions have forced educational institutions to become more efficient, demanding them to improve in areas including instructional quality, mode of study, access, and costs. Distance learning programs are evolving to satisfy, and to create new market demand. This expanded market renders it possible for educators to better serve working adults and those geographically and physically isolated from the campus. There exists strong demand for higher education to become more accessible, convenient, flexible, and effective for these individuals.

Besides, WBL furnishes the opportunity for interaction from the students, thus permitting them to acquire quality learning experiences to suit their specific demands or capabilities. WBL permits a student to enter and leave different course sections conveniently. They can freely and directly gain access to various parts of the course contents, and if they envisage any queries at any stage, they can point straight back into the relevant sections or into the references and back again. As such, it furnishes a

dynamic and active learning environment and provides an opportunity of stimulating pedagogical environment to take care of engineering students in self-directed learning through interaction, application and reflection. Not only do they allow people work at their own pace from different locations and allow organizations to add their specific knowledge to tailor make the teaching materials, WBL has also been used in some organizations so as to raise the effectiveness of their education and training operations for the ultimate goal in enhancing the productivity.

3 Impact on Teaching and Learning

Concerns with the on-line program design are mostly pertinent to the relative novelty of the WBL environment. Queries have been put forward regarding the pedagogical quality that technology furnishes. Some educators may be concerned that WBL is neither personal nor interactive and is consequently less effective than face-to-face instruction. A serious criticism of WBL is that it fails to create an effective learning environment due often to poor design. The common weakness of many online learning sites is their misapprehension that information is equal to learning and material is laid out basically on the site in a regular textbook format. In such cases, learners are merely passively involved in electronic page turning when reading and sorting through material.

It should be emphasized that there exist different levels of WBL depending upon the degree of interaction offered. The lowest level of WBL includes a more objectivist philosophical orientation where instructional contexts are previously organized and simply displayed to the learner. The highest level of WBL comprises a more constructivist view where learners are encouraged to reorganize, manipulate and personally synthesize course materials. As such, the design of the learning experience under an active and dynamic environment is the cornerstone of quality WBL. The ideal WBL program would be user-friendly, interactive, satisfying, engaging, and responsive to learners' experiences. Besides, it would employ multimedia effectively, accommodate action, exploration, and reflection. The mere use of the World Wide Web does not automatically lead to efficacious quality instruction.

As a result of the necessity for active participation of learners in WBL, which is inconsistent with the more conventional passive learning role, it may require a shift in teaching paradigm. Instructors may need to adopt a more learner-centered approach to their teaching, with a role shift from authoritative teacher to facilitator. It is imperative to design WBL with learners in mind, with emphasis placed on collaboration and active learning. Under this constructivist approach, there is a shift away from didactic instruction towards discovery-based learning. A fuller set of contexts has to be available, which becomes part of the learning environment. They should cater for learners of wide-ranging perspectives and hence must be adaptable as the learner endeavors to create meaning from contexts. The opportunity for interaction results directly from the active role of the learner. Interactions are significant in that they render participation in the cycle of instruction, training, performance assessment, and improvement processes. They enable learners to tailor learning experiences to meet their specific capabilities or demands. Interactions allow

clarification and the transfer of new ideas to existing conceptual frameworks. Moreover, they stimulate intrinsic motivation for learners by highlighting the significance of any novel information. In order to implement WBL efficaciously, new and responsive learning models, which would maximize technology for accomplishment of the teaching and learning transaction, are necessary to address the concerns of the learner and the challenges presented by the technology.

Technologies may furnish wealthy and flexible media for representing what students know and what they are learning. Yet they should function as intellectual tool kits that assist learners in establishing meaningful personal interpretations and representations of their environment. The objective thus becomes selecting the most effective tools to facilitate learning. In a technological society, academics should take a proactive role in the development and use of technology in the teaching process. New learning package should be developed by academics with technical support from computer programmers, which is founded on learner demands for quality content, delivery, and service that lead to desired learning outcomes.

4 Development Environment

It is not easy to compile an ideal web page if one is just using single web design software to create a web site. As such, in this case, several professional software programs, including Visual Rule Studio, Dreamweaver, Java, JavaScript, Flash, PhotoShop and PhotoImpact, are employed.

4.1 KBS Shell

In order to facilitate development of the knowledge base on fluid mechanics, KBS shell containing specific representation methods and inference mechanisms is employed. This system has been developed and implemented using a microcomputer-based KBS shell Visual Rule Studio [19], which is a hybrid application development tool under object-oriented programming design environment. This shell acts as an ActiveX Designer under the Microsoft Visual Basic 6.0 programming environment. Both production rules and procedural methods are employed to represent standard and heuristic knowledge on fluid mechanics. Rules are isolated as component objects, which are separated from both objects and application logic. As such, it produces objects that can interact with most modern development software. Rule development becomes a natural part of the component architecture development process. In addition, Visual Rule Studio is compatible with Active Server Pages and Microsoft Internet Information Server. In other words, the ruleset components can be deployed as part of a web server based application so that, with a web browser and Intranet or Internet access, it may virtually reach any users.

4.2 Web Production Tools

The main content, structure, frame, and most of the functions of the web pages are

built by using the software Dreamweaver [20]. Some embedded programs, which are called applets, can be interactive taking user input, responding to it, and presenting ever-changing content. They are written in Java [21], which is a programming language that is well suited to designing software that works in conjunction with the Internet. Besides, JavaScript [22] is employed to add some interactions to HyperText Markup Language (HTML), to allow for user interaction and feedback multimedia and animation, and to link HTML to other technologies such as Java and ActiveX. Flash [23] is used to produce the animation containing multiple scenes. It can create flash animations and interactive activities including vector graphics, interactive movies, buttons with actions, etc. It shows some interactive graphics, which make the web page more active and alive. PhotoShop [24], which is a pixel based image editing program, is employed to edit all the pictures and graphics in the web page of the package. PhotoImpact is used to perform some special effects in the pictures.

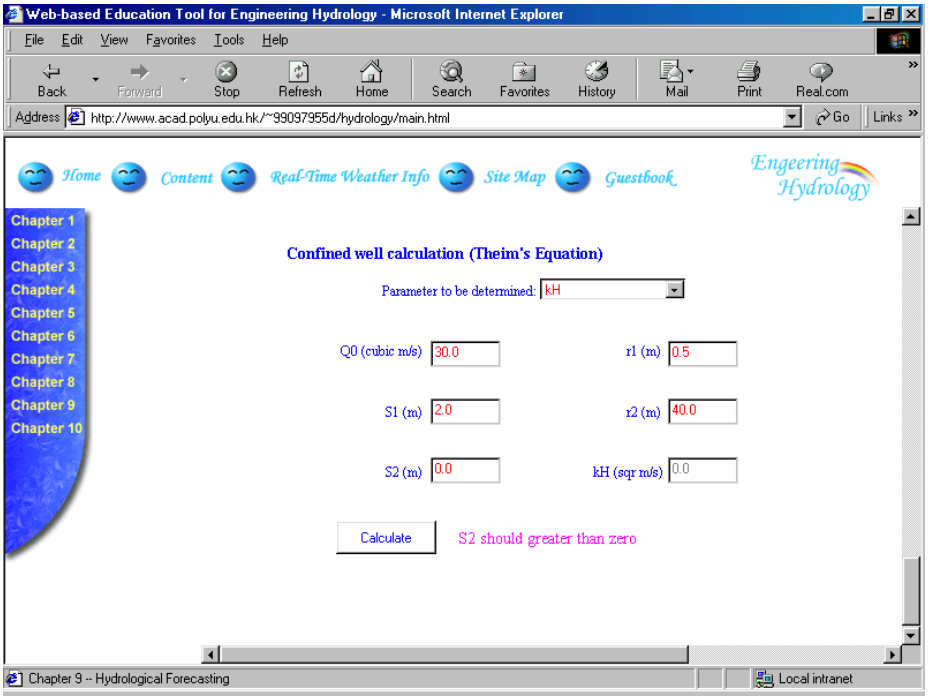

Fig. 1. Screen displaying the interactive "What-if" analysis on hydrology

5 Interactive Learning Package

In this study, a web-based interactive teaching package for diagnostic assessment on learning of fluid mechanics with an expert system approach is developed and

implemented, by employing the latest KBS technology and web production software. In addition to the usual WBL techniques, including animation, friendly user interface, graphic presentation of teaching contexts, etc., the innovative idea in this project is the integration of KBS into the learning package so as to effect the desired interaction between the system and the learner.

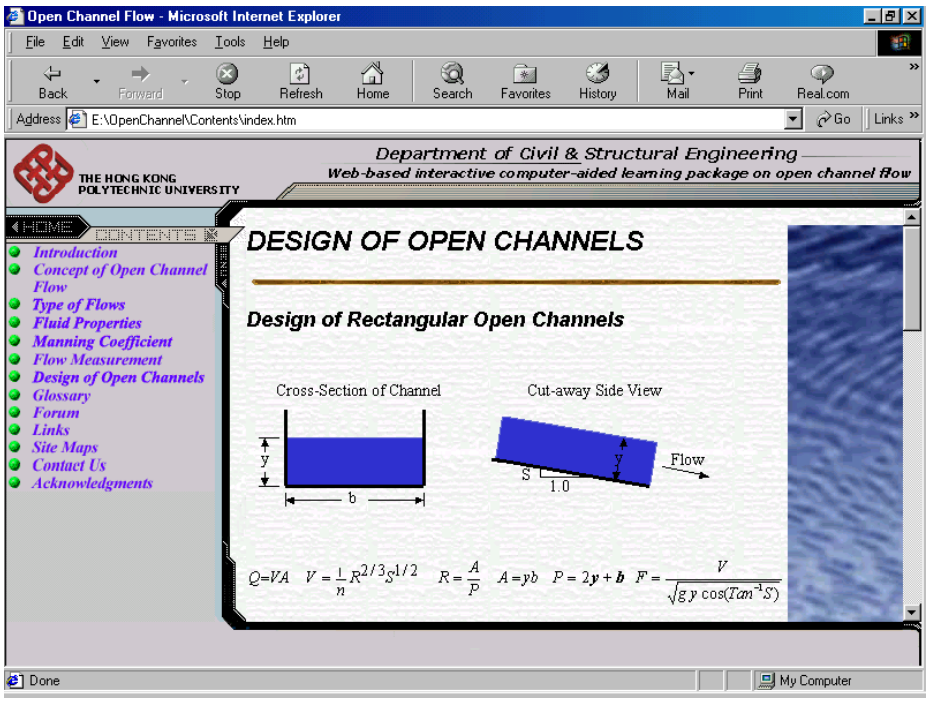

Fig. 2. Screen displaying instructional knowledge on open channel flow

The emphasis of the project is on the diagnostic assessment of learning performance and on the ensuing learning directive designed by the intelligent system, which depends on the response of the learner and the assessment outcome. Assessment exercises are carefully designed for each selected topic in fluid mechanics, covering all possible answers from the learner in mind. The covered topics include fluid at rest, types of flow, impact force, similitude, pipe flow, open channel flow, hydrology, hydrodynamics, coastal hydraulics, unsteady flow, and wind loading on structures, which are undertaken by different supervisors on the basis of their specialties. For each scenario of prompted answer from the learner, diagnostic assessment is performed by the system to determine the most probable shortfall or misconception of the specific learner on that particular topic. This heuristic knowledge can be represented by knowledge rules under the KBS approach.

So far the topics on hydrology, open channel flow, and fluid motion are included. Figure 1 shows the screen displaying the interactive “What-if” analysis on hydrology. Figure 2 shows the screen displaying instructional knowledge on open channel flow.

Figure 3 shows the screen showing diagnostic assessment on the design of open channel. Figure 4 shows the screen displaying instructional knowledge on fluid motion. Upon the completion, the whole package will be tested rigorously through trial runs, evaluated and used by the engineering undergraduate students, who are the ultimate customers. Since it will be disseminated on the Internet, it may also be accessible by all engineering students in other local tertiary institutions, or even worldwide.

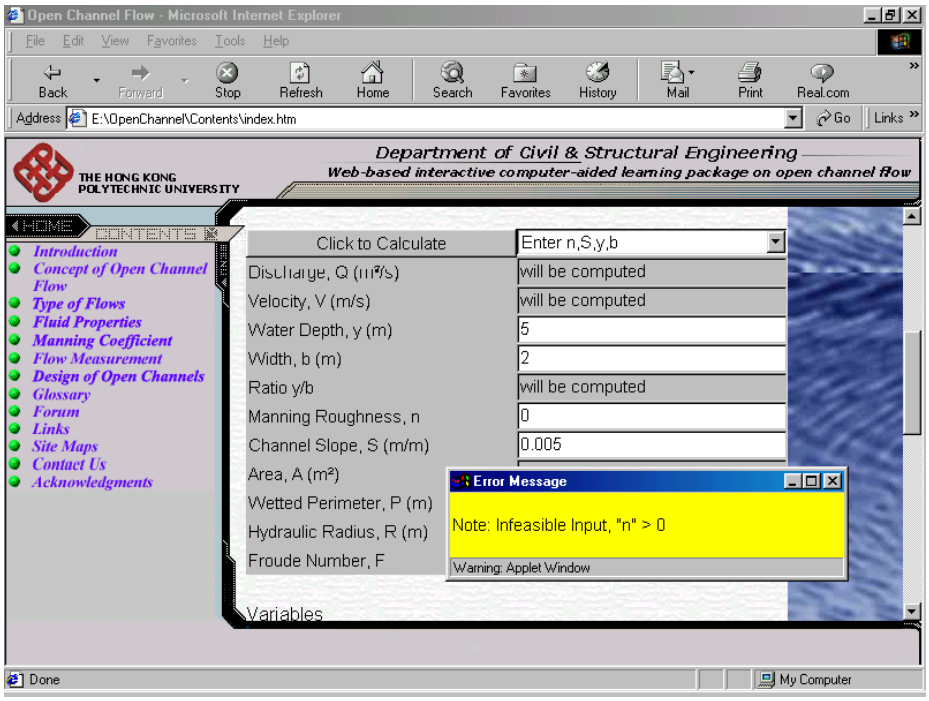

Fig. 3. Screen showing diagnostic assessment on the design of open channel

6 Conclusions

This paper delineates the development and implementation of a prototype web-based interactive teaching package for diagnostic assessment on learning of fluid mechanics with an expert system approach, by employing the latest knowledge-based system technology and web production software. It is shown, from the preliminary results, that the application of the latest software, including Visual Rule Studio, Dreamweaver, Java, JavaScript, Flash, PhotoShop and PhotoImpact, are viable for this domain problem. It is demonstrated that various theories on hydrology, open channel flow, fluid motion, can be performed using this package through an active and dynamic

learning environment. The flexibility and open infrastructure of Internet have been shown to be able to act as a media for developing learning application. The engineering students can gain deeper insight on this abstract subject through the interaction furnished in this package. It offers the possibility of providing a stimulating learning environment to engage learners in meaningful learning through reflection, application, and interaction.

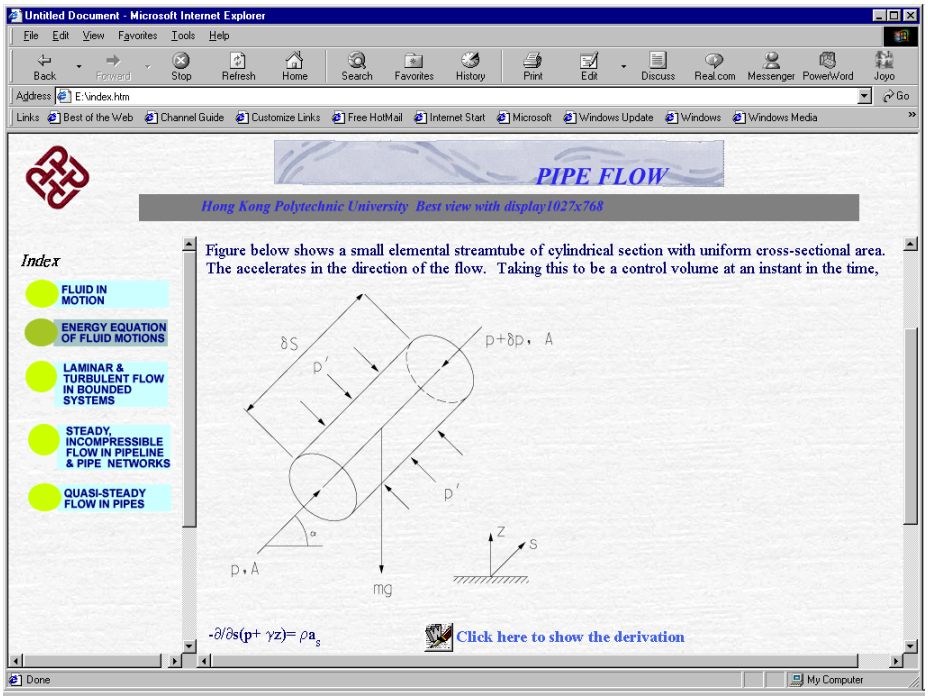

Fig. 4. Screen displaying instructional knowledge on fluid motion

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