

## WEB TECHNOLOGY: PREPARING STUDENTS FOR KNOWLEDGE-BASED SOCIETY THROUGH TUTORING

Kazi Sabbir Ahmed and Samuel NG Hong Kok  
sabbir@hotmail.com Samuel\_Ng@ite.edu.sg  
Institute of Technical Education, Head Quarter  
Educational Technology Department  
10 Dover Drive, Singapore 138683

**Abstract:** To maximise the learning potential of young students and better prepare them for the knowledge-based economy, the Institute of Technical Education (ITE) will be exploiting web-based tutoring technology to deliver lesson-specific activities efficiently to many students at the same time and yet allowing each one of them to learn at their own level, pace and time.

A topic on double entry practice in an Accounting Course has been developed for the web-based tutoring delivery approach. The topic is aimed at teaching students how to use a T-accounting method to enter a set of business transactions into the appropriate account books. Through a web-based interface that replicates the T-accounting method, students would process all the transactions one at a time. For each completed transaction entry, answers are checked against “Expert Answers” and students are allowed two more attempts to correct their errors. A “Student Model” database stores students’ performance history, which is used to determine the amount and level of practice for them to attain mastery. In this way, students can learn at their own pace and according to their learning potential. To make learning more interesting, the web-based user interface has been designed with motivational features.

**Keywords:** Information Technology, Knowledge-based Economy, Web-based Tutoring System, Student Model, and Accounting Course.

**Introduction:** Web technology is widely used for teaching and learning by the educational institutions around the world today. Thousands of Web-based courses and other educational applications have been made available on the Web within last five years as reported by Brusilovsky [Brusilovsky, P. (1999)]. Benefits for Web-based education are many folds, such as a) freedom of where to study, b) freedom of when to study, c) personal tuition, d) all students have direct communications with teacher, d) peer group discussion both synchronous and asynchronous, e) gain from questions ask by others etc. [Webb, G. (1997)]. But Kinshuk [Kinshuk, & Patel, A. (1997)] has warned that “*The freedom and flexibility offered by the Internet can, however, turn into an extensive waste of time, effort and resources, if the nature of educational processes and the capabilities of educational technologies are not adequately considered while designing a tutoring system.*” So, the importance of developing an efficient and useful pedagogical model for web-based tutoring is well established. Hence the web-based Intelligent Learning Environment (WILE) comes into the area of web-based education as a better solution.

As a result of a knowledge-based economy, which has changed the traditional economic concepts [Chaudhury, A. S., & Chew, L. M. (2000)], now-a-days educational institutions are experiencing the increased number of students. To ensure a good and improved quality of educational environment for the increased number of students, information technology is an area that educational institutions should exploit properly [Li, H. (1997)].

In this paper, we first discuss the architecture of a Web-based Intelligent Learning Environment. Then we introduce WILEAC, an adaptive Web-based Intelligent Learning Environment that supports drill and practice for Accounting Course. We also justify why Java-based solution is chosen to build WILEAC.

**Web-based Intelligent Learning Environment:** Anil et al. [Aggarwal, A. K., & Regina, B. (2000)] identified that learning can be taken place in four different fashions depending on time and place. “*Type I represents the traditional face-to-face classroom, where students congregate at the same time, at the same place, to be taught simultaneously the same material by the same person.*” Type II represents the learning environment where students come in a group at a specific place. Different groups come at different times but study the same material. Type III is a distance learning programme through audio/visual means. Type IV is through correspondence such as by mail, etc. Anil et al. [Aggarwal, A. K., Regina, B. (2000)] stated that all these four types of learning can be simulated by WWW technology. To make learning on WWW more effective, several researchers have emphasised on adaptation [Brusilovsky, P., Schwarz, E., & Weber G. (1996)] that can create an individualised learning environment.

Web-based Intelligent Learning Environment (WILE) is not a totally new kind of educational approach. WILE combines the features of traditional Intelligent Tutoring Systems (ITS) and learning environments [Brusilovsky, P. (1994)]. The two main features in ITS systems are curriculum sequencing and interactive problem solving support. These features differentiate ITS from traditional Computer-Aided Instruction (CAI). Stern, M. et al [Stern, M., Woolf, B. P., & Kurose, J. F. (1997)] suggested that the intelligence can be achieved in Web-based Learning Environment by three steps. *Firstly*, by using adaptive hypertext techniques including adaptive navigation support and adaptive presentation. *Secondly*, by dynamically constructing quizzes at the correct level of difficulty for the student. *Thirdly*, by predicting the next actions the student will take. Beck, J. et al. [Beck, J., Stern, M., & Haugsjaa, E. (1996)] defined the various components of Intelligent Tutoring Systems, which are – 1. *Student Model*, 2. *Pedagogical Module*, 3. *Domain Knowledge*, 4. *Expert Model*, and 5. *Communication Module*. We have implemented these five components in WILEAC, which is primarily built as a pedagogical partner to the traditional classroom instruction.

**Web-based Intelligent Learning Environment for Accounting Course (WILEAC):** Bloom [Bloom, B. S. (1984)] has demonstrated through results from empirical studies that effective one-on-one tutoring is the most effective instructional manipulation. Logistically and financially, however, one-on-one tutoring for all students in a specific class is not possible. But we can build a Web-based Intelligent Learning Environment, which can bring the personal tutor experience to all students. This philosophy drove us to

build WILEAC. Effective practice is a proven way to improve the performance of cognitive skill in any domain. WILEAC offers a drill and practice environment with an automated curriculum sequencing functionality.

We explain the system model of WILEAC in the context of Double Entry concept in the accounting course. WILEAC has two different components - one for teachers to build questions that are stored in the question bank, another for students to drill and practice.

In WILEAC, teachers can add questions to the question database with respective answers. Due to the ambiguous nature of answers, several different answers can be acceptable. So, teachers are expected to enter five different answers for one entry. Figure 1 shows how it is done in WILEAC. Question comprises of a Question Text with Question ID and associated Transaction Texts for that particular question.

**Transaction Entry**

**Creating Transaction Data for Double Entry Tutoring System**

Question ID  Transaction No  /

**Transaction**

**Answer**

Debit AC 1	<input type="text" value="Bank"/>	Credit AC 1	<input type="text" value="Capital"/>	Date 1	<input type="text" value="April 1"/>	Amount 1	<input type="text" value="10,000"/>
Debit AC 2	<input type="text" value="Bank Account"/>	Credit AC 2	<input type="text" value="Capital Account"/>	Date 2	<input type="text" value="Apr 1"/>	Amount 2	<input type="text" value="\$10,000"/>
Debit AC 3	<input type="text" value="Bank A/C"/>	Credit AC 3	<input type="text" value="Capital A/C"/>	Date 3	<input type="text" value="1 April"/>	Amount 3	<input type="text" value="10000"/>
Debit AC 4	<input type="text" value="Bank AC"/>	Credit AC 4	<input type="text" value="Capital AC"/>	Date 4	<input type="text" value="1 Apr"/>	Amount 4	<input type="text" value="10 000"/>
Debit AC 5	<input type="text" value="Bank"/>	Credit AC 5	<input type="text" value="Capital"/>	Date 5	<input type="text" value="1/4"/>	Amount 5	<input type="text" value="\$10 000"/>

Warning: Applet Window

Figure 1: Transaction data entry for question bank in teacher's module

When a student starts his session in WILEAC, he is given a new problem with a set of transactions according to his current knowledge of the subject stored in the student model. This new question is chosen on a random basis from the question bank. After filling in the answer for these transactions (see Figure 2), he will be given a feedback on the correctness of his attempt. The student's answer is compared with the expert's

answer, which is stored in the question bank together with the question itself. Correct answers will be shown if student fails to answer correctly in three attempts. He will proceed to next transaction when he either answers correctly or attempts wrongfully for three times. Performance is measured by the degree of correctness of his answer and stored in the student model. When he finishes the whole set of transactions, his current knowledge about the subject is recomputed based on previous performance and current performance. If he still require taking more quizzes according to his performance, he will be given another new problem, again chosen on a random basis from the question bank. Figure 2 shows the transaction quiz screen of the WILEAC.

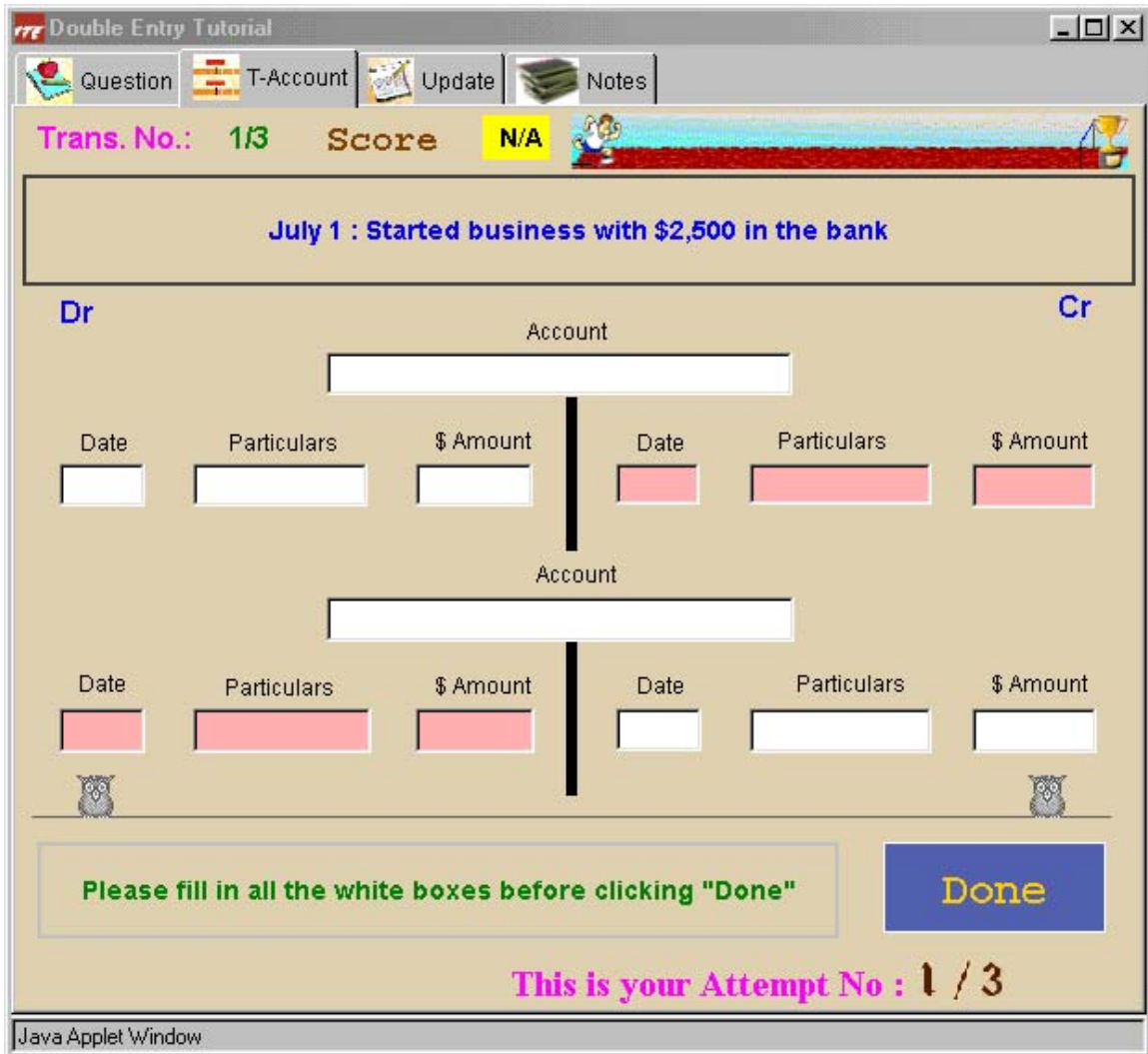


Figure2: WILEAC tutoring environment for students

**Student Model in WILEAC:** Student model is one of the most important components of any ITS that records information about the student. This information reflects the system's belief of the student's current knowledge state and helps to sequence the curriculum automatically. There are many student models; three are among them most important, such as – a) Overlay Student Model, b) Differential Student Model, and c)

Perturbation or Buggy Student Model. In WILEAC, we have used Overlay Student Model where the student's knowledge is assumed to be a subset of the expert's knowledge and the goal of tutoring is to enlarge this subset as shown Figure 3.

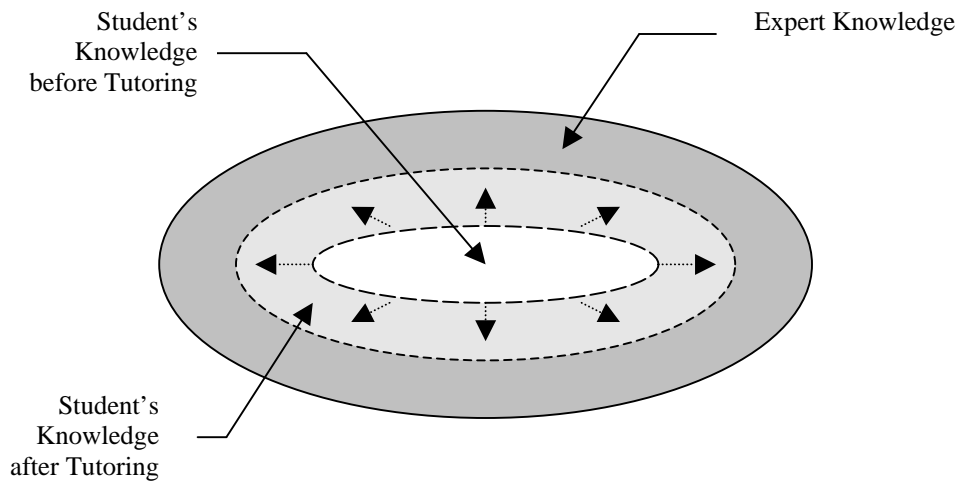


Figure 3: A representation of an Overlay model showing the effects of tutoring

Student model is widely used to sequence the curriculum [Stern, K., & Beverly, P. W. (1998)]. We have derived an algorithm based on the degree of correctness of student's answer to determine the current level of student's knowledge. So that system can sequence the next problem at an accurate level of difficulty for the student.

**System Architecture of WILEAC:** WILEAC system is implemented by six main software components: the client side software (browser), the WWW server, the Applet, the Servlet, JDBC-ODBC driver and the Student & Question database as shown in Figure 4. The browser (i.e. MSIE™, Netscape™) and the WWW server are the basic software for HTTP communications over the Internet. The applet is the engine for Communication module and the pedagogical module. The servlet in conjunction with the JDBC-ODBC driver makes communication between the student database, question bank and the applet.

Communication module and curriculum sequencing logic reside in the applet. Student interacts with the WILEAC through the communication module, which is the GUI part of the system. Plessis et al. [Plessis, J. P., Van, B. J. A., Tolmie, C. J. & Wollinger T. (1995)] comment that the interface for a CAL (Computer Aided Learning) program should be sensitive to the age of the students, cultural background, computer literacy level and other related factors. When designing the user interface of WILEAC, we have taken into account these above-mentioned factors. We believe that user interface has a great impact on student motivation.

Curriculum sequencing or the pedagogical module in the applet is responsible to compare the student's knowledge with the expert's knowledge and select the next quiz for the student at the appropriate level of difficulty.

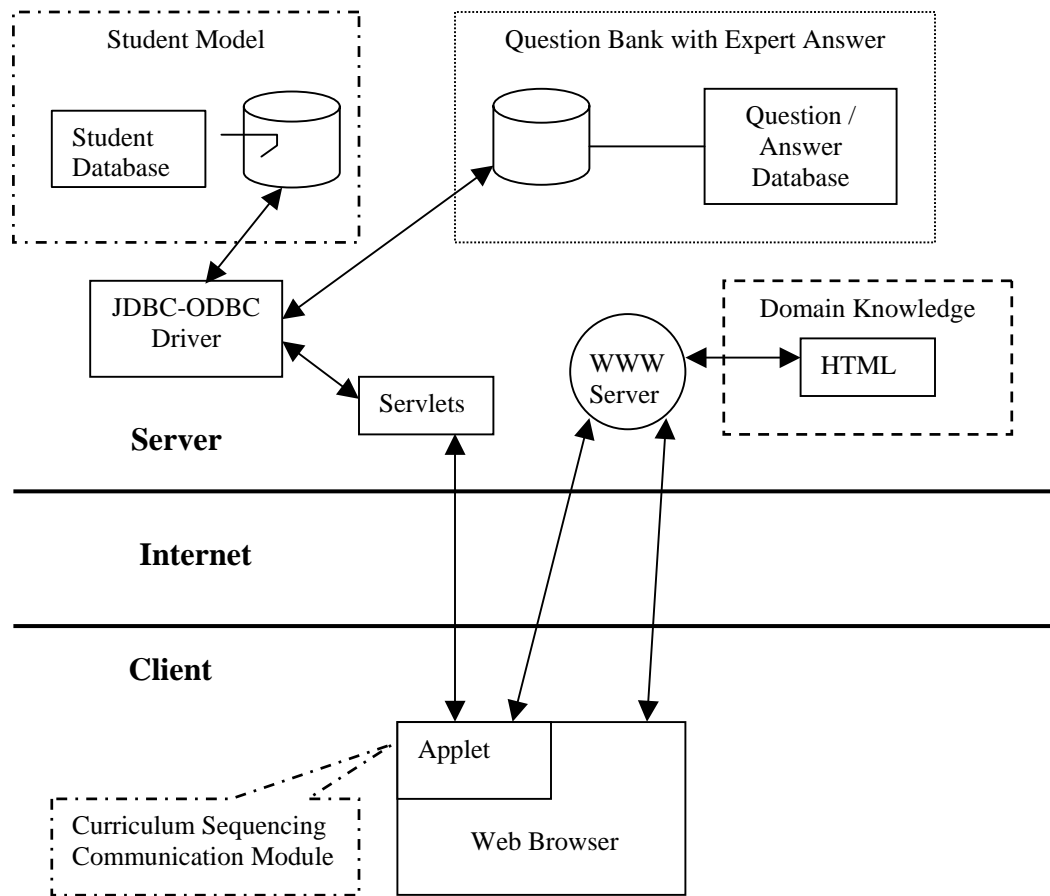


Figure 4: System architecture of WILEAC

Student model and question bank is already described in the earlier section.

**Justification of Using Java-based Architecture:** To deploy a Web-based Intelligent Learning Environment, there are basically three technological solutions as follows:

- *Java-only Solution:* The tutor – that is the entire program that interacts with the student – resides in a Java Applet which is downloaded by visiting a specific URL and executes on the client (student's) machine. All tutorial behaviour resides on the client.
- *HTML-CGI Architecture:* The user interacts with HTML entry forms in a Web browser; information entered by the user is sent to Web server which forwards it to the CGI (Common Gateway Interface) program which then replies with new HTML pages. All tutorial functionality resides on the server side (CGI program) but the user interacts with it using a standard Web browser.
- *Java Client/Server Architecture:* A downloadable Java Applet contains the user interface of the tutoring environment and communicates directly with the student

model and may be with the stored expert answer through servlets that talk to database via JDBC.

We have developed our system using third approach, which is considered one of the robust architectures among them. Java has many good features [Benjamin, Q., Joseph, J. R., Javed, A., & Hartly, T. (1997)] that made it the choice of technology for developing Web-based Intelligent Learning Environment. In a recent survey on Adaptive and Intelligent Technologies in web-based ITS systems done by Brusilovsky [Brusilovsky, P. (1999)] shows that most of the systems of this kind have used Java client/server technology to support problem solving and intelligent solution analysis. Sherman et al. [Sherman, R. A., Singley, M. K., & Peter, G. F. (1999)] stated that they have deployed Distributed Client/Server Technology to convert AlgeBrain (a Web-based ITS for Algebra) from a standalone application to a Web-based ITS. In AlgeBrain architecture, AlgeBrain Java Applet talks to AlgeBrain Application Server through socket connections where most of the tutorial behaviour resides.

Stern [Stern, M. K. (1997)] has identified few difficulties in Web-based Intelligent Learning Environment such as building a student model is difficult since the HTTP is a "stateless" protocol. But using Java Client/Server Architecture, problem of building student model can be resolved easily. Using Java Servlets can reduce network latency, which is occurred by the server side execution of CGI.

**Conclusion:** In this article, we presented WILEAC, which has a self-assessment and self-learning approach to grasp the concept of Double Entry in accounting course through "drill and practice". After analysing the system architecture of WILEAC, we found it highly re-usable framework for Web-based Intelligent Learning Environment and suitable to several knowledge domains. Currently, we are building WILEDs - Web-based Intelligent Learning Environment for Digital Systems course using this framework.

#### **Reference:**

- Aggarwal, A. K., & Regina, B. (2000). *Web-based Education*. Anil Aggarwal (Ed) Web-Based Learning and Teaching Technologies: Opportunities and Challenges, USA, pp 2-16 (ISBN 1-878289-60-8)
- Beck, J., Stern, M., & Haugsjaa, E. (1996). *Application of AI in Education*. ACM Crossroad, September, 1996.
- Benjamin, Q., Joseph, J. R., Javed, A., & Hartly, T. (1997). *Using Java to Develop Interactive Learning Material for the World Wide Web*. International Journal for Engineering Education, Vol 13, No. 5
- Bloom, B. S. (1984). *The 2-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring*. Educational Researcher, 13, 3-16
- Brusilovsky, P. (1994). *Student Model Centered Architecture for Intelligent Learning Environments*. In proceedings of Fourth International Conference on User Modeling, 15-19 August, Hyannis, MA, USA. User Modeling Inc, 1994, pp31-36
- Brusilovsky, P. (1999). *Adaptive and Intelligent Technologies for Web-based Education*. C. Rollinger and C. Peylo (eds.) Künstliche Intelligenz, Special Issue on Intelligent

- Systems and Teleteaching, 1999, 4, 19-25
- Brusilovsky, P., Schwarz, E., & Weber G. (1996). *ELM-ART: An Intelligent Tutoring System on World Wide Web*. In Frasson, C., Gauthier, G., & Lesgold, A. (Ed.), *Intelligent Tutoring Systems (Lecture Notes in Computer Science, Vol. 1086)*. Berlin: Springer Verlag. pp 261-269
- Chaudhury, A. S., & Chew, L. M. (2000). *Assessing the Preparedness of Information Institutions for the Knowledge-based Economy*. In proceedings of 28<sup>th</sup> Annual Conference by Canadian Association for Information Science, CAIS 2000: Dimension of a Global Information Science.
- Gerhard, G., & Marcus, S. (1997). *User Modeling and Adaptive Navigation Support in WWW-based Tutoring Systems*. In Anthony, J., Cecile, P., Carlo, T. (Eds), *User Modeling: proceedings of 6<sup>th</sup> International Conference, UM97, Vienna, New York: Springer Wien New York, 1997, pp 289-300*
- Kinshuk, & Patel, A. (1997). *A Conceptual Framework for Internet-based Intelligent Tutoring Systems*. A. Behrooz (eds.) *Knowledge Transfer (Vol II)*. PACE, London, UK, pp 117-124 (ISBN 900427-015-X)
- Li, H. (1997). *Viewpoint: Using Information Technology to Enhance Engineering Education*. *The International Journal of Engineering Education*. Vol 13, No. 5, pp 319-324
- Plessis, J. P., & Van B. J. A., Tolmie, C. J., & Wollinger T. (1995). *A model for intelligent computer-aided education systems*. *Computers & Education*, 24(2), pp89-106.
- Sherman, R. A., Singley, M. K., & Peter, G. F. (1999). *Deploying Intelligent Tutors on the Web: An Architecture and an Example*. *International Journal of Artificial Intelligence in Education*, 10(2), pp. 183-197
- Stern, K., & Beverly, P. W. (1998). *Curriculum Sequencing in a Web-based Tutor*. In proceedings of *Intelligent Tutoring Systems, 1998*
- Stern, M. K. (1997). *The Difficulties in Web-based Tutoring, and Some Possible Solutions*. In proceedings of the workshop "Intelligent Educational Systems on the World Wide Web" 8<sup>th</sup> World Conference of the AIED Society, Kobe, Japan, 18-22 August, 1997
- Stern, M., Woolf, B. P., & Kurose, J. F. (1997). *Intelligence on the Web*. In the Proceedings of the 8<sup>th</sup> World Conference of the AIED Society, Kobe, Japan, 18-22 August, 1997
- Webb, G. (1997). *A Theoretical Framework for Internet-Based Training at Sydney Institute of Technology*. In proceedings of AusWeb97 The 3<sup>rd</sup> Australian World Wide Web Conference.