Technology Assisted Problem Solving

S. Manjit Sidhu
University Tenaga Nasional, Malaysia

INTRODUCTION

Teaching conceptual and qualitative material effectively while leveraging the contents efficiently has been an elusive goal for many computer-aided learning (CAL) packages in the past. With the advent of newer technologies such as multimedia and virtual reality, these technologies are being researched and applied to various areas of educational settings, especially in science and technology. However the potential of these technologies has not been fully exploited, particularly in the teaching of engineering. In this paper we describe an innovative approach based on the principle of CAL to design and implement an integrated package known as technology assisted problem solving (TAPS) packages, which could guide students step-by-step to complete various engineering mechanics exercises. Some key concepts and development aspects of TAPS packages are also discussed.

BACKGROUND

Present CAL applications offer numerous advantages. Most importantly, CAL facilitates the implementation of effective training packages that can be made available to anyone who requires it without imposing any time constraint in learning. In addition, the CAL tutoring packages do not rely on the availability of a skilled human instructor and is not influenced by the number of students requiring training (Dean & Whitlock, 1983).

Although there are numerous benefits inherent in CAL, a major disadvantage with it is the way in which information is presented to the student. Conventional CAL packages present information at a pre-determined tutoring level and follow a set of structures. These packages do not take the student's basic knowledge or learning style into account and therefore lack the ability to adapt intelligently to meet the student's specific learning requirements (Vasandani, Govindaraj, & Mitchell, 1989). The only form of student adaptation that is occasionally implemented is the pace at which the course material is presented (Sclechter, 1991).

However over the past few years, CAL packages have been designed to incorporate multimedia to allow learners to perform multi-task simultaneously during a tutoring session. For example, a learner can read text and be narrated by displaying a video clip to explain certain concepts of the subject matter. CAL in its simplest form does not cater for the individual student. Information is presented in a predetermined sequence, regardless of how knowledgeable the student is at the beginning of the learning activity, or how quickly or slowly the learner absorbs and understands the course material (Rickel, 1989).

TECHNOLOGY ASSISTED PROBLEM SOLVING PACKAGES

A New Approach to Learning, Visualizing, and Problem Solving in Engineering

Problem-based learning, as the name implies, begins with a problem for students to solve or learn more about. Often these problems are framed in a scenario or case study format. Problems are designed to be "ill-structured" and to imitate the complexity of real-life cases. The problem-based approach uses an inquiry model, that is, students are presented with a problem and they begin by organizing any previous knowledge on the subject, posing any additional questions, and identifying areas they need more information. Students devise a plan for gathering more information, then do the necessary research and reconvene to share and summarize their new knowledge. Students may present their conclusions, and there may or may not be an end product (Duch, 1995; Hoffman & Ritchie, 1997; Stepien & Gallagher, 1993). All problem-based learning approaches rely on a problem as their driving forces, but may focus on the solution to varying degrees. Some problem-based approaches intend for students to clearly define the problem, develop hypotheses, gather information, and arrive at clearly-stated solutions (Allen, 1998). Others design the problems as learning-embedded cases that may have no solution but are meant to engage students in learning and information gathering (Wang, 1998).

In this paper we define technology assisted problem solving (TAPS) packages as specialized computer programs developed to work as stand-alone (PC-based) or with Web servers that can supplement student learning—for revision, laboratory experiments and self-study. The term TAPS is used to represent interactive multimedia CAL in which the student is engaged with a computer tutor in the problem-solving task of the subject matter. TAPS packages offer similar pedagogic values as an experienced human tutor, with the added advantage of guiding students to solve engineering problems on a more flexible mode, that is, a student has the freedom of working on the problem at his/her own pace, repeat all or certain steps, spend more time at each or particular step until they are able to understand and solve the problem. The objective of TAPS packages is to improve student's understanding of the selected engineering problems by guiding and presenting the problem-solving steps accordingly. The ultimate goal is to instill a sense of independent learning, encouraging critical thinking, and to promote deep learning. When tutoring a student on solving an engineering problem, a human tutor is expected to gauge the student's background knowledge, impart relevant course material at the correct level of detail, and clarify student's misunderstandings.

TAPS packages include the use of the computer to provide most aspects of instruction, which a classroom instructor could provide such as tutorials, questioning, and feedback contingent on answers—analytical and testing. The TAPS packages developed for this research has been customized to anticipate student needs, and have various interactive features built in to allow delivery control, navigation, and feedback. More specifically the packages are designed to assist the student in learning, visualizing, and problem solving in a step-by-step approach.

The TAPS packages also employ a variety of multimedia elements such as text, 2-D animated and still graphics, 3-D animated and still geometric models, audio, video and animations, stereoscopic images and simple artificial intelligence techniques, to develop individualized computer-based learning environments in which the student and computer tutor can have a flexibility that closely resembles what actually occurs when a student and human tutor communicate with each other. Such suppleness is important because without it, the package cannot be fully adaptive to the individual student's on-going learning and problem solving needs during instruction.

There are numerous difficulties with the implementation of realistic TAPS packages. The major problem with TAPS package development is that most of the features that are commonly found in non-computer-based tutoring packages are difficult to implement on the computer. In addition, many aspects of the tutoring process are taken for granted by the student. These include direct verbal feedback, visual and audio interaction, and an extensive knowledge base. When a student does not understand a concept, the norm is to ask a human tutor to provide a simpler explanation or to apply the concept to an everyday situation. This feature is difficult to implement in any computer-based tutoring package because the computer does not have sufficient intelligence to understand and interpret the course material.

Based on the aforementioned arguments, it is envisaged that an ideal TAPS package would be difficult to develop and implement. It is therefore necessary to identify key concepts that constitute a TAPS package and decide the best way of implementing similar forms of each of these concepts in a way that makes the tutoring and problem-solving environment as realistic and pedagogically effective as possible.

There are a number of key concepts that can be applied in the development of a TAPS package. Some of these are similar to intelligent tutoring systems (ITS) whereby a computer tutoring system incorporates aspects of intelligence, in particular an assessment model (used to monitor the performance of the student), and domain knowledge representation. In TAPS packages, these concepts can be divided into three main categories, namely learning scenarios, knowledge representation, and assessment modeling. However learning scenarios and knowledge representation concepts are discussed in details in the next sections of this paper.

Learning Scenarios

A learning scenario is a situation in which the student's learning takes place. When implementing a TAPS package, the criterion for determining the most appropriate learning scenario is based on the interaction required

Related Content

Student English Teachers' Vantage Points of the Digital Short Stories They Designed for Young Learners

Gülten Koar (2023). *International Journal of Online Pedagogy and Course Design (pp. 1-13).*

www.irma-international.org/article/student-english-teachers-vantage-points-of-the-digital-short-stories-they-designed-for-young-learners/315299

Teaching and Assessment of Course Outcomes in Switching Theory and Logic Design Course: A Case Study

Durga Prasad Garapati, S. M. Padmajaand N. V. Ramana (2021). *Assessment Tools for Mapping Learning Outcomes With Learning Objectives (pp. 97-115).*

www.irma-international.org/chapter/teaching-and-assessment-of-course-outcomes-in-switching-theory-and-logic-design-course/263875

Pedagogy and Design of Online Learning Environment in Computer Science Education for High Schools

Ebenezer Anohah (2016). *International Journal of Online Pedagogy and Course Design (pp. 39-51).*

www.irma-international.org/article/pedagogy-and-design-of-online-learning-environment-in-computer-science-education-for-high-schools/154895

Reducing Risk Through Academic Community Engagement in Homeland Security and Emergency Management

Magdalena Denhamand Ashish Kumar Khemka (2022). *Research Anthology on Service Learning and Community Engagement Teaching Practices (pp. 1525-1547).*

www.irma-international.org/chapter/reducing-risk-through-academic-community-engagement-in-homeland-security-and-emergency-management/296378

Emergent Pathways for the Future of Instructional Design

Pascal Roubides (2016). *International Journal of Online Pedagogy and Course Design (pp. 42-59).*

www.irma-international.org/article/emergent-pathways-for-the-future-of-instructional-design/142809