Mechanics Dynamics

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INTRODUCTION

The use of PCs in the educational sector has changed the learning environment of higher learning institutions and learning styles (the way individuals grasp and process information) of students in general. When coursewares (software that are used by students in their learning) were first introduced, the information was often presented at a pre-determined tutoring level and followed a set of structure. These coursewares provided surface approaches to learning (for example, the information had to be memorized by the learners) and did not take the student's basic knowledge or learning style into account and therefore lacked the ability to adapt intelligently to meet the student's specific learning requirements. However, with the advent of new technologies such as artificial intelligence, multimedia, and virtual reality, it is now possible to develop coursewares that could be designed to engage learners in more motivating environments. These coursewares could be implemented by using the principles of computer-aided learning (CAL) (a terminology used for imparting educational experiences electronically).

The aforementioned revolution not only contributed in delivering better educational materials but also helped in engaging the learners in other learning environments such as deep learning (relating previous knowledge to new knowledge), discovery learning (where the learner discovers what the instructor decides he/she is to discover using a process/model prescribed by the instructor), active learning, and other learning environments.

BACKGROUND

In general although newer technologies such as multimedia and virtual reality have influenced (stimulated the learning process of individuals) the way learners learn, however there is growing evidence that these technologies are not being fully utilized (Cairncross & Mannion, 2001; Manjit & Ramesh, 2005). According to Cairncross and Mannion (2001), early designs were driven by technology (i.e., focusing mainly on physical interface) rather than pedagogy. Additionally, Cairncross (2002) reported that it could take 40 hours to develop one hour's worth of quality interactive multimedia learning. This lengthy development time is extremely expensive because it is difficult and costly to find human experts to develop the interactive multimedia coursewares. As an option with most other teaching media, instructors wanting to use interactive multimedia courseware in their teaching can choose to develop simple unsophisticated materials locally or purchase more sophisticated, and thus more expensive, teaching materials from professional development units (commercial, software house, etc.). Schank (1994) argued that most multimedia programs are not suitable for learning because they merely add video and graphics to page-turning programs. Kinshuk and Patel (2003) added that the collection of multimedia objects, that is, pictures, graphics, sounds, and video, does not guarantee proper learning especially when the complexity of the task, skill, or learning increases. As such multimedia and virtual reality should be used where there is a potential for its use and necessity for such technologies to be employed in the learning environment. Some good examples where these technologies could be employed are physics, medical, and engineering education for teaching concepts that are difficult to learn and visualize from the textbooks. Additionally the coursewares employing such technologies should focus on discovery learning and problem solving techniques of the subject matter. The work reported in this paper described pertinent issues to the development of engineering mechanics dynamics prototype for a discovery-learning environment. For engineering and technology education, multimedia and virtual reality applications can include computer simulation, numerical analysis, computer-aided design (CAD), computer-aided manufacture (CAM), and electronic communications (Palmer, 2000).

DISCOVERY LEARNING

The concept of discovery learning has appeared numerous times throughout history as a part of the educational philosophy. Discovery learning has many definitions and is generally known as an inquiry-based learning method. However the most common method used for discovery learning is experimentation with some extrinsic (what is distinctly outside the thing in question) involvement for example clues, coaching, and a framework to help learners get to a reasonable conclusion. At the other end of the scope is the expository teaching model of discovery learning where the learner "*discovers*" what the instructor decides he/she is to discover using a process prescribed by the instructor. According to Sumeyra (2005), discovery learning could be used to accomplish three educational purposes by instructors as summarized in the following:

- Instructors want learners to know how to think and find things out for themselves. In other words, they want them to be less dependent on receiving knowledge from instructors and accepting the conclusions of others.
- Users of discovery learning want learners to see for themselves how knowledge is obtained. In other words, instructors want students to be able to learn by collecting, organizing, and analyzing information to reach their own conclusions.
- Instructors want learners to use their highest-order thinking skills (for example, to analyze, produce, and evaluate).

In a discovery learning environment, the role of the instructor may not be assumed as to impart knowledge but rather to create classroom experiences in which learners engage in order to discover knowledge. As the learner engages in the inquiry, the instructor encourages them to think deeply (where the learners draw on their own experience and prior knowledge to discover the truths that are to be learned). Most importantly learners accept the challenge of finding something out for themselves rather than having the instructor give them an answer.

In a discovery-learning environment, students become active learners as they participate to discover things on their own, for example, by encouraging them to ask questions, formulate their hypotheses, and carry out experiments on them. As such the learning is seen as a process of inquiry where learners play an important role, as opposed to a more didactic (tending to convey information in a linear fashion such as the instructor-centred style of teaching).

Discovery learning allows students to ascertain information and ideas on their own. In some ways, it is the most natural way to learn and often the student remembers the lesson learned more easily.

Sumeyra (2005) stated two main goals for discovery learning as listed in the following:

- Development of knowledge about the domain of discovery; and
- Development of skills that facilitate development of knowledge about the domain.

For discovery learning, it is therefore useful to employ modern technologies such as multimedia and virtual reality that could provide a virtual environment for students to explore, manipulate objects, perform experiments, and discover new concepts (for example, in representing actions in engineering such as object movement, links, pistons, and crankshaft in the form of dynamic illustrations (animated forms)). Since they are very important representative means in visualization experiments, the motions and actions of these objects maybe worthwhile to be shown in animated forms. On the other end, simulations are another area where new technologies can support students in discovery learning. For example, students may find it easier to investigate all possible loading conditions of a truss (a structure made from straight links connected at joints) to determine the most severe loading experienced by a truss member. In this situation, students could experiment safely by inputting different values for the load and investigate how such changes in the loading influence the internal reactions of the various truss members.

CASE STUDY

To address the previously mentioned issues, the present study discussed pertinent issues of a multimedia PC-based engineering courseware that has been developed to solve mechanics dynamics problems involving the motion of a projectile. Our past research has led to the implementation of structured two-dimensional (2-D) environment that enhanced visualization coupled with real-time motion by integrating 2-D animations with

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