CAN E-LEARNING REPLACE CLASSROOM LEARNING?

In an e-learning environment that emphasizes learner-centered activity and system interactivity, remote learners can outperform traditional classroom students.

By Dongsong Zhang, J. Leon Zhao, Lina Zhou, and Jay F. Nunamaker, Jr.

In recent years, the knowledge-based economy has exhibited a pervasive and ever-increasing demand for innovative ways of delivering education, which has led to dramatic changes in learning technology and organizations. As the new economy requires more and more people to learn new knowledge and skills in a timely and effective manner, the advancement of computer and networking technologies are providing a diverse means to support learning in a more personalized, flexible, portable, and on-demand manner. These radical changes in learning needs and technology are fueling a transition in modern learning in the era of the Internet, commonly referred to as e-learning [10]. In the midst of this transition, corporations, government organizations, and educational institutions must understand the e-learning phenomenon and make strategic decisions on how to adopt e-learning techniques in their unique environments. Here, we explore the recent advances in e-learning technology and practice, and present experimental results that compare the effectiveness of e-learning and conventional classroom learning. Our investigation shows that the Internet and multimedia technologies are reshaping the way knowledge is delivered, and that e-learning is becoming a real alternative to traditional classroom learning.

In the past few years, e-learning has emerged as a promising solution to lifelong learning and on-the-job work force training. E-learning can be defined as technology-based learning in which learning materials are delivered electronically to remote learners via a computer network. Effective and efficient training methods are crucial to companies to ensure that employees and channel partners are equipped with the latest information and advanced skills. Rushing to fill this need, thousands of online courses, including degree and certificate programs, are now offered by universities worldwide. In 2001, MIT announced its commitment to make materials from virtually all of its courses freely available on the Web for noncommercial use. In 2002, enrollment in the baccalaureate and graduate-degree programs at the University of Phoenix Online neared the 50,000 mark, a 70% increase from the previous year [10]. The Internet is becoming the dominant means of delivering information and knowledge because of low cost and real-time distribution. In comparison with traditional face-to-face classroom learning that centers on instructors who have control over class content and learning process, e-learning offers a learner-centered, self-paced learning environment [1, 3, 8, 9]. Table 1 illustrates the pros and cons of e-learning in comparison with traditional classroom learning.

	Traditional Classroom Learning	E-Learning
Advantages	• Immediate feedback • Being familiar to both instructors and students • Motivating students • Cultivation of a social community	• Learner-centered and self-paced • Time and location flexibility • Cost-effective for learners • Potentially available to global audience • Unlimited access to knowledge • Archival capability for knowledge reuse and sharing
Disadvantages	• Instructor-centered • Time and location constraints • More expensive to deliver	• Lack of immediate feedback in asynchronous e-learning • Increased preparation time for the instructor • Not comfortable to some people • Potentially more frustration, anxiety, and confusion

Table 1. Traditional classroom learning vs. e-learning.

As pointed out by previous studies, inadequately equipped e-learning systems can result in frustration, confusion, and reduced learner interest [2, 7]. For example, some e-learning systems only present text-based learning materials, which may lead to boredom and disengagement in students and prevent them from gaining a good understanding of a topic. With the advances of multimedia technology, more multimedia-based e-learning systems are becoming available. These systems integrate and present learning materials in diverse media such as text, image, sound, and video. However, some of the multimedia-based systems suffer from insufficient learner-content interactivity and flexibility because of their passive and unstructured way of presenting instructional content. Under such a system, learners have relatively little control over the knowledge structure and the learning process to meet individual needs. For example, it may be ineffective and time-consuming to locate a particular segment or to skip a portion of a three-hour instructional video delivered via the Internet, making interactive learning difficult. Sometimes a student may want to ask questions about the instruction materials and get answers immediately instead of sequentially going through an instructional video to find an answer. But few multimedia-based e-learning systems provide this capability.

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The Virtual Mentor

In order to address some of existing problems and develop interactive and flexible e-learning systems, we have proposed a concept called Virtual Mentor (VM), a multimedia-based e-learning environment that enables well-structured, synchronized, and interactive multimedia instructions. The concept of VM consists of the following principles:

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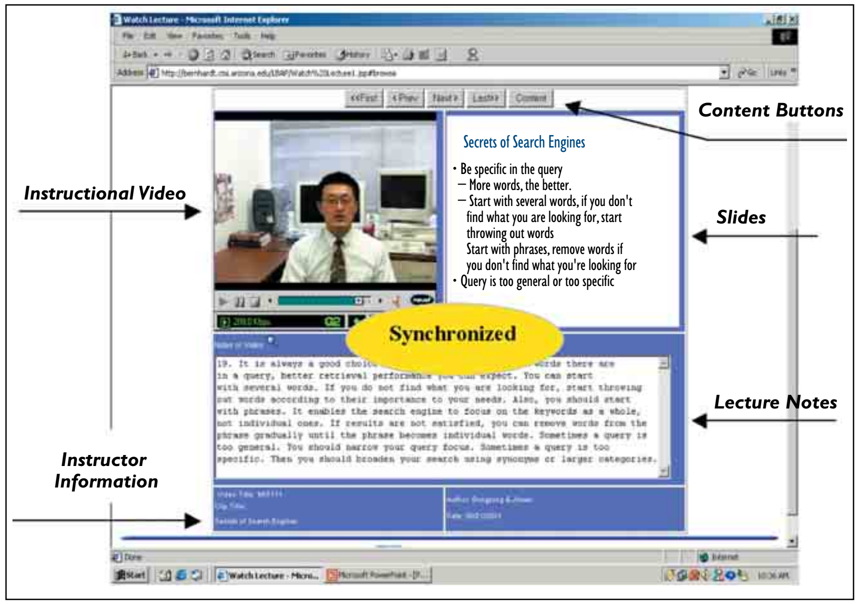
- *Multimedia-integration.* VM captures experts' knowledge/wisdom on videos in the form of interviews or lectures, and presents them with other associated materials in various media formats such as PowerPoint slides, narratives, and images.
- *Just-in-time knowledge acquisition.* VM enables learners to access knowledge at any time via the Internet.
- *Interactivity.* Learning is an active knowledge acquisition process via continuous interaction between VM and learners. Learners are also able to direct questions to VM, and receive real-time answers.
- *Self-directivity.* VM is a learner-centered process in which a learner chooses personal learning strategies, taking the initiative and responsibility to determine his or her learning needs.
- *Flexibility.* VM gives learners flexible control over the learning process, style, and content to meet their individual needs.
- *Intelligence.* VM monitors each individual's learning progress and provides personalized tutoring.



Synchronized multimedia content in the Interactive E-Classroom.

The VM concept is influenced by constructivist learning theory, which describes how learning takes place through proactive interactions and reinforcements [11]. According to this theory, learners actively construct their own knowledge based on prior knowledge and experience brought to bear on learning tasks. Learning is an active process conducted in a self-directed fashion. E-learning provides many opportunities for constructivist learning by supporting resource-rich, student-centered, and interactive learning.

We have developed a prototypical VM system called Learning By Asking (LBA), which presents synchronized multimedia materials on the Internet in an interactive and cohesive manner. Materials include instructional videos, presentation slides, and lecture notes. These instructional videos and the associated materials are collected during lectures or interviews. Since each video is likely to contain many subtopics, videos are logically segmented into smaller individual clips based on the content so that each video clip focuses on a specific subtopic. Then, these video clips are compressed and stored on a video streaming server. An integrated knowledge repository is created on a Web server, containing metadata of videos and other multimedia instructions.

LBA consists of two major subsystems: Asking-A-Question and Interactive E-Classroom. The Asking-A-Question subsystem allows learners to type in questions in either keywords or conversational English. The questions are then sent to the Web server, on which information processing and content retrieval take place. The learning content retrieved with respect to those questions is displayed immediately to learners. In this way, learning is conducted through a real-time question-answering interaction between learners and LBA. We have also embedded an intelligent learning assistant module into LBA to automatically generate personalized learning guidance in the form of follow-up suggestions after each question. These suggestions are dynamically generated based on the learning history of individual learners.

In a traditional classroom lecture, students can simultaneously observe and listen to an instructor, and watch PowerPoint slides or transparencies. An online classroom should have a similar level of synchronization of various online contents [6]. Therefore, LBA has an Interactive E-Classroom, which simulates a traditional classroom environment. It enables learners to watch online lectures presented via synchronized video and audio of the instructor, PowerPoint slides, and lecture notes on a single Web interface (see the figure here). While an instructional video is playing, the Interactive E-Classroom automatically shows the corresponding slides and lecture notes about the topic the instructor is introducing in the video.

The Interactive E-Classroom provides rich learner-content interaction. A learner can either allow the lecture to flow from the beginning to the end, slide by slide, or, by pressing control buttons located at the top of that interface, the learner can activate various operations to control the lecture content and the learning process. For example, the learner can click the Next button to skip the current video clip/slide/note if it is already understood, or press the Prev button to review the previous display. When the learner moves the mouse over the Content button, a pull-down menu shows a content index of the current lecture, allowing the learner to jump to a particular clip/slide/note directly by clicking any subtopic in the index. These control buttons are designed to provide sufficient interactivity between learners and the lecture.

	Lecture Content	Number of students in the classroom group	Number of students in e-learning group
Study 1	Normalization (Database)	17	17
Study 2	Internet Search Engines	34	35

Table 2. Learning contents and group size of two studies.

A text-based online discussion forum is integrated into LBA to enable learners to exchange ideas or post comments or questions. The messages are grouped by topic and are displayed in an order based on the time they are created, starting from the most recent.

	Study 1: Average / Total Score	Study 2: Average / Total Score
Classroom group	9.24 / 15	23.67 / 50
E-Learning group	10.88 / 15	34.14 / 50

Table 3. Comparison of average scores between classroom and e-learning groups [11].

To assess the effectiveness of interactive learning in a virtual mentor environment, we conducted two experiments using the Interactive E-Classroom of the LBA system. Subjects were undergraduate students at the University of Arizona (55.4% were male, either freshmen or sophomores) from more than 10 majors. In both studies, students were randomly assigned into the experimental groups. Students in traditional classroom groups took the regular lecture in a classroom and were allowed to ask the instructor questions, while students in e-learning groups were asked to use the Interactive E-Classroom in a research lab, and attended the lecture via the Internet (see the screen display in the figure). As illustrated in Table 2, the learning contents and group size of two experiments differed. The same instructors who taught the classroom group also prepared online course materials for the e-learning groups to ensure the lecture content was consistent across all experimental groups.

During the study, every group had the same amount of time for lectures and went through the same experimental procedure. The learning effectiveness was assessed by objective measures of student learning (test grades) and subjective measures (perceived satisfaction). We gave each student a pre-lecture test and a post-lecture test (closed-book, closed-notes) on the content covered by the lectures and used the difference between the two scores as the individual learning performance. Learner satisfaction was evaluated after the experiments via a questionnaire, which employed a 7-point Likert scale ranging from extremely dissatisfied (1) to extremely satisfied (7).

Although we used different learning contents and students in the two experiments, the results were consistent: the test grades of students who took lectures through the Interactive E-Classroom with interactive control and content synchronization (as illustrated in the figure) were significantly higher than those of students in traditional classroom groups (see Table 3). The difference in satisfaction levels of students in the classroom and e-learning groups was not significant.

In the post-study questionnaires, most students in e-learning groups reported they liked the multimedia presentation in the E-Classroom and were satisfied with the self-controlled learning process. They also thought that sufficient interactivity and flexibility was critical to an e-learning environment.

A Promising Alternative

As shown in Table 3, e-learning groups using the Interactive E-Classroom of LBA significantly outperformed traditional classroom groups as measured

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by the test scores. There is one plausible explanation for this interesting phenomenon. In a traditional classroom, learning is highly instructor-centered and sequential. Although many instructors encourage students to ask questions during lectures, for various reasons, many students do not question or ask for repetition in the class even when they have difficulty comprehending the lectures, and they do not have an opportunity to re-experience the lecture content selectively. In contrast, a VM environment like LBA emphasizes learner-centered activity and interactivity. When a student does not understand a specific concept, he or she can select a particular piece of content to review until it is fully understood.

Today, e-learning is still in an early stage, with many uncertain issues to be clarified and investigated. There are many factors potentially influencing e-learning effectiveness, such as media characteristics, learning context, technology, and learner characteristics. While our experiments have demonstrated that e-learning can be at least as effective as conventional classroom learning under certain situations, we are not in a position to claim that e-learning can replace traditional classroom learning. Learning is mostly a socio-cognitive activity. Not every student will find e-learning suitable for his or her learning style. Some students feel bored or intimidated before a computer. A number of students in our studies reported that although the system was interesting and effective, they would still prefer to go to traditional classrooms if they had a choice, since e-learning environments cannot create the real life on a campus. E-learning requires more maturity and self-discipline from students than traditional classroom education, which may explain the higher dropout rates in e-learning programs compared to conventional programs [4, 5]. There are also logistical concerns about e-learning. For instance, teaching on the Internet requires much more preparation time than in-classroom teaching. Furthermore, certain types of learning materials may be too difficult or too costly to be taught online.

Other important issues in e-learning must also be taken into consideration. Issues of trust, authorization, confidentiality, and individual responsibility must be resolved. Owners of intellectual property should be properly compensated. Security on the Internet is a growing challenge, primarily due to the open access by the public to this universal network. In addition, since multimedia materials are heavily used in e-learning systems, a high-bandwidth network is a basic requirement for efficient content access.

Nevertheless, we believe that e-learning is a promising alternative to traditional classroom learning, which is especially beneficial to remote and lifelong learning and training. In many cases, e-learning can significantly complement classroom learning. E-learning will keep growing as an indispensable part of academic and professional education. We should continue to explore how to create more appealing and effective online learning environments. One way to do this is to integrate appropriate pedagogical methods, to enhance system interactivity and personalization, and to better engage learners. C

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