

The Continuum of Distance Learning in Engineering Education

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Abstract

Distance education has rapidly emerged in the global university. The American Council of Education estimated that 85 percent of traditional colleges and universities offered, or soon would offer distance accessible classes. China alone produces more than 100,000 graduates, with more than half of China's 92,000 engineering and technology graduates having attained their degrees through distance education. As engineering education moves toward distance learning it is likely that the virtual engineering classroom will become much more student centered. The traditional classroom will likely be replaced with an intimate virtual environment. The student centered distance learning archetype will include dynamic demonstrations of theoretical engineering models allowing students to manipulate, experiment, and translate theories into real-world applications. These innovative engineering models will be virtual pedagogical adaptations suited to autonomous learners, individualized experience, and active participation. One such dynamic virtual engineering model is presented. The distance learning curriculum in engineering will emerge from the creative use of virtual technologies, theoretical adaptation, and the incorporation of comprehensive evaluation of student performance.

Introduction

Distance education is rapidly emerging as a viable alternative to the traditional university classroom. Technology is a major contributor to the tremendous growth and diversity in distance education¹. Virtual classrooms are emerging globally from Malaysia² to England³. China alone produces more than 100,000 graduates a year through distance education, with more than half of China's 92,000 engineering and technology graduates having attained their degrees through distance education¹.

Interest in distance education has risen quickly in both the public and private sectors and in corporate and university boardrooms. "Investors are pouring millions, soon to be billions, into the online education market. Conservative figures from analysts at Thomas Weisel Partners, a merchant bank in San Francisco, estimate a \$10 billion virtual higher-ed market by 2003 and \$11 billion corporate-learning market by the same year. That's 21 billion from almost nothing and it's the kind of market that makes venturesome investors drool"⁴. This expansion has occurred without benefit of research on the distance education model.

"Distance education is not new, it is just becoming more popular with adults. Colleges have offered distance education for more than 100 years. The first correspondence course was offered

at the University of Wisconsin via pony express in 1891”⁵. With the advent of the Internet many traditional classroom functions are conducted electronically. The new technology has transformed the way universities conduct day-to-day operations. Newcomers to Internet based instruction, Cook⁶ seeking advice quickly discover that only a few comprehensive discussions about online instruction exist. This information gap will soon be filled as the kinks in the virtual university are worked out.

Collegiate stakeholders expect the technology to drive the future of the global higher education system. “To some degree, all education is distance education. In traditional courses, students spend an average of only three hours per week attending class but are nevertheless required or expected to spend several additional hours on their own time reading, researching, preparing assignments, and perhaps conferring with other students. And in recent years, even campus-based students have come to rely on asynchronous e-mail conversations with faculty and other students rather than office appointments and meetings”⁷. The American university system utilizes distance education technology and techniques for convenience while the rest of the world may depend on this medium to support the infrastructure of higher education.

Uses and Purposes

Distance education is being utilized for an expanding range of purposes and in multiple settings. Universities are using it to increase the number of students who have access to the higher education system. Corporations keep abreast of technological advances and update worker’s skills using distance education. Government entities use distance education for training teachers and other professionals in remote or rural areas where traditional classroom settings do not exist. “Malaysian students pioneer on-line education a university in Malaysia is taking virtual education to the outer fringes of the information age. While many colleges around the world use the latest multimedia innovations to deliver some of their course or use the Internet to announce assignments, University Tun Abdul Razak-or Unitar-was set up with the sole aim of offering education through cyberspace”².

“In this new world order, agency heads are trying to find affordable, flexible and timely training programs for large numbers of workers. They also are seeking training programs that enable employees to make use of technological advances. Gone are the days of sending someone halfway across the country to spend five days in hotel conference room. That’s old school”⁸. In addition students at all levels expect something for their money. “One of the fundamental questions that course providers need to ask if they are going to maintain their position in what is becoming an increasingly competitive market, ‘Are students satisfied with their course?’”⁹.

Distance Learning Archetype

Although the classroom environment in Engineering and Construction Science is highly structured by the instructor, teaching students to be critical thinkers is essential in the virtual classroom of the future. The workplace is not systematic and concise, but rather it is filled with ambiguous situations. The teacher-centered classroom denies the student the opportunity to more self-directed, autonomous, and creative. The distance learning archetype can be best described as a dynamic creative autonomous learning environment. Often a virtual educational

delivery system is used to facilitate distance learning rather than the age-old method of correspondence course curriculum. These virtual delivery systems^{2,9,10,11} have similarities around the globe. These virtual delivery systems hold student autonomy and creativity as essential attributes.

Therefore the archetypal distance learner can be defined as being primarily an autonomous adult learner. This type of autonomous adult learning does differ from how children learn, and a theory of adult learning was identified and labeled as “andragogy” by Malcolm Knowles¹². He brought forth the word andragogy to describe the learning process for adults and believed that adults are self-directed learners. Adults accumulate a unique set of life experiences, that adults should be responsible for their own learning, and that adults want immediate application of what they learn¹².

The instructor must recognize the inherent differences between the distance and traditional classroom. The instructor must move from a teacher-centered approach to a more learner-centered approach to teaching. “Distance education is different from traditional classroom learning in that it must be more learner-centered. A classroom instructor may lecture for two or three hours at a time, but the Internet creates a forum that allows students to take a more active approach to focusing on their own education. Instructors frequently present theoretical concepts and models for on-line discussion. The students then work independently or in groups to translate theories into real-world applications”¹¹.

In addition the instructor or facilitator of a distance course must be prepared to devote much more time to course development. “Distance courses require copious development and preparation time for faculty. Because verbal and visual cues that exist in a traditional setting are absent. Course materials must be comprehensive and extremely clear to avoid student misinterpretation. Furthermore, instructors must adapt their course materials and teaching styles to the new medium, as Internet instruction and classroom instruction are two different creatures and are not interchangeable”¹³.

An Innovative Dynamic Virtual Modeling Concept

As technology rapidly changes, the importance of educating and training diverse populations of construction engineering/science students becomes more critical. Traditional lecture format teaching methods sometimes fall short of conveying the complex analysis and design principles that need to be mastered in structural design. However when the theories are exemplified in a virtual environment with multimedia, animation, interaction, and manipulated image visualization techniques in a virtual reality environment, students' conceptual understanding are enhanced. The important advantages of the virtual reality environment over other computer-based design tools are that it enables the user to interact with the simulation to conceptualize relations that are not apparent from a less dynamic representation, and to visualize models that are difficult to understand in other ways. The interactive nature of virtual environments made it a natural extension to the 3-D graphics that enable students to visualize real life structures before actually building them. One way to incorporate a more learner-centered experiential approach in virtual engineering and construction science education is to incorporate various teaching and learning visualization techniques through various media. Figure 1 illustrates a structural analysis

and design concept visualization technique wheel ¹⁴ to detail the teaching and learning exchange, which occurs in the virtual learning environment. The traditional lecture is modified in the distance learning classroom. This modification often includes direct on-line lectures or video taped lectures. The self-directed learner can have the opportunity to watch and listen to lectures more than once something not available in the traditional classroom. This virtual pedagogy focuses on an instructional design that incorporates guided and interactive engineering and construction science concepts.

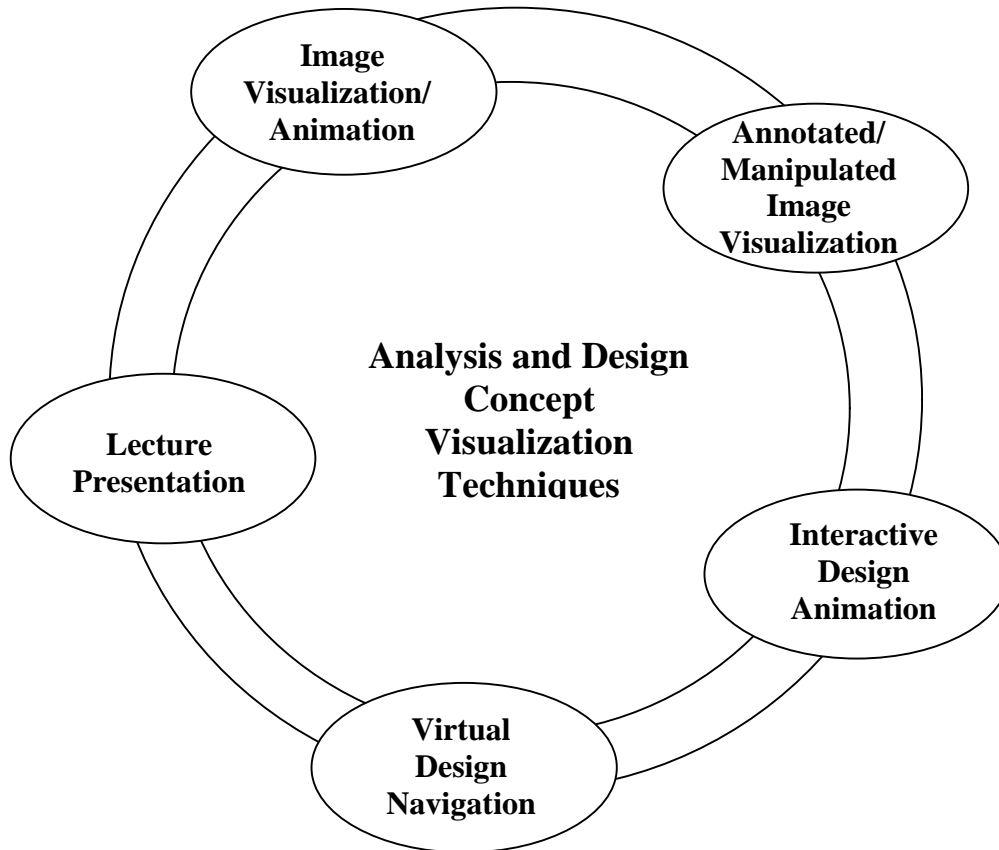


Figure 1 Analysis and Design Concept Visualization Technique Wheel

The concepts of image visualization/animation are combined with annotated/manipulated image visualization to provide for initialization of a dynamic virtual engineering model. These techniques allow for self-directed learning and provide the engineering or construction science professor with powerful tools for instructional enhancement. Animation/visualization techniques provide for virtual experiential learning when combined with Interactive Design Animation and Virtual Design Navigation. These activities are self-directed, experiential, and personalized for the autonomous self-directed distance learner. The interactive nature of the dynamic virtual teaching/learning model further validates the aforementioned Distance Learning Archetype that differs from the traditional teaching/learning exchange. The traditional classroom

does not provide for self-paced instruction, visualization of conceptual virtual models, and autonomous 3-D navigation within the interactive virtual engineering domain.

The virtual engineering and construction science curriculum should become more experiential. Virtual lessons should incorporate the real world whenever possible. Hands-on activities are premium opportunities for learning and teaching. Inclusions of self-directed virtual activities allow for the personal development of the learner. Therefore, students should be encouraged to create their own learning experiences using these virtual tools. Research in the fields of cognition, artificial intelligence, and learning science solidifies what common sense indicates learners learn best when they can practice and experience failures in their lessons with the guidance of a facilitator. Practice sessions can be enhanced when the facilitator shares relevant knowledge and experience with the learner ¹⁵.

The dynamic virtual model can promote and support professor led motivational lectures as well as self-directed experiential activities. The dynamic interactive nature of the virtual model attracts the attention of the autonomous learner. “Perhaps professors shouldn’t have to motivate their students, but the reality is that professors can motivate their students. By making it directly, frequently, and immediately pay off for students to do the things professors want them to do, professors can alter the choices that students make and ultimately alter what and how students learn” ¹⁶. Further, some students could learn how to motivate themselves from observing their professors and from experiencing the successes in completing what they are motivated to do ¹⁶. Utilization of a virtual pedagogy has the advantage of allowing for learner to view and participate in engineering lessons multiple times. In addition the dynamic interactive nature of these virtual techniques allows for a type of experiential education.

Teaching Style and Virtual Design Technologies

The engineering and construction science distance education archetype mandates that different teaching styles are in order. Engineering and construction science education has depended on a teacher-centered environment in the traditional classroom however the virtual environment requires a student-centered approach in order to be successful. Teaching style refers to an instructor’s characteristic behavior in the teaching-learning situation. Educational philosophy is a critical factor in determining an instructor’s personal teaching style ¹⁷. One’s teaching style can also be impacted by experiential background. There is evidence that teachers begin an instructional session with the type of learning activity that they prefer and gravitate toward methods they find useful ¹⁸.

One’s educational philosophy can be formulated through an examination of values, beliefs, and attitudes that are related to the teaching-learning exchange ¹⁹. When behavior is added to this picture, teaching style emerges, because teaching style is the distinctive qualities displayed by teachers that are persistent in situations regardless of content ¹⁷.

Technology can enhance teaching but what can teaching style do to enhance the technology? “The typical experience with knowledge management reminds us what we as training professionals already know: A learning initiative is about people first and technology second. That’s nothing new for those of who practice good instructional design. We determine the

performance issue first and then decide on the medium for the learning”²⁰. “In the university, the professor’s role has historically been that of an expert who lectures or ‘professes.’ Online learning is less likely to use top-down knowledge delivery methods, such as lecturing, and more likely to rely on peer-to-peer learning in the form of collaborative discussions and team projects”¹⁰.

Concluding Remarks

The collaborative mode is manifested out of necessity in the distance learning archetype that may be why the global acceptance of degrees received from distance institutions are uniformly accepted in many countries outside the United States. Teaching style does differ in the virtual university and many in traditional universities will struggle to adapt to new styles of teaching. The technology required in the distance learning archetype should induce a more student-centered approach to engineering and construction science distance education.

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