 

# Instructional Design for a Web-Enhanced Course in Construction Engineering and Management Education

**Namhun Lee, Ph.D.**
East Carolina University
Greenville, North Carolina

In the traditional classroom setting, the instructor controls the learning environment and students are considered passive learners into whom knowledge can be transferred. However, today's students are different from previous generations in the way they absorb, interpret, and process new information since they are accustomed to using technologies in nearly every part of life. They much prefer being networked and being interactive in their own learning process. In addition, they like random access to educational materials with support of web technologies. By understanding the nature of today's students, educators may take advantage of using web technologies to enhance student learning. Through the use of web technologies in the learning environment, students will be able to gain significant learning benefits. However, when designing web-enhanced instructions without the knowledge of learning theories and instructional design principles, the instruction often fails in providing the real content for students, which means that the use of web technologies does not influence the student's achievement. Therefore, this paper investigates how web technologies can be effectively incorporated into a construction engineering and management course, based on the understanding of learning theories and instructional design principles. This paper also describes three phases to develop a web-enhanced course and presents the application of three phases to developing a model course.

**Key Words:** Construction Education, Undergraduate Education, Web-Enhanced Instruction, Instructional Design

## Introduction

In a traditional classroom setting, instructors control learning environments and students are considered passive learners into whom knowledge can be transferred. Instructors decide what students should learn and what knowledge should be transmitted through a standard lecture. However, what if today's students much prefer to learning in a different learning environment? Regardless of the nature of today's students, should they learn in the same way that we did? This belief might be misplaced. Bransford et al.(1999) argue that today's students are different from previous generations in the way they absorb, interpret, and process new information since they are accustomed to using technologies in nearly every part of life. For this reason, today's students are often called 'Net-generation', 'Generation-Y', or 'Digital Natives'. They use technology for social networking, blogging, information sharing, communication, collaboration, or competition. Ample experience with technology enables the current generation of students to change their expectations regarding the way they acquire knowledge. From this point of view, the support of technology in their learning process is necessary.

Educators have used web-based technologies for motivating students and enhancing their learning. Specifically, the surge of web-based educational opportunities may extend students' learning experience by providing with instant access to vast resources of information anytime, anywhere. Higher education institutions have offered a variety of blended and online courses where different delivery methods have been employed to meet the needs of students. Although there are still ongoing debates about the effectiveness of online education courses, much research reports that interactive course websites have been successfully used for both online and face-to-face course delivery throughout professional disciplines (Leasure et al. 2000, Berger and Topal 2001, Buckley 2003, Weber and Lennon 2007). The research shows that the primary advantage of online instruction is the convenient and easy access to information. Accordingly, modern technologies and internet accessibility capable of online learning have led to a new teaching paradigm. Students are not passive vessels like being in the traditional classroom, but rather they can

be active and self-directed learners. In the same context, the role of the teacher is shifted from a knowledge transmitter into a facilitator.

Construction is a highly complex system which has a wide spectrum of interrelated elements with multiple feedback loops and non-linear relationships. This requires construction professionals to timely and effectively communicate among related parties throughout the construction process. Due to the generic characteristics of construction, it is essential for students in construction engineering and management to explore such complexity in an active classroom before facing real situations through communicating and collaborating with peers. Educators need to encourage the students to participate in such activities by appropriately providing multiple web-enhanced learning activities, considering the nature of today's students.

In this paper, the term 'web-enhanced' is referred to as the use of web-based teaching tools to create more active and self-paced learning environments. Mills (2006) emphasizes on established instruction theories, teaching practices, and learning principles for making a web-enhanced learning approach to be effective in the classroom. In addition, Bork (1996) claims that higher education instructors lack the knowledge of learning theories and instructional design principles; consequently, their web-based instructions often fail in providing the real content for students. Without those understandings, the use of technology does not influence the student's achievement (Schramm 1977, Clark 1983). In construction engineering and management education, there is little research on how web technologies, from the viewpoint of the instructional design, can be incorporated into instruction to enhance students' learning. Thus, it is worthwhile to discuss learning theories which can be applied in effectively delivering a web-enhanced instruction. Next section reviews instructional design strategies for web-enhanced format, based on learning theories and instructional design principles.

## Conceptual Learning Theory and Instructional Design Principle

Although the concept of instructional design is rooted in behaviorist psychology, the principles of cognitive psychology have influenced the development of instruction design (Chen 2007). Behaviorists, on the one hand, postulate that learning can be caused by external stimuli in the environment and indicated by an observable behavior. Learning outcomes as a result of behavioral responses to stimuli can be shaped by following reinforcement. With respect to instructional design, behaviorists claim three phases including analysis, design, and evaluation. The emphasis on designing instruction is to analyze the behavioral objectives and to assess learner performance with criterion-referenced tests. Learning can be reinforced through such teaching strategies as frequent cues, stimulus-response chaining, feedback, and repertoires.

On the other hand, cognitivists focus on learning as an internal process from the perspective of the information processing which involves the concepts like 'short-, long-term memory', 'automatic and controlled process of information', and 'cognitive structure'. This assumes that there is a sequence of mental activities for learners to understand and store the information given from an external world. Thus, learning can be facilitated and enhanced through the external manipulation of the instruction. Instructors should design their own instruction so that it can facilitate the internal learning process of an individual learner through chunking, repetition, and meaningful sequence of information. According to Gagné (1985), instruction should clearly define learning goals and objectives, classify the goals according to certain domains, select effective learning strategies, have a logical sequence of learning activities, and assess learning outcomes.

Jonassen (1992) posits that both behaviorism and cognitivism are primarily objectivistic in that they consider learning and knowing as the processes for representing an objective reality. Under this teaching paradigm, learners strive to learn the target objectives by the passive transfer of knowledge and perform the expected outcomes. On the contrary, constructivism claims that learners construct their own knowledge through interacting with the outside world and interpreting the experience, not simply transfer knowledge from the external world. This meaningful learning process will be facilitated when learners are actively involved in real world contexts through collaboration and social negotiation. From the constructivist's view, the instructor should provide students with learning embedded in real-life contexts where they can interact with the environment and peers to accomplish the task, so that students can realize multiple perspectives to solve the problem and actively use what they learned. The role of instruction is not to define the structure of learning required to accomplish a task, but to accurately describe the task.

Recently, the principles and practices of instructional design have shifted from objectivism toward constructivism (Jonassen 1992, Tam 2000, Vrasidas 2000). Posner (1995) argues that educators should select the most appropriate approach when designing an instruction, depending on a given purpose. Chen (2007) suggests a model of combining objectivist's instructional strategies and constructivist's ones. This pragmatic view of instructional design is referred to as reflective eclecticism. Next section explores how to eclectically apply the instructional design principles, based on different learning theories, to developing a model course using web-based teaching tools.

## Developing a Web-Enhanced Course: Application to a Model Course

Grabowsky et al. (2000) defines 'web-enhanced learning' as a classroom-based educational approach that allows students to use internet technologies to support students' learning. The web is considered as access to information which is conducive to learning purposefully. Buckley (2003) developed web-enhanced format with an online course management tool known as WebCT and added it to a traditional classroom. McCreanor (2000) refers to a web-enhanced course as the incorporation of web-based teaching tools into a traditional face-to-face course. He developed a web-enhanced course using the WebCT environment and the course included three primary on-line elements such as lesson plan, quiz, and homework. These efforts showed that web-based teaching tools can provide more opportunities to support the face-to-face classroom learning.

Despite the advantages of online courses, research shows that students are more satisfied with traditional lecture version than with online courses, due to the absence of enthusiastic instructors (Williams and Cecei 1997). Based on the fact, the use of web-based teaching tools is an effective delivery method in case of supplementing instructions offered by an enthusiastic instructor in a classroom. There are three phases which should be considered when developing the web-enhanced course:

1) Delineation of the course in a series of lecture modules, considering overall instructional approaches
2) Decision of appropriate instructional methods/strategies to support student learning
3) Incorporation of specific web-based learning activities

In construction engineering and management curriculum, the estimating course typically requires the knowledge of construction methods and materials as well as the ability to read contract drawings and specifications. It has been observed that students have difficulty in mastering the fundamental quantity takeoff techniques and estimating skills within a certain period due to lack of pre-requisite knowledge. Construction estimating is one of the subjects that require the instructor to be more knowledgeable based on practical experience. Thus, the instructor's competence is an essential factor to successfully convey such skillful knowledge to students. However, without well-designed instructions, it might not be effective to transfer the knowledge into students who need to learn and master the target skills through the course. The following part describes the suggested three phases for developing a web-enhanced construction estimating course.

### *Phase 1: Delineation of the Course in a Series of Lecture Modules, Considering Overall Instructional Approaches*

As aforementioned, there are two primary schools of thought to delineate the instruction. The construction estimating course has been taught only by the traditional lecture before the alternative delivery method is offered. The course is designed for junior or senior students who are on the introductory level of construction estimating. Jonassen (1991) defines three stages of knowledge acquisition such as introductory, advanced, and expert. He argues that constructivist-based approach is the most effective for the advanced stage of knowledge acquisition. From the constructivist's viewpoint, learners are expected to manage their own learning, but this may lead the students on the introductory level to be frustrated and uncomfortable to learn the subject. On the other hand, Jonassen (1991) agrees that introductory knowledge acquisition is better facilitated by an objectivistic approach.

Based on this understanding, the instruction for the model course is designed linearly on the foundation of the objectivistic perspective. The instructor first decides what students must know to understand the general concept of construction estimating. To effectively transfer fundamental knowledge to the students, the instructional goals and objectives are clearly clarified and learning contents are simplified and organized by lecture modules. Lecture notes are prepared, focusing on the goals and objectives of each lecture module, and are posted on a learning management

system such as Blackboard or Moodle. Upon the completion of each lecture module, the instructor assesses if the students meet the learning objective through either in-class activities or on-line activities. Considering how the web-enhanced learning environment supports the instructional goals and objectives, constructivist-based activities is employed as a transition from the objectivistic approach to the constructivist approach as the students obtain more knowledge. This model course is overall designed using the objectivism-based approach, but the instructor also takes a role as a facilitator to provide the collaborative, contextual and active learning environment. For this reason, the instructor needs to decide appropriate instructional strategies from constructivist's view as well.

### *Phase 2: Decision of Appropriate Instructional Methods/Strategies to Support Student Learning*

Among a full range of course delivery methods currently used, the instructor should select the most effective one, considering how to help students accomplish the learning objective through the web-enhanced instruction. Moreover, the use of appropriate instructional methods can motivate student learning and assess student performance effectively. For student engagement, instructors also need to consider the feasibility and the level of difficulty in the student's performing an assigned task.

In the model course, the lecture-based instruction is employed to transfer conceptual knowledge required to the students, assuming that all the students are on the introductory level of construction estimating. Upon the completion of each lecture module, the students are asked to take a quiz to measure the level of the student's understanding of the learning module. In case that some of the students don't meet the learning goals and objectives, self-study guides should be provided to those students. Due to the generic nature of the construction estimating course, the students should be able to apply the fundamental quantity takeoff techniques and estimating skills to a real context through various practical exercises. Thus, the instructor provides the students with simple but real case as an online exercise. The students are required to complete the online exercise within a certain period of time individually.

Table 1

***Instructional methods used for the model course***

| Methods | Characteristics | Example | When to Use |
|---|---|---|---|
| **Instructor-led Classroom** | Provide basic concepts necessary for further learning | Lecture | When transferring conceptual knowledge is primary objective. |
| **Instructor-led On-line** | Help students apply learned knowledge to new situations | Online Exercise | When students are active learners. |
| **Self-paced** | Allow self-paced learning of Content | Self-Study Guide | When there is a significant range of student performance. |
| **Virtual Classroom** | Encourage students to engage in self-paced discovery | Online Discussion | When the instructor's feedback is provided regularly. |
| **Blended** | Provide students with opportunities to drill and practice | Group Project, Case Study | When it is necessary to develop higher level of thinking skills. |

From the constructivist's view, complex and ill-structured problems promote high-level thinking level and foster collaboration and interaction. Based on this viewpoint, an actual construction project including drawings and specifications is given to the students for a practical practice within the real context. The instructor assigns project groups while considering the student's level in the class. The project is broken into several parts for the students not to be overwhelmed by the amount of work. Each part of project specifically explains well-defined tasks. All project groups should complete all project parts to prepare their own bid package. Throughout the project, the instructor assesses if the students can apply their learned knowledge to a real context.

While performing the project, the students play a role of junior estimator and the instructor plays a role as a senior estimator. The students are assigned in a small group (three to four students) to facilitate the learning among the group members through collaboration and interaction. Some studies indicate that collaborative learning can promote higher student learning outcomes and positive student-student relationships than do competitive or individualistic

learning (Johnson et al. 1991, Cabrera et al. 2002). The following section describes how all the instructional methods/strategies mentioned on this section are incorporated into web-based learning environment.

### *Phase 3: Incorporation of Specific Web-Based Learning Activities*

McCreanor (2000) proposes that web-based tools can be applied to provide an opportunity to significantly enhance face-to-face classroom learning. He incorporated the WebCT environment as a major source for educational materials in a senior level engineering course. He also delivered quizzes to students using CyberProf. Bannan and Mileheim (1997) states that web-based activities in a course design can be involved both on traditional forms of instructional activities and on unique forms of interpersonal exchange. Traditional forms of web-based activities include asynchronous instructional activities such as 'posting educational materials,' 'reading digital textbooks,' and 'watching course videos' through web technologies. On the other hand, synchronous online activities are considered unique web-based activities which usually happen through real-time interactions among students using cloud computing infrastructures.

In the estimating course, instruction delivery is supported by posting all course materials delivered to students on the interactive website, the Blackboard. The availability of course materials will enable the students to review the lecture contents anytime, anywhere. Online exercises, throughout the course, will be supported to enhance learning. The students either individually or in a group will be required to complete each online exercise within a limited timeframe. When the students have any questions or instructor's feedback is needed, they can interact with the instructor in real-time using synchronous communication channels such as instant messengers, e-mails, and Skype.

In terms of assessing student performance, the students will be required to take a quiz on the Blackboard, upon the completion of each lecture module, not only to help them self-assess but also provide feedback to the instructor. Furthermore, the students will be asked to complete and submit homework through the Blackboard. As homework incentives, the students can ask the instructor for review when it is completed before the due date. With the request, the instructor will provide quality feedback on the submitted homework. The students have the opportunity to resubmit the one corrected based on the instructor's feedback by the due date. From this process of completing homework, the instructor will be able to not only assess if the students understand what they need to know but also guide the students to self-motivated learning.

Throughout the course, the students will be advised to use a social networking site such as Ning, Facebook, or Twitter to openly share thoughts, viewpoints, and ideas relevant to the course topic with other students. The instructor will observe and manage all this site activities including discussion threads. Through this site, the students can also interact with the instructor asynchronously. One of the benefits of using the social networking site is that it preserves all posted questions and answers related to any particular issues or concerns raised during the course in the form of posted messages (Rajandran 2003). Therefore, it provides students with an interactive, active, and participatory learning environment in which they can explore or share other's opinions and thoughts. As a result, the students will improve their critical thinking by analyzing various ways to solve a problem. The incorporation of asynchronous discussion board into the course will also support collaborative learning.

## Conclusion

Mills (2006) defines three primary forms of web-enhanced learning as problem solving, inquiry and exploration, and collaborative learning. In this paper, the author emphasizes its use for both self-paced learning by posting educational materials on the interactive website and collaborative learning by supporting communication and exchange of information among students. Generally, in the web-enhanced course, students attend the face-to-face class but access the instructional materials via the web-based course delivery system used by the college, such as Blackboard and Moodle. The instructor employs online course documents, web-based discussions, and online exercises to enhance the instruction delivered by the face-to-face class. It is persuasive that web-enhanced learning extends teaching and learning beyond limited physical classrooms.

It is noteworthy, therefore, to use web-based technologies to support the classroom activities which would not be completed within limited classroom timeframe. After first obtaining conceptual knowledge from the lecture, students need to apply it into a new challenging situation to master the learned knowledge. However, students may not have an opportunity to complete the whole learning process, which means discussing and sharing their opinions

with peers, dealing with a new problem, having feedback from the instructor, correcting the answer, and having consistent feedback from the instructor. By and large, constructivist-based activities may not be effective within limited classroom timeframe. Cavanaugh (2005) describes that the constructivist-based approach requires much time and effort at student learning. With support of web-based technologies, students have more time to collaborate with their peers to construct knowledge through problem-solving tasks. Thus, both student-student and student-instructor interactions will be increased and be flexible beyond the physical learning environment.

The paper has discussed about how the web-based technologies can be applied to enhance student learning based on the understanding of learning theories and strategies. The incorporation of web-based technologies into the instruction will enable instructors to facilitate the collaborative learning among students, so that students have the opportunities to practice and improve the patterns of communication during learning. Moreover, in web-enhanced learning environments, student learning can be facilitated in constructing knowledge in self-paced. Further research will investigate how the web-enhanced instruction will increase student-student and student-instructor interactions and student participation in the learning environment. Thus, the effectiveness of web-enhanced learning environment can be evaluated based on student performance and their engagement.

## References

Bannan, B. & Milheim, W. D. (1997). Existing web-based instruction courses and their design. In Khan, B.H. (Ed), *Web-based instruction* (pp. 381-387). Englewood Cliffs, New Jersey: Educational Technology Publications.

Berger, K. A. & Topal, R. (2001). Technology to enhance learning: Use of web site platform in traditional classes and distance learning. *Marketing Education Review*, 11, 15-26.
Bork, A. (1996). Advantages of computer based learning. *Journal of Structured Learning*, 9 (1), 63-76.
Bransford, J. D., Brown, A. L., and Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Buckley, K. M. (2003). Evaluation of classroom-based, web-enhanced, and web-based distance learning nutrition courses for undergraduate nursing. *Journal of Nursing Education*, 42(8), 367-370.

Cabrera, A. F., Crissman, J. L., Bernal, E. M., Nora, A., Terenzini, P. T., & Pascarella, E. T. (2002). Collaborative learning: Its impact on college students' development and diversity. *Journal of College Student Development*, 43(1), 20-34.

Cavanaugh, J. (2005). Teaching online-a time comparison. *Online Journal of Distance Learning Administration*, 8(1). Retrieved from http://www.westga.edu/~distance/ojdla/spring81/cavanaugh81.htm

Chen, S. (2007). Instructional design strategies for intensive online courses: An objectivist-constructivist blended approach. *Journal of Interactive Online Learning*, 6(1), 72-85.
Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research*, 53(4), 445-459.
Gagné, R. M. (1985). *The conditions of learning and theory of instruction*, 4th Edition. New York: Harcourt Brace College Publishers.

Grabowski, B. L., Koszalka, T. A., & McCarthy, M. (2000). *The web-enhanced learning environment strategies handbook and reflection tool*. College of Education, Pennsylvania State University. Retrieved from http://www.ed.psu.edu/nasa/welessite/weles.pdf

Johnson, D. W., & Jognson, R. T., & Smith, K. A. (1991). Cooperative learning: Increasing college faculty instructional productivity, *ASHE-ERIC Higher Education Report No.4*. Washington, DC: George Washington University, School of Education and Human Development.

Jonassen, D. H. (1991). Evaluating constructivistic learning. *Educational Technology*, 31(9), 29-33.
Jonassen, D.H. (1992). Objectivism verses constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development*, 39(3), 5-14.

Leasure, A. R., Davis, L., & Thievon, S. L. (2000). Comparison of student outcomes and preferences in a traditional vs. world wide web-based baccalaureate nursing research course. *Journal of nursing education*, 39, 149-154.
McCreanor, P. T. (2000). Developing a web-enhanced course: A case study, *30th ASEE/IEEE Frontier in Education Conference*, Oct, Kansas City, MO.

Mills, S. C. (2006). *Using the internet for active teaching and learning*. New Jersey: Pearson Education.
Posner, G. J. (1995). *Analyzing the curriculum*. New York: McGraw-Hill, Inc.

Rajandran, V. (2003). A study investigating the impact of web-enhanced learning on student motivation. *CDTL Brief*, 6(9). Retrieved from http://www.cdtl.nus.edu.sg/brief/v6n9/sec3.asp

Schramm, W. (1977). *Big media, little media*. Beverly Hills, CA: SAGE.
Tam, M. (2000). Constructivism, instructional design, and technology: Implications for transforming distance learning. *Educational Technology and Society*, 3(2). Retrieved from http://www.ifets.info/journals/3_2/tam.pdf
Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunications*, 6(4), 339-362.

Weber, J. M. & Lennon, R. (2007). Multi-course comparison of traditional versus web-based course delivery system. *The Journal of Educators Online*, 4(2), 1-19.

Williams, W. M & Ceci, S. J. (1997). "How'm I doing?" Problems with student ratings of instructors and courses. *Change*, 29(5), 12-23.