Technology in the Civil Engineering Classroom: Introduction and Assessment

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Abstract

The introduction of innovative technologies into the civil engineering classroom is providing unprecedented opportunities to examine traditional educational methodologies. The development of video, multimedia, and advanced computer modelling technologies provides educators with the tools to diverge from the static arena of textbooks and enter the arena of interactive, hands-on education. However, the rapid evolution of these tools presents a potentially damaging impact to a civil engineering student's education. The rapid adoption of technology by educators as teaching aids is preempting a systematic assessment of the educational validity of these technologies within the civil engineering curriculum. In response to this trend toward rapid technology integration, this paper describes efforts currently underway at Georgia Tech to introduce and assess the impact of technology within a civil engineering classroom environment.

1.0 Introduction

In the traditional classroom experience, civil engineering students are exposed to topics ranging from water resources management to transportation to structural mechanics and design to construction over the course of an academic career. Students obtain in-depth knowledge and training in subjects such as construction scheduling and traffic management through a curriculum emphasizing specialization and narrow fields of expertise. In the traditional classroom setting, examples are often used to convey specific elements of a project such as a difficult structural problem or a complex cost estimating situation. However, these blackboard-based examples often have a distinctively artificial feeling. Specifically, blackboard-based examples fail to provide students with a project context in which to understand the information being provided. Furthermore, the examples tend to be oversimplified and thus fail to highlight the numerous interdisciplinary forces which influence an actual problem solution [1]. One potential solution to this fundamental educational issue being put forth by many engineering educators is the use of multimedia technologies in the classroom [2].

The rapid expansion of multimedia technology including CD-ROM, World Wide Web, and video technologies is providing engineering educators with unprecedented opportunities to break away from the traditional blackboard-based education paradigm. However, this rapid introduction of technology into the classroom is not being accompanied by an equivalent level of concern for the impact of these technologies on the educational experience of the students. Rather, the technology is being introduced with assumptions

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about the inherent value of multimedia for expanding the educational value of the civil engineering classroom. In response to this vacuum of educational study, a series of experiments are being implemented at the School of Civil and Environmental Engineering at Georgia Tech to introduce and assess multimedia technologies within traditional civil engineering curricula.

Specifically, the assessment project focuses on examining the impact of video and multimedia technology within the context of several civil engineering courses. The paper focuses on two principal components of the project; 1) the use of video as an innovative teaching aid to convey complex project management concepts, and 2) the use of assessment techniques to evaluate the impact of video technology on student retention. Together, these areas are intended to establish a methodology for educators to effectively introduce innovative teaching technologies and objectively evaluate the impact of these technologies on the overall classroom environment.

2.0 The Classroom Experiments

The development of a set of tests to evaluate the appropriateness of multimedia technologies in the civil engineering classroom must be approached with a series of realistic, not idealistic, goals. Specifically, any tests conducted must be evaluated for what they are, a representative sample of the civil engineering student population at a given place and at a given time. Similarly, any conclusions drawn from these tests must be evaluated with the same caveats. With an appropriate number of tests, and with the diverse student population at Georgia Tech, a realistic sample of civil engineering students is expected. Thus, a series of initial tests are developed to provide a baseline set of results from which further tests can be compared and contrasted to provide a well-rounded picture for the engineering educator. It is with this set of specific goals that the Georgia Tech tests are being approached; to provide educators with a well-founded starting point from which to further examine the impact of multimedia on the civil engineering curriculum.

The classroom tests have been developed to approach a series of questions over an extended period of time including; 1) What multimedia technologies appear to have the most promise, 2) What avenue of dissemination appears to have the greatest ability to reach the greatest number of students, 3) What curricular concepts are most conducive to multimedia support, and 4) What level of students can obtain the greatest benefit from multimedia technologies. To provide the greatest amount of data in response to these questions the following two test environments are being implemented over the next several quarters.

Undergraduate Structures

The fundamental understanding of structural concepts in the domain of reinforced concrete is essential to an undergraduate civil engineering student. Without a fundamental understanding of issues such as reinforcement, strength, and connections, a student will be ill-prepared to assume a professional position in the civil engineering profession. Thus, the authors have selected a junior-level reinforced concrete course to test the ability of video and multimedia to impact the retention of fundamental structural engineering concepts. In this test, students will be given the opportunity to view actual examples of reinforced concrete structural elements through the use of video clips digitized onto CD-ROM and also available via a World Wide Web (WWW) site. Examples will include video clips of concrete formwork, connections, reinforcement, and pouring with both good and bad results. Through the use of a laptop and portable projector, the authors will have the ability to utilize the clips at selected points throughout the course to reinforce hard to understand, essential, or visual concepts. The WWW site will allow the students to access this information as they study the material to better understand the contextual situations of the problems being studied. The key objective of the test is to compare and assess the retention and understanding by the students of the selected concepts with previous students taught by the authors in the same course who did not have the technology available during the course.

Graduate Project Management

Complementing the undergraduate structures test will be a similar activity in the field of project management. However, rather than focusing on the undergraduate level, the project management test will focus on the capability of multimedia tools to impact civil engineering education at the graduate level. Project management has been selected as the specific domain due to its emphasis on concepts such as interdisciplinary teamwork, project planning and control, and design negotiation, each of which are difficult for students to place in a real context without seeing actual jobsites. Thus, in an effort to augment the sparse number of opportunities students have to be in the field during the duration of a course, the test will provide the students with multimedia examples of actual job sites. Similar to the reinforced concrete test, the graduate students will be given the opportunity to view actual examples of construction job sites through the use of video clips digitized onto CD-ROM and a WWW site. Examples will include video clips of complex construction operations requiring advanced planning and design, site design illustrating scheduling concepts, and design components illustrating constructability issues. The authors will once again have the ability to utilize the clips at selected points throughout the course to reinforce hard to understand, essential, or visual concepts. The key objective is again to compare and assess the retention by the graduate students of the selected concepts with previous students taught by the authors in the same course.

3.0 The Material

The development of materials for a unique experiment, such as those being conducted within this study, requires a unique aspect on which to build fundamental examples. The 1996 Atlanta Olympic Games have provided this unique aspect for the multimedia tests. Specifically, the authors have spent the last 14 months gathering a diverse array of data from project participants associated with a cross section of the projects being developed for the Olympic Games. From large stadia to outdoor arenas to public parks, the authors have been videotaping both construction operations and interviews with project participants to create a video library of cases from which to extract the multimedia information necessary to conduct the educational experiments. Further, these facitilities present an interesting topic for an international audience.

For example, the Georgia Tech Aquatics Center represents an excellent example of a highly visible project which transcends the boundaries of civil engineering disciplines. From the structural engineering perspective, the Aquatics Center is a combination of a concrete grandstand with a steel truss supported, wide-span roof (Figure 1). The reinforced concrete components of the structure include both precast and cast-in-place elements constructed over a period of eight months. During this construction time, examples of connections, reinforcement, formwork, and concrete placement were collected and catalogued for the express purpose of supporting the education of civil engineering students. Similarly, the Aquatics Center provided excellent examples of project management due to its location in a confined area with limited laydown space and limited access. Additionally, issues of strict budgets and severe weather delays provided the authors with the opportunity to collect a diverse array of materials relevant to advanced project management concepts.

When combined with additional projects from around the city of Atlanta, each focused on the 1996 Olympic Games, the authors have a unique library of materials from which to extract multimedia examples.

Figure 1: Georgia Tech Aquatics Center Construction

4.0 Assessment Issues

The assessment issues focus around the four questions posed earlier in this paper. Specifically, the assessment desires to learn what forms of multimedia have the most promise for enabling the majority of students to learn engineering material. Furthermore, the results of the assessment should provide a set of guidelines for use by civil engineering faculty (and perhaps more generally for faculty in other engineering disciplines) as to when to effectively utilize various forms of multimedia in the education process.

The first form of the assessment concerns baseline studies. We have been documenting students' understandings of engineering issues in the above mentioned courses. We have been looking at the correct conceptions as well as the misconceptions found in the students. This baseline study has been taking place over the last year and to date includes approximately 150 students.

Beginning with winter quarter 1996, the next phase of assessment will commence. During this phase we will document the preferred methods of acquiring the multimedia materials (i.e. CD-ROM vs. a WWW site). These preferences will include both the subjective desires of the students as well as any educational benefits of the dissemination media. The tests will include assessment opportunities to determine the kinds of course content most appropriate to multimedia delivery / reference. The tests will be structured so that a variety of topic content classifications (mathematical formulation, experimental observations, building code usage, construction expertise, etc.) can be studied to see the impact of multimedia by topic area. During these studies, we will gather information about the students to see if there are certain experiences of the students which are conducive or disruptive to multimedia. Perhaps some students utilize this mechansim for learning more so than other kinds of students. Finally, we expect to determine how topics presented with multimedia are retained over a longer term (more than one quarter).

Through these studies, we expect to learn much more about the impact of multimedia delivery and content on engineering education.

5.0 Anticipated Results and Conclusions

As stated previously in this paper, the multimedia experiments are intended to provide a strong foundation from which the authors and others can continue to expand the use of multimedia in the classroom. However, rather than expanding with the sole purpose of being the first ones to incorporate multimedia as a central component of education, the authors espouse the introduction of multimedia through a planned and thoughtful process. Rather than using multimedia as a gimmick to keep the attention of students, multimedia should be introduced as another element in the educators palette of tools from which to choose. Multimedia is a powerful and visual medium. Educators run the risk of leaving students with the impression that the graphic, and not the concept, is the essence of a particular lesson if the multimedia components are not introduced properly. Furthermore, many possibilities exist whereby the students actually "learn" something from the multimedia material other than what the instructor intended and there are little or no information on what items students learn from these environments. Information overload is also possible if the multimedia material is not carefully planned and orchestrated within the educational context. The multimedia experiments introduced in this paper have been developed for the purpose of anticipating these possible detractions from the overall educational goals of a civil engineering educator and are being thoroughly planned to reduce the possibility of this outcome.

Therefore, the authors anticipate several key findings from this experiment in multimedia education as applied to civil engineering including:

1) A baseline measurement indicating the capability of multimedia to support the presentation of complex classroom concepts;
2) A set of positive and negative guidelines for introducing multimedia and video into the civil engineering classroom and the differences required for graduate and undergraduate students; and,
3) A set of guidelines for continuing and expanding these tests both at Georgia Tech and in cooperation with other faculty, at civil engineering schools throughout the country.

The combination of these findings will provide the engineering education community with a valuable starting point from which to continue discussions and experiments focusing on the advancement of civil engineering education and the incorporation of advanced teaching tools into the civil engineering classroom.

References

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