AC 2010-518: USING VIDEO TECHNOLOGY TO EXTEND LEARNING STYLES IN A GEOTECHNICAL ENGINEERING LABORATORY

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Using Video Technology to Extend Learning Styles in a Geotechnical Engineering Laboratory

Abstract

This paper presents an update for an ongoing project that involves extensive use of video technology for classroom activities in a geotechnical engineering laboratory. Specifically, synchronous video conferencing between California Polytechnic State University (Primarily Undergraduate Institution) and Auburn University (Research-1 University) have been conducted. In addition, video productions have been assigned and completed by students in lieu of conventional written laboratory reports. These activities are conducted to develop new teaching methodologies and to investigate the pedagogical benefits of incorporating unconventional learning styles into teaching of geotechnical engineering laboratory courses. New experiments for the undergraduate laboratory have been developed as part of this project. Role-playing by students was included. Geotechnical competitions have been held between the universities incorporating synchronous video conferencing. Universally accessible archival videos are being produced. Opportunities, challenges, and strategies for implementing these teaching methodologies are described. Specifically, new activities and revised activities related to the project are described.

Introduction

Learning styles are categorized using six common systems: Meyers-Briggs Type Indicator (MBTI), The Kolb Learning Cycle, the Felder and Silverman’s Index of Learning Styles, the Herrmann Brain Dominance Instrument, the Dunn and Dunn Learning Styles Model, and Gardner’s Theory of Multiple Intelligences [Table 1].

<table>
<thead>
<tr>
<th>MBTI</th>
<th>Based on 4 preference dichotomies including: energy source (introversion vs. extraversion), perceiving mental process (sensing vs. intuition), judging mental process (thinking vs. feeling), and outside world orientation (judging vs. perceiving) resulting in 16 personality types.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolb Learning Cycle</td>
<td>Based on quadrants of 2 dimensions of perception (sensing/feeling vs. thinking) and 2 dimensions of processing (doing vs. watching).</td>
</tr>
<tr>
<td>Felder and Silverman’s Index of Learning Styles</td>
<td>Based on 5 dimensions of learning: perception (sensory vs. intuitive), input (visual vs. auditory), organization (inductive vs. deductive), processing (active vs. reflective), and understanding (sequential vs. global).</td>
</tr>
<tr>
<td>Herrmann Brain Dominance Instrument</td>
<td>Based on 4 quadrants of thinking preferences generally characterized as: i) mathematical, technical, logical, ii) organizational, planned, conservative, iii) interpersonal, emotional, spiritual, and iv) imaginative, conceptual, artistic</td>
</tr>
<tr>
<td>Dunn and Dunn Learning Styles Model</td>
<td>Multidimensional stimuli groups encompassing environmental, emotional, sociological, physiological, and psychological areas and 21 subcategories or elements that are ranked according to influence on individuals’ learning.</td>
</tr>
<tr>
<td>Gardner’s Theory of Multiple Intelligences</td>
<td>Based on 7 intelligences including: verbal/linguistic, logical/mathematical, visual/spatial, bodily-kinetic, musical, interpersonal, and intrapersonal.</td>
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</table>
Conventional geotechnical engineering teaching methods are based in technical and mathematical learning modes (as compared to personal and artistic learning modes). Enhancing the learning environment using hands-on activities and teamwork exercises (which are common in laboratory environments) is effective based on educational research. However, student learning occurs using a broad variety of learning styles, including feeling, personal, and artistic modes. For improving learning using learning different styles, novel use of technology has been demonstrated to be successful at further engaging engineering students⁷,⁸.

Development of professional skills and awareness of broad societal context for engineering projects are becoming increasingly important in civil engineering education⁹. Professional skills are typically not adequately included in classroom experiences in undergraduate geotechnical engineering coursework.

This project has been conducted to investigate the inclusion of advanced technology and inter-university collaborations to enhance teaching and learning in geotechnical engineering laboratory courses. Teaching methods incorporating novel use of video technology are being developed to promote students to incorporate a broader variety of learning styles than is typically used in conventional engineering laboratories. A collaboration was established between two universities in the U.S. for this collaboration: California Polytechnic State University and Auburn University. California Polytechnic State University is a predominantly undergraduate institution, while Auburn University is a Tier 1 research institution. The new teaching methodologies emphasize the use video technology (both video conferencing and video production).

This paper provides progress on this extensive investigation including a) new activities that have been conducted at the universities (teamwork activities and archiving of video modules), b) new activities that have occurred between the universities (video conferencing and sharing of student learning modules), and new assessment data. Some of the categories of activities reported have been conducted over multiple terms and modifications have been made to improve effectiveness of these new teaching methods. This paper presents the most recent versions of activities and provides context and justification for modifications that have been made in the teaching methods. A description of the exercises, assessment of the methodology, and suggestions for successful adoption of similar efforts are provided in this paper. Details of the broader scope of this project, including international collaboration aspects, are provided elsewhere¹⁰.

**Project Scope and New Features and Activities**

The project includes use of advanced video technology for inter-university collaboration; use of video technology for both teaching and learning in a laboratory setting; and incorporation of professional collaboration for specific classroom activities. The universities initiated this project to enhance student learning in geotechnical engineering. Specifically, these exercises were conducted to challenge students in new ways and broaden their fundamental skill sets including professional skills associated with communication and global awareness. These components, which are critical in the ASCE Body of Knowledge (BOK) and ABET Criteria, are generally difficult to integrate across the curriculum in conventional classroom environments. Interaction between the universities provided a novel approach for highlighting the importance of local
The advanced video technology used in the investigation included two main components: video conferencing and video production. Synchronous video conferencing was used for inter-university student interactions and inter-university guest lectures provided during the laboratory courses. Specific synchronous video-conferencing activities included: a) geotechnical sand castle competition, b) demonstration of Soils Magic, and c) analysis of inter-laboratory testing results. Video production was used to: a) document test procedures (i.e., produce a short film in lieu of a portion of a conventional written laboratory report), b) conduct role-playing as owners of a project and develop testing request to provide to the students at the partner university, c) demonstrate an aspect of soil mechanics using a visually dramatic simple experiment, or d) document advanced geotechnical testing capabilities at the university (beyond a level that would be typically included in the undergraduate geotechnical engineering laboratory course). Details of the activities are provided in Tables 2 and 3.

The configuration for the video conferencing equipment included a webcam at each participating laboratory classroom. Various software packages were used for the video-conferencing activities including Skype and Elluminate (for synchronous conferencing). Panopto and various video-editing packages (for archiving video modules) have been recently used in the project. For some synchronous video conference sessions, two LCD projectors were operated, one to display the slides for the presentation (previously downloaded file to achieve high resolution with images) and a second to display a full-screen image of the face(s) of the partners at the other university. The new video conference activities included a sand castle building competition that had strict rules for construction activities (e.g., only 3 people at a time could be speaking or touching the sand). The Soils Magic show was repeated with enhanced video and audio features (e.g., higher quality video camera, video camera on tripod, zoom used to document experimental details, high contrast background used for selected experiments, wireless microphone used for the presentation), to best document the test procedures. The inter-laboratory testing analysis involved comparison of testing procedures and test results for a given soil type. Role-playing was incorporated into this activity wherein the students were acting as cooperating, but separate testing laboratories contributing to a single, high-profile project.

For the video productions, student groups were each provided camcorders for use in the classroom as well as for outside the classroom for studio and field work. Facilities were available at both universities for video editing and production. Students were provided training in use the video editing equipment as needed. Students were responsible for video editing and production to complete an archival video of the assignment. Expectations for the final films were discussed in class prior to the taping and during the period while the students were completing production work on their videos. The new video production activities included videotaping test procedures with a refined scope from previous trials. A five-minute maximum duration for the final film was imposed in an effort to reduce the workload associated with this assignment at a manageable level for the students. The duration of video modules was shorter than previous terms in response to student comments related to the large time commitment of editing and production. The case history presentations were videotaped to archive the content and permit students to see themselves in a public speaking environment. The documentation of...
advanced testing procedures included presentations related to large-scale Marriotte bottle for constant head hydraulic conductivity testing, interface direct shear apparatus for geosynthetics, and rockfall analysis on natural terrain.

Table 2. Summary of Video-Conferencing Learning Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Student or Instructor</th>
<th>Summary of Activity</th>
<th>Status of Activity</th>
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<tbody>
<tr>
<td>Sand castle competition</td>
<td>Students</td>
<td>Conducted early in the term to allow student groups to meet each other in engaging and competitive activity. Involved construction of sand castle at each university with highly prescribed team dynamic rules for conduct during the construction.</td>
<td>New</td>
</tr>
<tr>
<td>Demonstration of Soils Magic Experiments</td>
<td>Instructor</td>
<td>A Soils Magic show was presented by synchronous video conference to demonstrate surprising aspects of soil behavior and provide descriptions of the underlying principles. Conducted near the end of the term so that students at the receiving university had sufficient technical background to understand the experiments and connection to soil mechanics from their course.</td>
<td>Repeated from previous trials using enhanced imaging for the video broadcast to best demonstrate the experimental details</td>
</tr>
<tr>
<td>Analysis of inter-laboratory testing results including role-playing</td>
<td>Students and Instructors</td>
<td>Testing of hydraulic conductivity of identical sand at 2 laboratories. Posting of results and discussion of inter-laboratory variability as well as inherent variability in engineering properties of soils. The students acted as a consulting / testing laboratory that were collaborating to provide results for a single, high-profile project.</td>
<td>Analysis of interlaboratory testing: new; role playing was repeated from previous trials incorporating higher degree of consistency on project selection and incorporated higher level of group-to-group discussions using video conferencing</td>
</tr>
<tr>
<td>Activity</td>
<td>Student or Instructor Content</td>
<td>Summary of Activity</td>
<td>Status of Activity</td>
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<tr>
<td>Document test procedures</td>
<td>Students</td>
<td>The films were expected to contain all relevant information as compared to the test procedures being presented in a typical written laboratory report. Students videotaped their test procedures during their normal laboratory sessions. The test procedures were not significantly affected by the videotaping. In some cases, students provided narration as to the steps involved in the test procedures.</td>
<td>Repeated from previous trials incorporating smaller scope of content for the video production (only test procedures instead of entire laboratory report content) and limiting duration of video module</td>
</tr>
<tr>
<td>Case History Research Project or Demonstrate aspect of soil mechanics</td>
<td>Students</td>
<td>For the case history research projects, students selected a given project and described the geotechnical background associated with the design and/or failure. The presentations were given live in class at XYZ University and videotaped for archive. For the experimental demonstrations of soil mechanics principles, students used experiments published as <em>Soils Magic</em> as guidelines for their activities. Students selected an experiment/demonstration, conducted and videotaped the experiments, described the equipment needed for the demonstration, described the relevant theory behind the soil behavior, and related the experiment to a real-world geotechnical application. This represents a scaled-down (and student-produced) version of the full <em>Soils Magic</em> show that was included in Table 2.</td>
<td>New</td>
</tr>
<tr>
<td>Document advanced geotechnical testing capabilities at university</td>
<td>Students</td>
<td>Students developed video learning modules associated with laboratory and field geotechnical testing that extended beyond typical coverage in the undergraduate laboratory course. Students described testing apparatus, procedures, and analysis of test results.</td>
<td>Repeated from previous term to include field testing and testing using recently acquired laboratory equipment and also sharing of video learning modules</td>
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</table>

Table 3. Summary of Video-Production Learning Activities
Results

Advanced video technology incorporated into the geotechnical engineering laboratory course broadened the scope and technical content of the course as well as allowed for inclusion of new teaching and learning styles. The technical benefits to the curriculum included: 1) development of new experiments for the geotechnical engineering laboratory, 2) drawing connection between theory, experiments, and actual geotechnical engineering projects, 3) establishing the importance of standardized testing methods and experimental variability, and 4) inclusion of higher level technical content related to geotechnical analysis and design. Pedagogical benefits included: 1) bringing use of advanced video technology into the classroom (both for conferencing and film productions), 2) promoting inter-university communications among students, 3) requiring students to use different learning styles in completing the assignments, and 4) requiring students to utilize unconventional communication and graphics modes in team settings.

The video conferencing sessions provided engaging additions to the laboratory learning environments. The project activities challenged students with entirely new learning modes currently not present in most engineering education environments. New team dynamics were apparent with video content associated with assignments. The video conferencing provided an opportunity to evaluate student performance in an unscripted interaction with their peers at another university. Specifically, the sand castle competition session (Figure 1) engaged the students and promoted team spirit for winning the competition. The soil mechanics principles associated with sand castles was discussed in relation to the activity. The winner of the competition was sent a school pennant of the losing team to hang in their laboratory for the duration of the term. This provided continuity to the term-long collaborative experience and a platform for friendly discussions during the future video conference meetings. The entire sand castle competition activity (including delivery of rules, construction, and judging) occurred over a duration of 30 minutes and resulted in strong camaraderie among the students. The Soils Magic show was highly successful when delivered remotely by video conference. The improved video/audio handling as compared to previous trials (e.g., zoom of experimental details, assuring high contrast for images, wireless microphone) improved the broadcast quality. The comparison and analysis of inter-laboratory testing results demonstrated the high level of variability in hydraulic conductivity testing of soils. The variation in hydraulic conductivity spanned approximately a half an order of magnitude. This set a foundation with firsthand testing experience for a meaningful discussion related to variability of soil properties, led by an instructor, using the students’ own data.

The video production activities provided opportunities for using different learning styles than either conventional laboratory sessions or the affiliated video conferencing sessions. Filming of the test procedures had specific benefits of increasing the level of attention to experimental detail, increasing accountability of contributions of individual team members (by virtue that their contributions were taped), and for the case of the research / case history presentations, an ability to allow students to view themselves in a public speaking environment. Keeping durations of films to a maximum of 5 minutes as well as prescribing a maximum duration for an individual video clip (15 seconds) within a video module kept the workload at a manageable level for the students while maintaining some requirement for editing and video processing. The final videos
that resulted were of generally higher quality than those completed before these prescribed limits.

Figure 1. Synchronous Video Conference during Sand Castle Building Competition (note the screen showing the other university to track real-time progress during the competition)

External assessment of the activities has been conducted through Arroyo Research Services (not affiliated with either partner university). Written or web-based surveys specific to project activities were distributed at the end of each term of that incorporated the new teaching methodologies. Assessment results below represent the most recent project results (Fall 2009). In addition, 5 focus groups of 4 students each were questioned (without the presence of an instructor) in November 2009. Participants of the focus groups were California Polytechnic State University students in the geotechnical engineering laboratory class who had participated in the video experiences during the semester. Students produced very similar findings across lab groups related to the video-enriched activities. These include:

- Students in every group reported that videotaping of experiments caused them to pay more attention to what they were doing in the experiment and to be more focused on what was happening during the experiment. They learned the “importance of documenting your work,” and also mentioned that, “it really made you learn the procedure.” Moreover,
students report that video documenting allowed better examination of errors and outliers, and that they found more sources of experiment error.

- Students took broad leeway in how they approached the video documented experiments, including one group that created a “falling head” song to accompany their presentation.
- Although students thought that their edited videos were more useful than the run-time videos produced by the Auburn University students, they didn’t see value in learning video editing skills within the course and would have preferred to have learned them in another setting.
- All noted that they spent significantly more time on the labs for which they produced edited video compared to non-videotaped labs.
- All students reported that this was their first time using interactive video for learning or in a professional setting.
- Students generally liked comparing their experiences with other students from Auburn University, and it helped them be more self-critical of their own lab procedures and approaches.
- Students recommended that video be used to create video introductions and lab instructions so class time could focus on concepts rather than procedures.
- Students also thought it would be valuable to view videos of student-run experiments from previous classes and to add to them as a part of their class experience.

Student comments about the learning experiences were generally favorable. When asked to rate the level of enjoyment (from 0 to 10) for the video conference (specifically the sand castle competition), students responded with an average rating of 7.8 (responses ranged from 0 to 10). When asked to rate level of enjoyment (from 0 to 10) for the video production (specifically the taping of test procedures), students responded with an average rating of 6.3 (responses ranged from 0 to 10). The zero ratings indicated that certain students were strongly against inclusion of video technology in the classroom. When asked to rate the level of agreement (from 1 to 5, where 5 represents strongly agree) with the following statement: “The course learning activities included some that appealed to my learning style”, students responded with an average rating of 3.7 (responses ranged from 1 to 5).

The distribution of numerical results for enjoyment of sand castle competition and associated video conference is presented graphically in Figure 2a. The distribution of numerical results for enjoyment of video production (video taping test procedures for compaction lab) is presented in Figure 2b. One group of students – Group 3 (a section of laboratory) had significantly higher ratings for all of the video activities than the other sections. This was attributed to timing (the section that had favorable ratings met in the morning, and the others in the late afternoon) as well as general personalities of the students. This group of students was generally much more enthusiastic about the classroom activities than the other sections.
Specific verbatim student comments related to these exercises are presented below.

Video Conference Experiences:
I thoroughly enjoy the idea of comparing our results with that of another lab in a different university. Since we see them interactively on-line, you really know that another lab actually did the same test.

Very interesting including Auburn University in the lab though I wish we could have done more with them directly.
Fun and worthwhile. Interesting to compare results and note similarities/differences in the way test was performed.

b) Video production (laboratory procedures by video)

Figure 2. Assessment Data for the Video Learning Experiences
All in all, the concept is great, but I’d love more interaction than just a Q & A session. So far it is a lot cooler than any other lab. It’s amazing simply that we can talk to them in real time. All said and done, that was a good time. Interesting to work with another lab group. Maybe more interaction between students? It’s something different. If it stays within the structure of the class, I would continue doing this.

Video Production Experiences:
As a visual learner, this was very helpful. Even though it’s a lot more work it is a very good way to pass on the information one learned. The video helped understand how detailed procedures are important. I was way more detail oriented, and overall I feel like I will remember these procedures for a long time. Normally, I forget the lab once it is over with. I think that because I had to spend so much more time doing this report, I learned the procedure backwards and forwards.

The new teaching methods described in this paper can provide critical insight and opportunity well suited to teaching the professional aspects of engineering education (e.g., teamwork, communication skills, global and societal context of problems) that are included in the ASCE BOK and ABET Criteria. These aspects have commonly been reported to be challenging to implement into engineering curricula\textsuperscript{12,13}. The new teaching methods provide an effective set of activities to bring professional aspects into the classroom naturally.

Specific challenges associated with this teaching methodology relate to logistics of conducting synchronous video-conferencing and student perception of workload for the associated assignments. Software and hardware configurations caused some challenges, but alignment of timing of the sessions across time zones and curricular schedule were more pronounced. The students found the video productions to be highly time consuming and this affected their interpretations of the value of these exercises. It appeared that in some laboratory sections, certain students were highly disinterested in the activities and this affected group dynamics for those groups containing these students.

**Recommendations and Future Implementation**

Based on student comments, it is evident that they are interested in having more interaction with students at different universities than what this project has provided to date. The team will build enhanced opportunities for small group interactions to address this desire by the students. A summary of recommended practices for successful video experiences in classroom settings are outlined in Table 3.

Baseline data have been obtained for the participating students’ predominant learning styles at both universities using Felder and Silverman’s Index of Learning Styles. This database will be used in conjunction with project results to evaluate impact of the newly developed teaching methodologies on various types of learners. In addition, within a specific type of learner (i.e., for a given student), the relative impact of the project on the effectiveness of their learning across different learning styles will be evaluated.
Table 3. Recommended Practices for Integrating Video Conferencing into Geotechnical Engineering Classes

<table>
<thead>
<tr>
<th>Recommended Practice</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorporate small group interactions with the video conference activities</td>
<td>Personalizes experience for students and encourages participation</td>
</tr>
<tr>
<td>Allow extra time for preparation of video production assignments</td>
<td>Students perceive that video work is not part of normal curriculum and a balance needs to be reached</td>
</tr>
<tr>
<td>Use external speakers for audio</td>
<td>Louder volume necessary for class environment</td>
</tr>
<tr>
<td>Limit the duration of clip used in film productions</td>
<td>Increases quality of final video production</td>
</tr>
</tbody>
</table>

**Summary and Conclusions**

Innovative teaching methods using advanced video technology that allow for collaboration between partner universities have been implemented and modified for improvement in subsequent trials in a geotechnical engineering laboratory course. The activities included video conferencing and video production. The technical benefits to the curriculum included: 1) development of new experiments for the geotechnical engineering laboratory, 2) drawing connection between theory, experiments, and actual geotechnical engineering projects, 3) establishing the importance of standardized testing methods and experimental variability, and 4) inclusion of higher level technical content related to geotechnical analysis and design.

Pedagogical benefits included: 1) bringing use of advanced video technology into the classroom (both for conferencing and film productions), 2) promoting inter-university communications among students, 3) requiring students to use different learning styles in completing the assignments, and 4) requiring students to utilize unconventional communication and graphics modes in team settings. The improvements largely related to assuring student engagement and keeping the focus on geotechnical aspects of the coursework and not the supplementary video technology.

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