AC 2011-2384: INCORPORATING VARIOUS LEARNING STYLES IN A GEOTECHNICAL ENGINEERING LABORATORY

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Incorporating Various Learning Styles in a Geotechnical Engineering Laboratory

Abstract

This paper is an update of an ongoing project involving extensive use of video technology for classroom activities in a geotechnical engineering laboratory course. In particular, synchronous video conferencing was conducted between California Polytechnic State University (Primarily Undergraduate Institution) and Auburn University (Research-1 Institution). Synchronous video conferencing was conducted between university classrooms and practitioners. In some cases, international partners (both practitioners and universities) were involved in the conferencing activities. Video productions were assigned and completed by students in lieu of conventional written laboratory reports. For selected assignments, graphics-only (i.e., no words) or audio-only documentation of laboratory experiences was required. All of the activities have been undertaken to investigate the pedagogical benefits of incorporating unconventional learning styles into teaching of geotechnical engineering laboratory courses. Assessment of these learning activities is presented. Opportunities, challenges, and strategies for implementing this teaching methodology are described.

Introduction and Background

This project was conducted to develop new teaching methodologies that emphasize unconventional learning styles for an engineering laboratory environment as well as to incorporate technology for enhancing communications in classroom settings. The project includes assessment of methods for enhancing teaching and learning in geotechnical engineering laboratory courses. Teaching methods incorporating novel use of video technology are being developed to promote learning by stimulating a broader variety of learning styles than is typically used in conventional engineering laboratories. Learning-style-specific assignments have been developed and assessed. A collaboration was established between two U.S. universities for this project: California Polytechnic State University (Cal Poly) and Auburn University (Auburn). Cal Poly is a predominantly undergraduate institution, while Auburn is a Tier 1 research institution.

This paper provides progress on this extensive investigation including a) recent activities that have been conducted at the universities, b) recent activities that have occurred between the universities and other project partners, and c) overview of assessment methods and 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 also provided.

Recent Project Activities and Developments

Recent advances on the project have included in-class interactions with practitioners, incorporation of learning-style-specific (e.g., audio-only) format requirements for laboratory assignments, development of inter-university competitions based on laboratory experiments, incorporation of new technology, and expansion of film production in lieu of written laboratory reports. In addition, new project assessment has been conducted using various techniques including peer evaluation, correlation of student work with learning-style-specific activities, and small break-out video-conference focus groups of students with an external evaluator.

In-Class Interaction using Video Conferencing

Video conferencing has been used extensively in this project. Synchronous video conferencing has been used for university-university communications, university-practitioner experiences, and assessment activities. International experiences have been integrated into the scope of the project at both partner universities including international university-university as well as university-practitioner interactions.

Internet-based synchronous video conferencing was conducted between university partners. Exercises were developed to provide meaningful and stimulating interactions. The interactions have included role-playing (e.g., client assigning work to the partner university); sharing, comparing, and discussing variability in experimental test data; sharing of visually intensive soil mechanics demonstrations (e.g., Soils Magic Show[1, 2]); sharing of experimental test procedures using unique testing equipment; and providing laboratory and local geologic tours.

Both Cal Poly and Auburn have had remote interactions with practitioners in the laboratory classroom. At Auburn, a deep foundation consultant provided a guest lecture to the class using internet-based video conference. The focus of the video conference was on professionalism and professional practice, topics not commonly included in undergraduate curricula. The practitioner provided coverage of practices related to client development, work procedures including subcontracting, and avoidance of liability. Litigation, an important part of geotechnical practice, was covered with special emphasis on avoidance. The students were highly interested and engaged. Student interest was piqued by guest lecture. The audio aspect of the technology used allowed the students to ask questions to the practitioner at various times. The importance of written and oral communication was emphasized, with examples from professional practice. At the end, the practitioner allowed open discussion of geotechnical engineering. Subsequent laboratory and classroom reviews of the remote seminar indicated that the students enjoyed the experience, and the lecture by the practitioner brought out additional insights on professional practice.

At Cal Poly, interaction with a practitioner from Japan took place via internet-based video conference. This session was conducted in a similar format as previous years in the project, which has been described in detail elsewhere.[3, 4] The experience included a guest lecture via video conference on rockfall analysis, a related laboratory experiment related to rockfall, a design problem related to rockfall barrier specifications (both length and energy absorption level of barrier), breakout sessions for discussion between the practitioner and small groups of students, and production of a written laboratory report that was shared with the engineers at the Japanese consulting firm. For the design problem, the students used the theory introduced during the guest lecture together with test results from coefficient of restitution and rock rolling experiments. The breakout sessions were conducted after the guest lecture, wherein student groups visited various stations to complete the laboratory.

As a new development this year, the assignment contained test procedures documented as figures (with very limited text). This format of test procedures forced students to incorporate a predominantly visual learning style into the assignment and had an added benefit of providing a document that could be shared with a broad audience at the foreign office without requirements for translation.

Learning-Style-Specific Assignments

During the past year portions of assignments that were specific to individual learning styles have been incorporated to course content. Two examples include solely audio components and solely graphical components for laboratory reports.

For the audio assignments, students were required to record a summary of test procedures (replacing the conventional written summary). The students from Cal Poly and Auburn exchanged the audio recordings and assessed the effectiveness of both their own group's recording and at least one selected recording from the other university. A rubric was provided to the students to rate the technical as well as audio clarity in the recordings. The groups evaluated whether standardized testing procedures (e.g., ASTM) were followed based on the recorded summaries. A variety of formats were used for the audio files (ranging from video files without images to smartphone voice recordings). The grain size distribution exercise was selected because its procedure is relatively straightforward to describe without images. Most audio clips presented by the students were approximately four minutes in duration. Additional experiments with more complicated procedures will be used for future audio assignments.

For the graphical assignments, students were required to present the Test Procedures portion of laboratory reports using only graphics. Some students chose to make detailed computerized drafting representations, while others chose less formal cartoon strip formats. Examples of student work for the graphical assignments are presented in Figures 1-4. These exercises required students to capture the essence of the testing procedures without the extensive use of words. A portion of the students delivered high quality graphical representations of the procedures, indicating that they were engaged by the required presentation format.

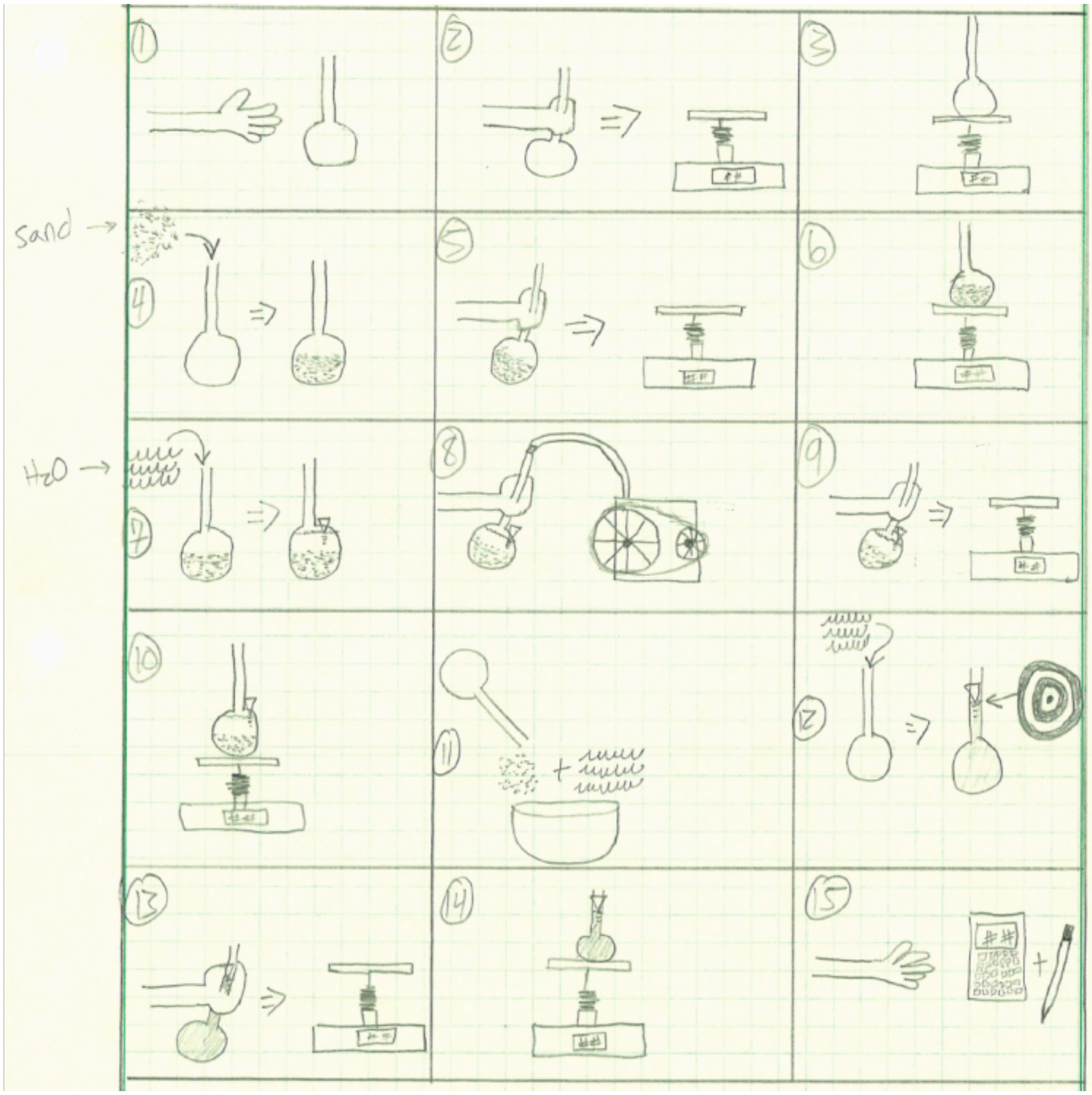

Figure 1. Example of graphics-only experimental test procedures for specific gravity test

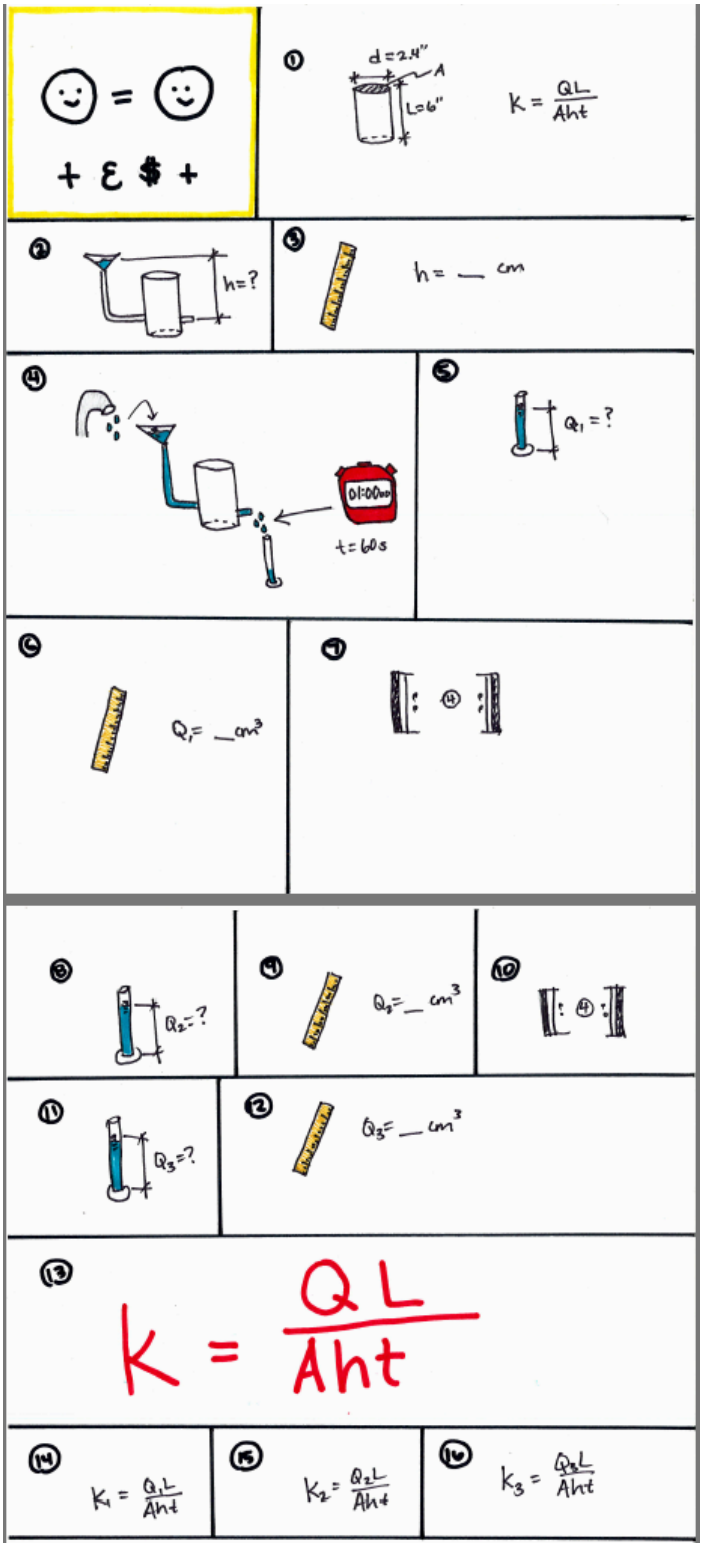

Figure 2. Example of graphics-only experimental test procedures for constant head hydraulic conductivity test

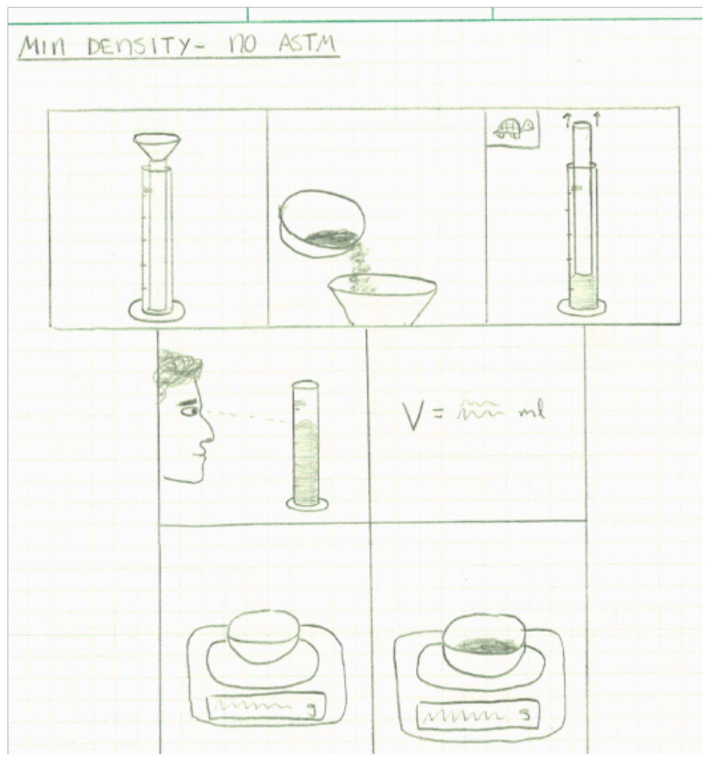

Figure 3. Example of graphics-only test procedures for minimum dry density test

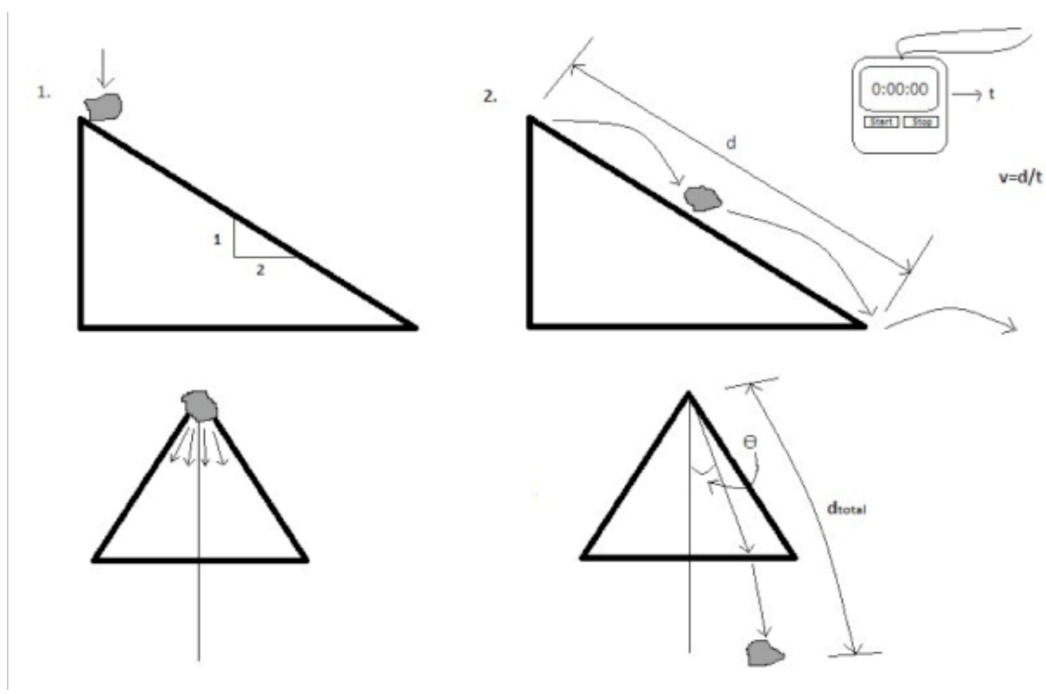

Figure 4. Example of graphics-only test procedures for rock rolling tests

Inter-University Competitions
New student competitions were developed as part of the project in the past year. The new competitions included minimum/maximum dry density and prediction of flow though a scaled model seepage tank. For the density experiments, identical soil samples were distributed to students at both universities. The students performed their typical laboratory exercises to determine specific gravity, and minimum and maximum dry density. The competition included obtaining the lowest minimum dry density for the given soil. Factors affecting the results of the competition included operator variability, testing set-up, and any level of vibration.

For the seepage tank competition, a video was prepared at Auburn describing the operation and dimensions of a scaled physical model of a sheetpile cutoff wall. The tank was filled with a sand soil that was shared between the universities. Each university classroom determined the hydraulic properties of the sand using their own experimental apparatus. Then, the student groups predicted flow rates by constructing flownets. The students at Auburn constructed flownets manually whereas the students at Cal Poly constructed flownets with the assistance of software (FEHT). Students produced videos of the entire laboratory experience and shared these videos.

The winning team for the competitions received a university pennant from the other school. With one of the universities highly ranked nationally in football, the dynamic between the classrooms was enhanced to include colloquial interactions with extra pride and humorous anecdotes. Kudos and a prize were graciously awarded by the losing team, in their video-based concession speech. Also, vengeance was sworn.

Incorporation of New Technology
In addition to video conferencing, video recording, and use of editing equipment, new technologies including smartphones and iPads were introduced to classroom activities in the past year. The smartphones were used for making audio and video recordings if students selected using these instead of digital camcorders provided in the classroom as part of the project. Allowing students to use their own phones has proven beneficial for efficient file management with good knowledge of equipment. In addition, students appear to enjoy using their own hardware and demonstrating features to other students that do not have their own smartphones. The use of iPads was incorporated during fall term of 2010. The devices were provided to students for use in viewing other student work (i.e., sharing of videos between universities). The use of iPads has great potential for engaging students in a laboratory environment by providing access to simple and rapid data entry, file sharing, and individualized exploratory learning with instantaneous web searches during the laboratory session. The devices are sufficiently new and novel to provide quickly engage student interest based on curiosity at any use. In some cases, unexpected levels of engagement in course materials were observed (i.e., students that had not been engaged with other course exercises became highly involved with exercises utilizing iPads). However, the research team was challenged with developing meaningful experiences that use this technology in the laboratory learning experience.

Expansion of Film Productions
Production of films in lieu of conventional written laboratory reports has been a central component of this project. These exercises are described in detail in other publications.[4, 5, 6] A

photograph of students filming test procedures is presented in Figure 5. In the past year, the interactions included using video to provide an assignment from one school to another (seepage tank competition described above). In addition, the student films have been archived on university websites Occasional filtering of material to be posted was required in these assignments.

Figure 5. Students videotaping procedures for a geological mapping exercise

Project Assessment
Assessment of project activities has been conducted using a) peer evaluation of student work, b) the Felder-Silverman Learning Styles Index,[7] c) student surveys, d) focus group video conferences between students and an external assessment consultant, and e) analysis of student work products.

The assessment is designed to determine the overall effects of the new learning modes, as well as the extent to which these new learning modes have differential outcomes according to student learning styles, as predicted by Feldman.[7] The first stage of outcomes analysis examined whether project activities were having a differential impact on students by learning style. Bivariate correlations and Analysis of Variance (ANOVA)[8] indicated significant correlations among specific project activities and discrete Learning Styles, e.g. a statistically significant ($p < .05$) positive correlation between the Sensing-Intuitive Learning Style and creating digital videos, and statistically significant negative correlation ($p <.05$) between the Sequential Learning Style and interacting with remote professionals from different universities.

Additional preliminary data was obtained from focus groups conducted in a private room with no instructors present, both in person and via interactive video. This format, in itself, represents an innovative project development that has proven effective for acquiring assessment data from students. Students participated in assessment focus groups in small teams of 3-4 students. These groups were the same groups as those that had been used for multiple laboratory assignments during the term. While feedback has been used to refine the course experience, students report finding value in creating video and other alternative lab reports; they report that they change their approach to the lab, preparing more carefully when they have to teach the concepts involved, working more as a team, and paying closer attention to detail when performing the labs.

Determination of overall project outcomes, designed to test the effects of project activities on student learning goals, are in progress. Findings will be based on a non-equivalent group quasi-experimental design using analysis of student work via rubrics designed in accordance with Wiggins.[9] The analysis will compare student work produced using the instructional strategies outlined above to student work produced in other lab sections and previous course iterations.

Summary and Conclusions

This project is being conducted to evaluate the effects of incorporating unconventional learning styles into geotechnical engineering laboratory courses. The project includes synchronous video conferencing, production of films in lieu of conventional written laboratory reports, use of new technologies for communications and archiving experiences, development of learning-style specific assignments, inter-university competitions, interaction with practitioners, and international interactions. Assessment of the project has been conducted using various formats including small focus group sessions with an external consultant.

The teaching methods developed in this project have been demonstrated to be effective in broadening student learning experiences. The various project activities, systems, and modules developed in this investigation have affected students differently, depending on their own predominant learning style. These methods can be readily adapted for use in other disciplines and educational levels.

Acknowledgments

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