Bringing international practice to the geotechnical engineering classroom using video-conferencing

Rapprocher la pratique internationale de la géotechnique en classe utilisation de la vidéo-conférence

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ABSTRACT

This investigation was conducted to incorporate video-conferencing technology to permit international professional practitioner involvement into geotechnical engineering courses. The study was conducted as a collaboration between California Polytechnic State University (U.S.A.) and Nippon Koei Co., Ltd. (Japan). The initiative was originally established for the undergraduate Geotechnical Engineering Laboratory course and was expanded to include graduate level geotechnical engineering courses. Video conferencing was conducted between Nippon Koei offices and the classroom. The conferencing activities included a tour of laboratory facilities at the company and discussion of specific current geotechnical engineering projects. A laboratory and/or class assignment was developed for which Nippon Koei served as an external client. Students were required to submit their work to both the professor and the practitioner for review. Cross-cultural discussions at a professional level provided appreciation for standardized testing methods; the importance of research in civil engineering practice; inclusion of large-scale current case studies into classroom discussions; and differences in approaching design problems in different countries. The new teaching methodologies described in this paper (global video-conferencing with an international practitioner and practitioner review of assignments) are well suited for developing students' broad communication skills and providing global context for engineering problems. In addition, the methods have served well to expand technical content of courses related to analysis methodologies and instrumentation. Student evaluations indicated a high level of enjoyment and enhanced learning. Experiences, challenges, and opportunities associated with these teaching methodologies are described in the paper. Guidance is provided for successful implementation of such initiatives.

RÉSUMÉ

Cette enquête a été menée afin d'intégrer la technologie de vidéo-conférence afin de permettre la participation internationale et professionnelle en cours de l'ingénierie géotechnique. L'étude a été menée en collaboration entre California Polytechnic State University (USA) et Nippon Koei Co., Ltd (Japon). L'initiative a été créée au début pour le cours au premier cycle intitulé Geotechnical Engineering Laboratory et après elle a été élargie pour inclure des cours en études supérieures en génie géotechnique. La vidéo-conférence a été menée entre les bureaux de Nippon Koei et la salle de classe. Les activités de la conférence comprenait une visite des installations de laboratoire au sein de la compagnie et la discussion des projets de génie géotechnique en cours. Un laboratoire et / ou devoir de classe qui a été développé dont Nippon Koei a servi comme client externe. Les étudiants sont tenus de présenter pour examen leur travail au professeur et au praticien en même temps. Des discussions inter-culturelles au niveau professionnel ont mené à une appréciation des méthodes d'essai standardisées, l'importance de la recherche dans la pratique du génie civil, l'inclusion à grande échelle en cours d'études de cas dans les discussions en classe et les différences dans l'approche de problèmes de conception dans différents pays. Les nouvelles méthodes d'enseignement décrites dans ce document (vidéo-conférences mondiales avec un praticien international et l'examen pratique des devoirs) sont bien adaptées pour le développement des aptitudes à la communication chez les étudiants et pour fournir un encadrement mondial des problèmes d'ingénierie. En outre, les méthodes ont bien servi à développer le contenu technique des cours liés aux méthodes d'analyse et de l'instrumentation. Les évaluations du cours ont indiqué un niveau élevé de plaisir et de l'apprentissage de la part des étudiants. Les expériences, les défis et les possibilités associés à ces méthodes d'enseignement sont décrits dans le document. Des indications pour la réussite de la mise en œuvre de ces initiatives y sont également fournies.

Keywords: Education, Video-Conference, Practitioner, Pedagogy, Teaching, Learning

1 INTRODUCTION

Conventional geotechnical engineering teaching methods include a one-way lecture presentation directed at students with low participation from students. Conventional geotechnical engineering laboratory courses have similar attributes, but incorporate enhanced teaching and learning styles with hands-on experiments and work in teams. Various systems have been developed to describe teaching and learning styles (summarized in Hanson and Kuraoka 2008). A common general distinction is made in the different systems between technical, detailed, or mathematical modes and feeling, artistic, or personal modes of teaching and learning. While the systems vary in terminology and origin of categories, common traits exist in the learning style identified for the majority of engineering faculty. This learning style is then reflected in the teaching style of the faculty and leads to predominance of a single teaching style (exclusively technical and mathematical modes) for much of engineering curricula. However, student learning occurs across a broad variety of learning styles.

Educational research indicates that active student participation in the classroom experience is beneficial to learning effectiveness. Novel use of technology has been demonstrated to be highly successful at engaging engineering students (e.g., Klosky et al. 2005). Development of professional skills and awareness of broad societal context for

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engineering projects are becoming increasingly important in civil engineering education (Bowman and Farr 2000). Professional perspectives are typically not adequately included in classroom experiences in upper level undergraduate and graduate geotechnical engineering coursework.

This investigation was conducted to incorporate advanced technology and an international professional practitioner into geotechnical engineering courses. A teaching method incorporating novel use of video conferencing was used. A collaboration was established between a university in the U.S.A. and an industrial partner in Japan. This paper provides an overview of the implementation of this teaching method, a description of the exercises, perceptions of stakeholders, and suggestions for successful adoption of similar efforts.

2 PROJECT DESCRIPTION

The project included use of video conferencing to include professional perspectives and active discourse in classroom settings. These teaching methods were applied to undergraduate level CE382 Geotechnical Engineering Laboratory and graduate level CE585 Slope Stability Analysis at California Polytechnic State University (Cal Poly), U.S.A. The industrial partner in this study was the civil engineering research and consultancy firm Nippon Koei Co., Ltd., Japan. The company employs approximately 700 technical specialists working on both domestic and international projects. While Nippon Koei is headquartered in Tokyo Japan with offices throughout the country, the firm maintains overseas offices in North African and East Asian countries.

Cal Poly 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.

Japan faces new challenges due to declining population, global warming, and aging infrastructure. These new challenges are not present only for Japan but also problematic for countries in Europe and North America. Nippon Koei is interested in helping develop new strategies to educate stakeholders and promote discussion related to these global problems. Nippon Koei recognizes that private companies need to take active role in promoting education in civil engineering, as it is vital to generate competitive young engineers who are needed in maintaining a sustainable society. Also, it is important to allow students and young engineers to experience contact with international organizations, as they face global civil engineering issues that require international collaboration. The technical staff at Nippon Koei believe that providing a connection to real projects allows students an opportunity to better understand the concepts and theories of geotechnical engineering as well as develop appreciation for the importance of laboratory testing techniques.

The video conferencing included a guest lecture and detailed description/assignment of a related laboratory exercise for CE382 and a follow-up assignment in CE585. Time was permitted for a formal presentation followed by discussion with the students. The industrial partner assigned a project for the students to complete over the following week. Synchronous video conferencing between Cal Poly and Nippon Koei was conducted in Fall 2007, Spring 2008, and Fall 2008.

The topic for the laboratory exercise in CE382 was rockfall analysis. Dr. Senro Kuraoka of Nippon Koei provided a lecture on a broad overview of the firm's activities and facilities, followed by a detailed description of rockfall analysis and mitigation strategies in Japan. Dr. Kuraoka presented examples of rockfall problems and design options for energy absorption (e.g., netting, fences, and berms). Details of large-scale research-grade experimental testing for determining coefficient of restitution and rockfall dynamics were presented (Fig. 1).

a) Case History of Rockfall Failure in Japan

b) Research-Grade Testing for Coefficient of Restitution

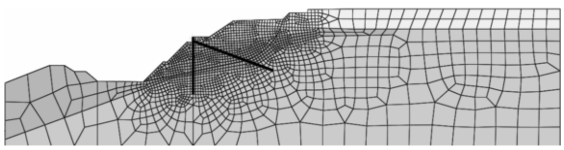
Fig. 1. Undergraduate Level Exercises

This activity represented an extension to an existing sequence of laboratory assignments written from a hypothetical client to a consulting firm (student teams) to request tests to be conducted and for test results and interpretation associated with a specific project (Hanson 1999). The assignments were provided to the students in business letter format (outlining the request for experimental testing) from Nippon Koei. Dr. Kuraoka described the specific request for test results during the video conference. This was similar to other assignments during the term with the exception that for this exercise a "real client" was associated with the project. The students knew that both the professor and the industrial partner would review their work.

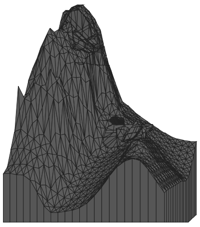
The topic for the lecture component of the graduate level CE585 was the use of ground anchors for excavations on slopes. Dr. Kuraoka presented numerous case histories that involved the use of sophisticated numerical modeling techniques including finite element analysis and distinct element method (Fig. 2). In addition, problematic soil conditions that included highly strain-softening behavior, were included in the presentations. The case histories presented the practical perspective as well as provided a framework for soil mechanics and slope stability that had been presented in class.

The configuration for the video conferencing equipment included a webcam at Nippon Koei and a webcam in the classroom. Widely available freeware was used for the internet-based video conferencing. In the classroom, 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 of the guest lecturer.

The video conferencing was repeated multiple times using different configurations. Due to technical difficulties with the video conferencing equipment and overall room configuration, unintended variables were introduced to the investigation. In one session, we lost the video portion of communication, but audio communication remained intact. In another session, the two screens were spread out a great distance at the front of the room.



a) Finite Element Analysis of Ground Anchors



b) Distinct Element Method Analysis of Rockfall

Fig. 2. Graduate Level Exercises

3 RESULTS

Inclusion of the video conferencing activities broadened the scope and technical content of each of the selected classes. The greatest fundamental benefit was demonstrating to the students that the theoretical soil mechanics being taught during the regular classes of the term has application to large-scale and real-world projects. The technical benefits to the curriculum included: 1) development of a new experiment for the geotechnical engineering laboratory, 2) drawing connection between theory and case histories, 3) analysis of complex problems that are excessively sophisticated for typical classroom assignments, 4) conceptual coverage of the application of advanced numerical techniques and probabilistic analyses, 5) establishing the importance of standardized testing methods and scale of experiments, and 6) addition of design project in the laboratory session. Pedagogical benefits included: 1) highlighting importance of the global engineering community, 2) bringing use of technology into the classroom (both for conferencing and taping of experiments), 3) technical, yet casual interaction with a practicing professional, and 4) higher level technical content related to geotechnical analysis and design and incorporation of different learning styles.

The participation of Nippon Koei in the classroom led directly to the development of a new experiment to be included in CE382 – analysis of rockfall. Rockfall had not previously been included as a topic in the laboratory course, yet was well suited to provide a hands-on experiment related to a subject of particular local interest in California. The exercise involved the determination of the coefficient of restitution of rocks falling from various heights onto different surfaces. The analysis involved imaging technology and basic physics concepts. The students recognized that the test procedures were scaled down in comparison to what was being conducted in Japan for consulting and research purposes. The images of the experiments were recorded using digital camcorders to characterize shape of rocks and rebound behavior in experimental tests. Students enjoyed using the camcorders during the laboratory session. The physics concepts in the assignment related to trajectory motion and coefficient of restitution, which provided a specific opportunity to evaluate students' retention of these concepts from previous courses.

The video conferencing modules provided engaging additions to both laboratory and lecture learning environments. The project activities challenged students with entirely new learning modes currently not present in most engineering education environments. The video conferencing provided an opportunity to evaluate student performance in an unscripted interaction with a senior practitioner. A video image of the entire class was being broadcast to the industrial partner. The pressure of being taped kept students generally alert for the presentation. Discussion at the end of the formal presentation provided an opportunity to evaluate students' oral communication skills (e.g., asking questions to the practitioner). Questions from the students at the end of the video conference included both technical aspects of the subject as well as broader and relatively non-technical issues related to comparisons between working experiences in the U.S.A. and Japan. The overall level of engagement and level and scope of questioning was noticeably higher during the sessions that included working audio and video networking compared to the session that had only audio communication. In addition, the presence of dual projectors was determined to be a critical component of successful implementation of this method. Being able to view both the presenter and the technical material duplicated the experience of attending an in-person presentation. The connection between the live speaker and the slide presentation was somewhat weakened in the trial that had the two screens spread out at the front of the classroom. These results are generally consistent with the findings of Pullen (2001), who reported that distance learning activities containing live video are most effective.

A summary of recommended practices for successful experiences are outlined in Table 2.

Table 2. Recommended Practices for Integrating Video Conferencing into Geotechnical Engineering Classes

Recommended Practice	Comments
Use 2 closely-spaced projectors: 1 for slide presentation and 1 for live video-feed	Clarity and size of images is enhanced with 2 projectors
Use audio and video, not just audio	Students were noticably more engaged when interacting with the image of presenter and seeing his expressions
Plan a subject that permits an experiment to directly relate to a real project that is described by a practitioner	Strong connection develops student appreciation for testing methods
Use external speakers for audio	Louder volume necessary for class environment
Use flexible and portable webcam	Student questions can be personalized with image of single student by moving camera around room

The teaching methods used in this study involving video conferencing and video recording support a recommendation by Felder et al. (2002) to "teach around the cycle". Such teaching employs a variety of styles that develops whole brain thinking skills (Lumsdaine and Lumsdaine 1995). The combination of factors needed for completion of the associated assignments (i.e., interaction with practitioners and professionals in a classroom setting, global perspective of engineering problems, and design) challenged students in new ways and broadened their fundamental skill sets, especially with professional skills such as communication and global awareness.

Nippon Koei Co., Ltd. had positive experiences with live video-conferencing with the classroom. Nippon Koei did not directly use the students' results as the level of experimentation conducted by undergraduates in one hour was simplified in comparison to the large-scale research-grade coefficient of restitution testing conducted at the company for consulting projects. The video conferencing activity provided exposure of the multinational company to American students and provided opportunity for junior Nippon Koei engineers to review student work. Video conferencing also provided international exposure for Nippon Koei's projects and facilities. It was particularly interesting to have open discussions between the students and the practitioner after the formal presentation. The industrial partner was highly interested in students' inquiries about employment opportunities and internships at Nippon Koei.

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, students responded with an average rating of 9.13 (responses ranged from 7 to 10). When asked to rate the level of agreement (from 1 to 5, where 5 represents strongly agree) with the following statement: "Interacting with professionals from different institutions via video conference enhanced the learning experience", students responded with an average rating of 4.53 (responses ranged from 4 to 5). Specific verbatim student comments related to these exercises are presented below:

The Japanese teleconference was interesting and added to the general knowledge and breadth of the topic.
Topic of rockfall and collaboration is interesting.
The video connection was well worth it, I recommend keeping it.
Enjoyed/appreciated effort of live Japan feed.
Live video conference is cool because we see how our material taught in class is applied in the real world.
It's nice to get a real life perspective of the application of techniques we learn in class.
Good insight not just into the topics but what it's like to be a professional.
I think an industry perspective provides a deeper understanding of ground improvement.
These kinds of presentations need to occur more often in upper division civil engineering courses.
The Tokyo presentation was really cool and reinforced the notion of "global engineering" and how important these relationships are.

The authors plan to further integrate this teaching method into the curriculum to further incorporate the depth and breadth of the inherent underlying pedagogical benefits. This method 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, ABET Criteria, and the International Technology Education Association's Standards for Technological Literacy: Content for the Study of Technology. These aspects have commonly been reported to be challenging to implement into engineering curricula (Gorham et al. 2003, Shuman et al. 2005). The teaching methods described in this paper support broad curricular efforts to provide pedagogies of engagement (Smith et al. 2005), preparing students who have highly adaptive skills for rapidly changing environments (Bransford 2007), and supporting the notion that academia is a center of innovation, creativity, and energetic activities (Katehi and Ross 2007).

4 SUMMARY AND CONCLUSIONS

An innovative teaching method using synchronous video conferencing with an international industrial partner (located in Japan) was implemented at California Polytechnic State University (U.S.A.). The main benefits of the innovative teaching method included broadening the scope and scale of problems considered in laboratory and lecture settings while directly including professional skills (e.g., communication) in the curriculum. The technical benefits to the curriculum included: 1) development of a new experiment for the geotechnical engineering laboratory, 2) drawing connection between theory and case histories, 3) analysis of complex problems that are much too sophisticated for typical classroom assignments, 4) conceptual coverage of the application of advanced numerical techniques and probabilistic analyses, 5) establishing the importance of standardized testing methods and scale of experiments, and 6) addition of design project in the laboratory session. Pedagogical benefits included: 1) bringing use of technology into the classroom (both for conferencing and taping of experiments), 2) highlighting importance of the global engineering community, 3) technical, yet casual interaction with a practicing professional, and 4) higher level technical content related to geotechnical analysis and design and incorporation of different learning styles. This teaching method has promise for broader integration into engineering curricula to provide enhanced teaching and learning.

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