AC 2008-1531: INTERNATIONAL COLLABORATION FOR GEOTECHNICAL ENGINEERING LABORATORY EXERCISES

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Abstract

The project described in this paper is a collaborative effort between California Polytechnic State University and Nippon Koei Co., Ltd. based in Tokyo, Japan. The collaboration was established for the Geotechnical Engineering Laboratory course at the University. Video and telephone conferencing were 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 assignment was developed for which Nippon Koei served as an external client. The client requested geotechnical testing to be completed by a consulting firm that consisted of the students. Students were required to reply to the client using an unconventional laboratory report format that included written and video components. The students were observed to be more careful with experimental procedures when videotaping themselves during testing than conducting tests in a conventional laboratory session. Cross-cultural discussions at a professional level provided appreciation for standardized testing methods, the importance of research in civil engineering practice, and differences in approaching design problems in different countries. Reports submitted to an external client provided incentive for strong student performance. The new teaching methodologies described in this paper (global video-conferencing with an overseas practitioner and development of laboratory assignments as short films) are well suited for teaching softer aspects of the BOK related to development of broad communication skills and providing global context for engineering problems. Experiences, challenges, and opportunities associated with this teaching methodologies are described in the paper. Description of formal assessment plans is also provided in the paper.

Introduction and Background

A teaching method incorporating novel use of video conferencing and video production of laboratory reports was investigated. The methods were applied to undergraduate CE382 Geotechnical Engineering Laboratory at California Polytechnic State University. Video conferencing was conducted with a Japanese consultancy/research firm (industrial partner) in association with a new topic for this course. 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. Preparation of laboratory reports as a video production was also investigated in this class. In lieu of submitting a written report, teams were required to produce a film that contained all the typical components of a laboratory report in this new media. This paper provides an overview of the pedagogical rationale for implementing this teaching method, a description of the exercises and student perceptions, suggested modifications for improvement and suggested methods for implementation of similar efforts, and a framework for formal assessment of the further development of these methods.

Effectiveness at learning has been correlated to the alignment of a student's predominant learning style and the predominant teaching style. Various systems have been developed to describe learning styles. Learning styles are categorized using six common systems: Meyers-Briggs Type Indicator (MBTI)[1], The Kolb Learning Cycle[2], the Felder and Silverman's Index of Learning Styles[3], the Herrmann Brain Dominance Instrument[4], the Dunn and Dunn Learning Styles Model[5], and Gardner's Theory of Multiple Intelligences[6] [Table 1].

Table 1. Summary of Learning Style Systems

MBTI	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.
Kolb Learning Cycle	Based on quadrants of 2 dimensions of perception (sensing/feeling vs. thinking) and 2 dimensions of processing (doing vs. watching).
Felder and Silverman's Index of Learning Styles	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).
Herrmann Brain Dominance Instrument	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
Dunn and Dunn Learning Styles Model	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.
Gardner's Theory of Multiple Intelligences	Based on 7 intelligences including: verbal/linguistic, logical/mathematical, visual/spatial, bodily-kinetic, musical, interpersonal, and intrapersonal.

A common general distinction is made between technical, detailed, or mathematical modes of learning and feeling, artistic, or personal modes of learning using all the different systems. 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 for much of engineering curricula. Engineering is generally taught using exclusively technical and mathematical modes. However, student learning occurs using a broad variety of learning styles.

Novel use of technology has been demonstrated to be extremely successful at engaging undergraduate engineering students. As an example, Klosky et al.[7] integrated instant messaging into assisting students outside of class. They determined the use of this unconventional mode of communication between student and professor to be highly effective as students use instant messaging daily. While this study demonstrates that students are receptive to embracing the integration of web-based technology into the learning experience, the use of instant messaging does not directly challenge the students as a mode of communication.

This investigation was conducted to improve student learning of geotechnical engineering curricula by providing broad-based learning exercises (including methods that draw from independent and unconventional learning styles). The methods included challenging uses of student-friendly technology (digital camcorders and video editing stations) and triggered student interest by challenging them with high-level technical tasks that were not directly related to the coursework, but necessary for completing the associated assignment. The combination of factors needed for completion of the associated assignments (i.e., unconventional learning modes, extensive and expert use of electronic technologies, interaction with practitioners and professionals in a classroom setting, and global perspective of engineering problems) challenged students in new ways and broadened their fundamental skill sets, especially with softer skills associated with communication, teamwork, and global awareness. These components, which are critical in the BOK and ABET Criteria, are difficult to integrate across the curriculum. This paper describes two separate teaching methods, both related to video content, that promote such integration.

Teaching Methodologies

The new teaching methodologies included two components: video conferencing and video production. The methods were applied in cooperation with an industrial partner who contributed to both the teaching and the assessment of student performance.

Video Conferencing

Video conferencing between a laboratory classroom and an industrial partner located overseas was conducted. The video conferencing permitted an opportunity for a specialized guest lecture and detailed description/assignment of a related laboratory exercise. The addition of video conferencing provided multiple pedagogical benefits including international exposure for the classroom, interaction with a practitioner, and expanded technical content for the course.

Video Format for Laboratory Report

Another aspect of this learning initiative was the required completion of laboratory assignments as film productions instead of written reports. A maximum duration of 10 min. was enforced for the films to promote concise productions and to keep workload reasonable. Students were required to document laboratory testing procedures on video, provide summary and analysis of results in video format, and finally produce film that compiled this information. The films were expected to contain all relevant information in a typical written laboratory report. The addition of video production provided pedagogical benefits of requiring students to use different learning styles in completing the assignment and requiring students to utilize unconventional communication and graphics modes in team settings.

Project Description

Industrial Partner

The industrial partner in this study was the Japanese civil engineering research and consultancy firm Nippon Koei Co., Ltd. The company employs approximately 700 technical specialists working on both domestic and overseas projects. While Nippon Koei headquarters is in Tokyo Japan, the consultancy/research firm maintains overseas offices in North African and East Asian countries. Japan faces new challenges due to declining population, global warming, and aging infrastructure at the onset of the 21st century. These new challenges are not present only for Japan but also problematic for the 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 engineers 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 and develop appreciation for the importance of laboratory testing techniques.

Experiences to Date

Synchronous video conferencing between the geotechnical engineering laboratory at California Polytechnic State University and Nippon Koei Co., Ltd. was conducted in Fall 2007. The configuration for the video conferencing equipment included a webcam at Nippon Koei and a webcam in the classroom laboratory. 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 the face of the guest lecturer. The equipment configuration generally worked well for the activity.

The topic for the laboratory exercise was rockfall analysis. Dr. Senro Kuraoka of Nippon Koei who is an expert in rockfall analysis provided a lecture, which included a broad overview of the company'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 also presented.

The interaction with Nippon Koei 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. The topic was well suited for the course as rockfall provided an experiment related to an exciting and dramatic subject that involved imaging technology and basic physics concepts. The exercise involved the determination of the coefficient of restitution of rocks falling from various heights onto different surfaces. 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 included in the assignment related to trajectory motion and coefficient of restitution. This aspect provided a specific opportunity to evaluate students' retention of these concepts from previous courses.

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.[8] 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 video conferencing was repeated for a second section of the laboratory course later in the same week. Due to technical difficulties with the video conferencing equipment, an unintended variable was introduced to the investigation. The overall configuration of the equipment remained the same, but we lost the video portion of communication on the second day. Audio communication remained intact.

Digital camcorders were used by the students to record experimental test procedures in the laboratory sessions as well as to prepare the remainder their video reports. Separate filming sessions were held outside of class to describe data, analysis, results, interpretation, and design implications for the associated assignment. Editing of the films was conducted at the University's Media Distribution Services Office. Training for using editing stations was provided by campus staff. The equipment allowed complete editing capabilities for sound (e.g., voice-over, background music) and images (e.g., speed of video footage, importing graphics).

Results

Both the video conferencing and the video production modules provided engaging additions to a laboratory learning environment. 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' discussion 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 US and Japan. The overall level of engagement and level and scope of questioning was noticeably higher during the first section of the class (that included video) compared to the second section (that had only audio communication). The focus on the entire presentation was at a higher level and the discussion that followed was much more interactive. In addition, the presence of dual projectors was determined to be as 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. These results are consistent with the findings of Pullen[9], who reported that distance learning activities that contain live video are most effective.

The final video modules submitted by the students were generally creative and well produced overall. Benefits from the video production experience include enhanced learning, increased requirements for well-integrated teamwork, increased accountability for grading work submitted by a team, and increased attention to experimental detail. Production of the films required that members of the groups worked together to complete various aspects of the process. Students commonly worked together in pairs to complete modules of the films. In comparison, for a conventional written laboratory report submitted by a team in which at times most work is often completed individually (occasionally by a single person) and the interactive group work begins at the stapler. All students had access to the video editing stations and tripods were available to hold the camera for presentation of filmed content. Even thought the enhanced teamwork was not explicitly required in the assignment, the students felt more comfortable working together in this new environment for laboratory preparation. The accountability for team participation was clearly enhanced as each team member was expected to participate and his or her participation was evident in the film for the assessment of team performance. It was observed that the students paid much closer attention to experimental test procedures and details while documenting the activities with digital cameras and narration than in a conventional laboratory setting. In addition, the presence of an external reviewer (industrial partner) influenced student perception of the review (i.e., grading) process and their subsequent performance.

These teaching methods involving video conferencing and video productions support a recommendation by Felder et al.[10] to "teach around the cycle" employing a variety of styles that will develop whole brain thinking skills[11]. The tasks associated with taping, broadcast, and post-production work on the laboratory videos challenged students in a more creative and artistic context than is commonly encountered in a typical engineering laboratory experience. This provided opportunities for all students to be challenged in new ways and promoted enhanced learning.

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 is of significantly lesser quality than large-scale research-grade coefficient of restitution testing conducted at the company for their consulting projects. The video conferencing activity provided exposure of the multinational company to American students and provided opportunity for junior engineers at the company 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 company representative after the formal presentation. The industrial partner was highly interested in students' inquiries about employment opportunities at Nippon Koei.

Student comments about the learning experiences were generally consistent. The students had favorable comments about the video conferencing. The students had mixed comments related to the video production mode for the laboratory reports, but generally expressed concerns about the time commitment associated with this activity. Several students were inspired by the activity and enjoyed the experience. However, the majority of comments related to film production (even from those students that reported enjoyed it) indicated that the time commitment was large, especially due to a need to align schedules of team members to meet for large blocks of time outside of class to complete the assignment. Specific verbatim student comments related to these exercises are presented below:

Video Conference

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.

Extra effort is well appreciated and definitely worth it.

Video Production Mode for Laboratory Reports

Video presentation is an awesome idea, but very time consuming.

Making the video was fun, but it took a long time.

I don't like the video reports. I think that they take way too much time and the majority of the work falls on one person.

Videos are an interesting way to do a lab report, but not equivalent to one week's lab in terms of time.

Thought video labs would be long and tedious, but they turned out to be fairly interesting.

Videos were a little much. Fun, but would rather just do a report. I liked producing the video, it just took a lot of time. I think the second time around would be a lot smoother with allowed time.

The video presentation was very difficult and time consuming. Didn't feel like it was an effective way to demonstrate our group.

I didn't like doing the video report. It seemed like a lot more time for a lesser product.

Video editing takes too much time and collaboration.

A video is ten times harder than a written report because it takes ten times longer to edit than to write.

Some of the video work seemed like a heavy load for a 1-unit class.

Didn't really like the video lab report, but it was something new.

No more video lab reports, too hard to get everyone together (schedule conflicts).

The video lab took three times more work than the other labs. It is great that you want to challenge students and have them be innovative but not when it requires so much work.

The authors plan to further integrate this teaching method into the curriculum (despite the general tone of complaints related to video production) due to the depth and breadth of the inherent underlying pedagogical benefits. A set of relatively simple modifications should remedy much of the perceived problems (from student comments) with this mode of learning. These modifications include:

1) Provide training for use of editing stations during class time such that all students are familiar with the procedures and expected time commitment associated with completion of the assignment. Alternatively, each group could attend training together. For reference in this study, the students were trained how to use the video editing stations individually (or in small groups as they chose) for this investigation. This change would align well with a movement for providing specialized instruction for communication skills in engineering education[12].
2) Integrate use of Mac-platform computer programs (e.g., i-Movie) to provide more simplified editing and production of the films. This change would still require training as

outlined in #1, but would likely reduce total time commitment associated with video production.

3) Schedule the laboratory sessions that involve video production early in the term to permit extra time for editing and production as necessary. For reference, the first video assignment was scheduled near midterm examinations (and the FE Exam) and the second assignment occurred during the last week of the term (which was not completed as a complete video production due to highly vocal resistance by the students). This late schedule was not intended, but occurred due to the limited availability of the industrial partner during this period.
4) Provide more in-class time for students to work in their groups on the activities. For reference, during this investigation, an extension was provided to the due date, but additional class time was not allocated.
5) Repeat the exercise for at least two laboratory reports. The great benefits of scaling the learning curve would become evident for a repeat experience in this regard. For reference, it was originally intended to have two laboratory reports prepared in this manner, but the second assignment was scheduled for the week preceding final exams and the scope of the assignment was subsequently narrowed.
6) Develop this teaching methodology in a course that offers more credit hours to better align the workload with the credit received.

The authors expect that the students' perceptions would become more positive with the first five modifications. The sixth modification is a broader curricular concern that would not be relevant at some universities (specifically where laboratory and lecture are integrated into a single course or if this teaching method is integrated into a multiple-credit course). Overall, the video aspect of laboratory preparation needs to be emphasized as a central theme of the course so that student awareness and expectations will be at an appropriate level.

When the problems and perceptions related to the workload and scheduling are resolved, this method will provide critical insight and opportunity well suited to teaching the softer aspects of engineering education (e.g., teamwork, communication skills, global and societal context of problems) that are included in the BOK, ABET Criteria, and the International Technology Education Association's Standards for Technological Literacy: Content for the Study of Technology. It has been commonly reported that these aspects are a challenge to implement into engineering curricula[13, 14]. The teaching methods described in this paper support broad curricular efforts to provide pedagogies of engagement[15], preparing students who have highly adaptive skills for rapidly changing environments[16], and supporting the notion that academia is a center of innovation, creativity, and energetic activities[17]. A summary of recommended practices for successful experiences are outlined in Table 2.

Table 2. Recommended Practices for Integrating Video into Laboratory Exercises

Mode	Recommended Practice	Comments
Video Conference	Use 2 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 much more engaged when interacting with the image of a face and seeing 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
Video Module Production	Assign early in term	Permits sufficient time for editing and production
	Identify best equipment available for video production	Mac-platform computers effective, larger editing stations inefficient and difficult to learn how to use
	Provide training for video production	Reduces individual time for students to learn equipment outside of class
	Select experiment that is conducive to imaging technology	Rockfall was very effective in this regard
	View selected videos in follow-up class	Highly entertaining class activity that publicizes student work. Popcorn a good addition.
	Consider competition for films	Awards for various categories (“Viewers’ Choice”, “Technical Production”, “Cinematography”)
	Repeat assignment format during term	Permits students to apply their scaling of the learning curve of the related technology
	Integrate activity into laboratory course	The hands-on aspects of experimental testing represent an extremely good match for the video content.

Assessment Plan

As this teaching method is further developed and implemented, assessment of the video conferencing and video productions will be conducted to evaluate the impacts on teaching and learning effectiveness. A learning-style-specific assessment matrix will be developed to quantify student and faculty experiences, knowledge, attitudes, perceptions, interests, and abilities. Checklists, surveys, written tests, essays, writing samples, published instruments, interviews, and observational techniques will be used to develop both formative and summative data for assessment. Direct measures including grading rubrics and multiple observers will be used for assessment. In addition, surveys and interviews will be used as indirect measures. Students will be evaluated for learning effectiveness and faculty will be evaluated for teaching effectiveness. Correlations of baseline rankings and changes in rankings due to participating in the proposed activities will be developed for all participants and analyzed as different subgroups within the participating population. A fundamental framework for establishing the subgroups will be predominant learning styles and demographic statistics. Control conditions will be established as either groups of students not participating in these activities (with all other variables constant) or as separate technical topics throughout the term, some that include implementation of the methods (test group) and some that use more conventional methods (control).

It is expected that the teaching methods described herein will provide different benefits to different groups of participating students, depending on their predominant learning style and proven degree of success in progressing through the engineering curriculum. Since 2006, baseline data has been collected to determine Felder and Silverman Learning Style Index for all freshmen (approximately 160 per year) in the Civil and Environmental Engineering Department at California Polytechnic State University. This information is maintained as a database to track trends and correlations in student performance. This system has been selected due to its prominent use in civil engineering education. Similar data will continue to be collected for all first-term freshman students at California Polytechnic State University. This data is currently used to identify the students that have a potential for problems with learning due to fundamental conflicts with conventional teaching modes. In addition, this data will be used throughout this project to track the relative performance of students in non-conventional learning exercises. Changes in learning and teaching abilities in different learning/teaching modes will be developed graphically using a matrix of a participant's abilities across different learning modes (ranked before and after participation in the project). Rubrics will be developed for assessing abilities (i.e., assigning numerical values) through class observations and review of assignments. Personal perceptions of abilities will also be evaluated using surveys and interviews. This relatively rigorous assessment plan is intended to be applied to the general mode of teaching using video technology in the Civil and Environmental Engineering Department at California Polytechnic State University and not be limited to the experiences within only the 1-credit class described in this paper.

Summary and Conclusions

An innovative teaching method using both synchronous video conferencing with an industrial partner located overseas and video production by students in lieu of written laboratory reports was implemented at California Polytechnic State University. The main broad benefit of the method was directly including soft skills in the curriculum. Specific benefits of video conferencing included: exposure to global perspectives, interaction with a senior practitioner in the classroom, enhanced connection between laboratory experiments and real projects, and addition of new topics in the laboratory course. Specific benefits of video production included: enhanced learning using unconventional learning styles, increased expectations for teamwork, increased accountability for grading work submitted by a team, and increased attention to experimental detail. Drawbacks of the method included large time commitment and a significant learning curve associated with video editing. Simple modifications are envisioned that would resolve student concerns related to time commitment. Steps of a learning-style-specific assessment method are described for implementation as this method is further developed and used. This teaching method has promise for broader integration into engineering curricula to provide teaching using unconventional learning styles.

Bibliography

1. Lawrence, G. (1994). *People Types and Tiger Stripes,* 3rd Edition, Center for Applications of Psychological Type, Gainesville, Florida.
2. Kolb, D. A. (1984). *Experiential Learning – Experience as the Source of Learning and Development,* Prentice Hall, Englewood Cliffs, NJ.
3. Felder, R. M. and Silverman, L. K. (1988). "Learning and teaching styles in engineering education," *Engineering Education*, Vol. 78, No. 7, 674-681.
4. Herrmann, N. (1995). *The Creative Brain,* The Ned Herrmann Group, Lake Lure, North Carolina.
5. Dunn, R. (1990). "Understanding the Dunn and Dunn learning styles model and the need for individual diagnosis and prescription," *Reading, Writing, and Learning Disabilities,* Hemisphere Publishing Corporation, 6:223-247.
6. Gardner, H. (1993). *Frames of Mind The Theory of Multiple Intelligences,* HarperCollins Publishers, New York.
7. Klosky, J. L., Ressler, S. J., and Erickson, J. (2005). "AIM for Better Student Learning: Using Instant Messaging to Facilitate Improved Instructor-Student Communication," *ASEE Annual Conference Proceedings*, American Society of Engineering Education, 2005 National Conference.
8. Hanson, J. L. (1999). "Early Experimentation in Civil Engineering Materials," *Proceedings of the American Society of Engineering Education National Conference and Exposition: Engineering Education to Serve the World*, p. 1935-1943.
9. Pullen, J. M. (2001). "Applicability of Internet Video in Distance Education for Engineering," *Proceedings, 31st ASEE/IEEE Frontiers in Education Conference*, T2F-14-19.
10. Felder, R. M., Felder, G. N., and Dietz, E. J. (2002). "The effects of personality type on engineering student performance and attitudes," *Journal of Engineering Education*, ASEE, v 91, n 1, 3-17.
11. Lumsdaine, M. and Lumsdaine, E. (1995). "Thinking preferences of engineering students: implications for curriculum restructuring," *Journal of Engineering Education,* April, 193-204.
12. Large Seagrave, J. (2007). "Interdisciplinary Pedagogy: Using Teams to Teach the BOK," *Proceedings, Annual Conference and Exposition,* 11 pp.
13. Gorham, D., Newberry, P. B., and Bickart, T. A. (2003). "Engineering Accreditation and Standards for Technological Literacy," *Journal of Engineering Education*, ASEE, Vol. 93, No. 1, 95-99.
14. Shuman, L. J., Besterfield-Sacre, M. and McGourty, J. (2005). "The ABET "Professional Skills" – Can They Be Taught? Can They Be Assessed?," *Journal of Engineering Education*, ASEE, Vol. 95, No. 1, 41-55.
15. Smith, K. A., Sheppard, S. D., Johnson, D. W., and Johnson, R. T. (2005). "Pedagogies of Engagement: Classroom-Based Practices," *Journal of Engineering Education*, ASEE, Vol. 95, No. 1, 87-101.
16. Bransford, J. (2007). "Preparing People for Rapidly Changing Environments," *Journal of Engineering Education*, ASEE, Vol. 97, No. 1, 1-3.
17. Katehi, L. and Ross, M. (2007). "Technology and Culture: Exploring the Creative Instinct through Cultural Interpretations," *Journal of Engineering Education*, ASEE, Vol. 97, No. 2, 89-90.