AC 2011-2010: IMPROVING ENGINEERING EDUCATION IN DEVELOPING COUNTRIES: A STUDY

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Improving Engineering Education in Developing Countries: A

Study in India

Abstract:

Multi-media case studies have been shown to improve higher-order cognitive skills and team working skills in classrooms in developed countries. In this study, we wanted to find out the impact of such case studies by conducting workshops with students and faculty members in India. This article describes two workshops conducted in India, analyzes two surveys that were completed by the participants of these workshops, and presents findings from the study. The results show that the multi-media case studies developed by LITEE were well accepted in India and were perceived to result in improvements in higher-order cognitive skills and team-working skills. The faculty and student teams performed similarly to how the U.S. teams perform irrespective of limitations in infrastructure conditions. These workshops show that the students and faculty members in India are willing to spend the extra effort needed to compensate for poor infrastructure in achieving educational outcomes. Once the infrastructure conditions improve in India, these students, particularly female students, will provide a strong competition to the U.S. students in retaining jobs and pursuing meaningful careers.

Key Words: LITEE; Engineering Education; Developing Countries; India; Multi-Media Case Studies

1 Introduction to Engineering Education in India

Over the past decade, the economy in India has progressed at the average rate of 7-8%, and the IT industry has presence globally. India has become a major contributor to the global IT industry revolution and is a leader among developing countries. Engineering education has played a key role during this development; it became a main focus in the country after 1990.

However, India's exponential growth in technical education has also led to a huge gap between quality and quantity due to the restricted availability of qualified faculty. Therefore, India is trying to improve the qualifications of its faculty members and expend resources from both domestic funds and financial support from international organizations, and invite faculty members from organizations in developed countries (National Project Implementation Unit, 2011). Several educational institutions in India have obtained World Bank funding and have recruited U.S. educators to improve the quality of education to help them (National

Project Implementation Unit, 2011; NIT Trichy, 2011).

Two researchers from the Laboratory for Innovative Technology and Engineering Education (LITEE), Auburn University, were invited to use LITEE multi-media case studies to train engineering students at the National Institute of Technology, Trichy, during summer 2008, and to train several educators and students in a workshop at the National Institute of Technology, Calicut, during summer 2009. This paper provides details about the TEQIP World Bank program, training provided, case studies used, and results of an evaluation.

2 Case Studies and LITEE

U.S. universities lose 40% of freshman students admitted to engineering programs by the end of their sophomore year, and employers chide schools for not providing the skills that are needed by industries (Prados & Proctor, 2000; Engineering Student Retention, 2011). Prados & Proctor (2000) showed that the education establishment is not doing an adequate job of educating engineering students.

Employees are required to have a variety of good skills such as decision-making, problem-solving, team-working skills and even problem-identifying and analyzing, content-integrating and interrelating and so on (Rieley & Crossley, 2000; Cole et al, 2000; Tan & Thoen, 2000; Bradley et al, 2007). So, the teaching approach requires faculty to believe and affirm that every student can learn and model good practices that increase learning. However, the traditional teaching approach cannot develop Higher Order Cognitive Skills (HOCS) and problem-solving skills that are needed in the work (Broussard et al., 2007; Mbarika, 2003).

The mission of the Laboratory for Innovative Technology and Engineering Education (LITEE), created at Auburn University, is to bring real-world issues into classrooms, using multimedia case studies that illustrate in detail how an industrial problem is analyzed and a solution found. Use of such a case study in a classroom enables students to experience a real problem, develop a solution, and then compare their proposed solution with what was actually done. LITEE has developed eighteen case studies and these are available for use by instructors and students from the website: www.liteecases.com.

We disseminated these materials to faculties and students initially by using conventional methods such as presentations at conferences and publications in journals, but it took two to three years for publication and distribution of the materials and delayed the dissemination effort significantly. What's more, we found that the traditional methods of dissemination were simply not reaching engineering educators. Additionally, the process of administering and evaluating a case study is very different from the conventional lecture-based instructional methodology. With our case study methodology, the teacher's role becomes that of a facilitator rather than a leader of the class, therefore, there was a strong need to design an effective way of disseminating these materials. We decided to develop focused workshops to

provide hands-on training for faculty members who are willing to consider using these materials in their classrooms (Raju et al., 2002).

Stanwick (2010) examined whether presenting a multimedia case study enhances the learning experience of students in an undergraduate management class and the results proved that “the multimedia case did indeed enhance the learning experience of the students.” To evaluate the effectiveness of using a LITEE multimedia case study and access how the implementation aids student learning, Elrod et al. (2010) studied and found that the LITEE case study did aid student learning and broadened their vision by taking municipal development and teaching the professional side of project management as an example. Fini’s (2010) study also found that working with real cases could motivate students and maximize their learning and relate the theories to the practice, and learn to tackle real world problems. Similarly, Mbarika et al.’s study (2010) that aimed to examine if multi-media case studies do improve HOCS, also proved that they did improve the participants’ perceived HOCS and their self-reported learning, learning interest, challenges to their thought processes, and learning from others were improved.

Several universities in the U.S. have adopted instructional materials developed by LITEE including the Electrical Technology Program in Alabama A&M University, Introduction to Engineering Course in University of Virginia and Illinois Institute of Technology, Indiana University, Purdue University, Embry-Riddle Aeronautical University, and Louisiana State University. The feedback from the faculties and students from these universities have been extremely positive. The case study method was one of the most effective way found by the faculty members to motivate the students to improve their higher-level cognitive skills (Raju et al., 2000), the students experienced a realistic and complex scenario, learned about real-world decision-making issues, and analyzed the case study and benefited greatly according to the statements by the instructors.

3 Research Review and Research Questions

A suitable balance between technical knowledge and business knowledge need to be created (Trauth et al., 1993; Kirsch et al., 2007) so that graduates gain not only strong leadership skills but also become proficient in information technology (IT) concepts (Glyer-Culver, 2003) and have strong soft skills and cognitive skills (Kirsch et al, 2007). It is more difficult for students who lack context-based collaborative skills in obtaining and retaining employment (Kirsch et al, 2007). More and more programs have required students to participate in teamwork assignment and presentations and to “solve business problems experientially through a cross-functional approach” (Slater et al., 1995). Some educational institutions have incorporated information technologies including online discussions and field experiences into their teaching methods (Leidner & Jarvenpaa, 1995; Moffett, 2001; Sudzina & Sudzina, 2003; Santhanam et al, 2008).

Case studies have greatly succeeded in improving the learning experiences of undergraduates because they help students make connections between theory and its actual

practice (Mizukami, 2002; Butler et al, 2006) and greatly aid in teaching critical thinking skills (Lee, 2007), and have also been used successfully in other disciplines to train students for the professional world (Koh & Branch, 2004). Furthermore, adding various forms of media to the case studies allows students to learn about information technologies while having a more hands-on, real-world experience. Such technologies in classrooms enable the effective acquisitions of constructive, cognitive, collaborative, and social-cultural models of learning (Leidner & Jarvenpaa, 1995).

LITEE workshops have been designed to provide a real-world problem-solving context to students. The study by Sankar & Clayton (2010) stated that the multimedia case method was able to bring about many important benefits to students: perceived a comparatively greater improvement in their higher-order cognitive skills, ease of learning, team working skills, attitude toward information technologies and self-efficacy.

The methodology has been proved to be useful, helpful and valuable. Although the use of multimedia case studies has been growing in popularity in recent decades (Fasko, 2003) and is generally met with positive responses from students (Razvi & Allen, 2005), there is limited research to investigate the situation about the use of multimedia instructional materials in developing countries. So there is an apparent need for more research and empirical data regarding the usefulness of teaching with multimedia case studies in developing countries. But the education level and the knowledge base of the students and the faculties are not like those in America, and the extent that the students and the faculties accept and use the new tools and methods are different from those in America. So this research was performed to answer the following research questions:

RQ1: *Are the learners in India favorable toward LITEE workshops?*

RQ2: *Did the information that LITEE workshops deliver meet the expectation of the learners in India?*

RQ3: *Was the information that LITEE workshops delivered sufficient in helping learners improve skills in teaching, lecturing and multi-media learning?*

4 Study

In this section, we discuss the workshops that were conducted in India, describe evaluation instruments that were used, analyze the results, and provide conclusions.

4.1. Workshop at NIT Trichy, Summer 2008

A LITEE researcher was invited to conduct workshops for students and faculty members

at NIT Trichy as part of the TEQIP program during Summer 2008. A two-day workshop was conducted for students who worked as part of the placement center. The students included undergraduate and graduate students majoring in different engineering fields. The Lorn case study was used in this workshop. During the first day, the researcher introduced the case study and the relevant ethical codes, and provided the CD version of the case study to the students. They were divided into teams and assigned the case studies. The students were asked to play the roles of the plaintiff, defendant, expert witness, and jury.

Jim Russell, a maintenance worker at Lorn Manufacturing Inc., lost three of the fingers on his left hand during a routine maintenance procedure on a cotton manufacturing device, the Lap Winder. This occurred when the Lap Winder he was maintaining suddenly came on. Russell sued Lorn Manufacturing Inc., the designers of the Lap Winder device, for negligence. This negligence suit involves the Codes of Standards that applied to the design and building of the Lap Winder, the testimony of two expert engineering witnesses on the safety of the Lap Winder device, and whether Lorn Manufacturing failed to follow appropriate safety considerations in designing their Lap Winder device. The ultimate question to be decided in this case is whether Jim Russell, the Lorn Textile Manufacturing, Inc., or the textile plant bears the responsibility for this particular injury and the safety of this particular type of machine.

The students were divided into groups of 4 students. Two people in each group represented the lawyer and expert witness for the plaintiff and two others represented the lawyer and expert witness for the defendant. Students then played the role of the lawyers and the expert witnesses in the trial. Each lawyer had 4 minutes to present a direct examination of his expert witness. Then, each opposing lawyer had 2 minutes to present a cross examination of that witness. Thereby, each team presented a discussion of the case study from the perspective of both the defendant and plaintiff. A jury team of students listened to the arguments and made the final decision on whether Lorn Manufacturing was guilty of negligence or not.

The students took the assignment very seriously and performed very well during the mock trial. They showed mastery of the technical material and made effective, forceful arguments. The jury team listened to the lawyers and expert witness and came up with excellent decisions. The two jury teams decided that the worker was negligent and as per the information provided, Lorn Manufacturing was not guilty of negligence in engineering design. It was surprising that the decision was very similar to that made by good engineering teams in the U.S. classrooms. The researcher expected that the students will be partial to the worker given that India has a tendency to be a socialistic country. But the students worked with the material provided and interpreted the legal statutes well. Some of the infrastructure elements, such as availability of Internet, computers, etc., were not consistent and led to scrambling for resources at times. Some of the students had difficulty in expressing their thoughts given their limited command of English; others did very well. Overall, the Indian student team performed similarly to how the U.S. student teams typically perform on this case study. About 1/3rd of the student team was composed of women students, and they were

assertive in making their points and were willing to take leadership positions. Their willingness to learn and experiment with new instructional materials seemed to overcome the limitations provided by the infrastructure.

4.2. Workshop at NIT Calicut, Summer 2009

Two researchers at LITEE were invited to NIT Calicut during Summer 2009 to provide a workshop to faculty members and students as part of the TEQIP program. The researchers worked with the administration of NIT Calicut so that a mix of faculty members and students were invited to the workshop conducted over a weekend. The response was strong and a total of 54 participants attended the workshop. The schedule followed in the workshop is shown in Appendix A.

During the first day, teams of faculty members and students worked on the Della case study. This case study shows the dilemma faced by the plant manager of Della Steam Plant, who had no hesitation in shutting down the turbine-generator unit based on the recommendation of Lucy Stone, the manufacturer representative, and Bob Make, the day shift maintenance engineer. Lucy Stone ran an overtrip speed test on a turbine-generator unit that was restarted after a two-month preventive maintenance overhaul. The unit began to vibrate heavily and caused the building to shake. An overspeed trip mechanism attached to the turbine-generator tripped, causing the unit to coast down to a stop in the next few minutes. Many employees were scared and started moving away from the unit. Everyone around the turbine thought that it was going to come apart. Lucy Stone studied the vibration chart produced by the shaft rider probe attached to the turbine generator unit. The chart showed that it was a 17 mil (one thousandths of an inch) vibration level and she felt it was too near the 22 mil clearance between the shaft and the bearing. She recommended to Sam Towers that the unit be torn down and inspected thoroughly. She expected that the retainer rings might have to be replaced.

Steve Potts, the engineer in charge of predictive maintenance at Della Steam plant, looked at the charts that track the overall vibration level and the vibration level at the running speed of the turbine generator at 7.56 a.m., the time the vibration started. He noticed that the vibration level at the running speed (1X speed) indicated by the solid line in Figure 3 was only 3 mils. Based on these data, Steve surmised that the vibration occurred due to oil whip. He concluded that Lucy should have waited for 24 hours for the oil to heat up before running the overspeed trip test. He recommended to Sam to restart the unit immediately since the vibration problem was due to an oil whip and save \$900,000 by avoiding an unnecessary shutdown. Sam was in a dilemma since, in the past, the plant engineers had always agreed with the recommendation by the RLS engineers. This was the first time Steve had not agreed with Lucy, which created a dilemma.

The NIT Calicut faculty members guided the students in understanding the charts and argued for restart of the unit, a decision that faculty members in the U.S. typically come to after analyzing the case study. The interactions among the faculty members and students

were strong and positive. After this exercise, the students accompanying each faculty member were requested to work in teams and choose other case studies that are available from the LITEE website. The teams chose a wide variety of case studies, including the STS 51-L, Chick-fil-A, and Lorn case studies. The students analyzed these case studies on the second day and the faculty members evaluated their presentations and provided helpful feedback. Through this process, the faculty members were provided hands-on experience on using the case studies and active student participation showed that the case studies were valuable in the learning experience.

The researchers wanted the faculty members to use these case studies in their classrooms and offered small grants of \$2,000 per faculty member. Such a grant in the U.S. led to a strong response from faculty members and led to an NSF sponsored dissemination grant. The response from the Indian faculty members was lukewarm and there were no applicants for the grant. An administrator explained that the fund amounts were not attractive and that the system did not have appropriate mechanisms to provide extra funds to faculty members for conducting research projects (either summer salaries or consulting grants). In addition, the faculty members in India were on a fixed salary scale with automatic increments and their pay was not correlated with their performance.

4.3 Questionnaires

In order to evaluate the effectiveness of LITEE case studies used in these workshops, we used two questionnaires, shown in Appendices II & III. Questionnaire I (found in Appendix II), entitled “Survey of Attitudes and Perceptions towards MIS” included 51 questions, among which there are 36 questions related to instructional materials, 4 for the identifications of the surveyed and 11 for improvement suggestions. Questionnaire II (found in Appendix III), entitled “Bringing Real-World Experiences to Classrooms through LITEE Case Studies,” included 7 questions.

The 41 students at NIT Trichy completed Questionnaire I, of which 8 responses were incomplete.

Questionnaire II was completed by 26 students and 28 faculty members at NIT Calicut. Four questions were not finished or were left blank.

4.4 Evaluation and Findings

We used Microsoft Excel to calculate the means and standard deviations and then used SPSS to analyze the factors.

4.4.1 Evaluation of NIT Trichy Workshop

Questionnaire I requested the participants to use 5 ratings “A, B, C, D and E” which represent Strongly Disagree (SD), Disagree, Neutral (neither agree nor disagree), Agree and Strongly Agree (SA), respectively. We will assign values 1, 2, 3, 4 and 5, which means A=1, B=2, C=3, D=4 and E=5. Because questions 2, 4, 5, 6, 9 and 12 are negative questions, the ratings A, B, C, D and E, of these questions are assigned 5, 4, 3, 2, and 1. The responses from the 33 post-surveys are included here (Table 1).

Table 1: Descriptive Statistics

	N	Mean	Std. Deviation	Variance
VAR00001	41	2.8049	1.0055	1.011
VAR00002	41	3.8049	1.0540	1.111
VAR00003	41	3.4146	.8937	.799
VAR00004	39	4.4872	.6833	.467
VAR00005	40	3.4500	1.1972	1.433
VAR00006	41	3.5854	1.0482	1.099
VAR00007	41	3.6341	.7667	.588
VAR00008	41	4.0000	.9487	.900
VAR00009	40	3.8500	1.0513	1.105
VAR00010	41	4.2927	.8439	.712
VAR00011	41	3.6829	.9859	.972
VAR00012	41	3.5610	.9759	.952
VAR00013	41	4.0488	.9988	.998
VAR00014	41	4.2927	.8439	.712
VAR00015	41	3.8049	.6790	.461
VAR00016	41	3.9024	.7002	.490

VAR00017	41	3.7073	.6798	.462
VAR00018	41	3.8049	.8432	.711
VAR00019	40	3.8250	.7121	.507
VAR00020	41	3.9024	1.0441	1.090
VAR00021	40	3.5750	.8738	.763
VAR00022	40	3.6000	.9819	.964
VAR00023	41	3.6098	.8024	.644
VAR00024	41	3.6341	.9153	.838
VAR00025	41	3.3902	1.0459	1.094
VAR00026	41	3.7805	.8518	.726
VAR00027	41	3.8293	.8917	.795
VAR00028	40	3.5750	.9306	.866
VAR00029	41	3.9512	.9734	.948
VAR00030	41	3.9512	.9988	.998
VAR00031	40	3.2750	.9604	.922
VAR00032	41	4.0732	.9053	.820
VAR00033	41	3.9024	1.0199	1.040
VAR00034	40	4.3000	.7232	.523
VAR00035	41	3.8049	.8432	.711
VAR00036	41	3.7073	1.1671	1.362

In Table 1, the means of the 36 questions are all more than 3, except for the first question. The first question requests the perception of the learners about the difficulty level and the means of 28 variables among all the questions are more than 4. The results are favorable and indicate that the LITEE Workshops were acceptable to the participants and were perceived to be beneficial.

We used SPSS 10.0 to do principal analysis. Through factor analysis, in the Rotated Component Matrix as the Table 2 shows, there are 3 Components that are abbreviated C_i ($i=1, 2, 3$). C_1 includes 29 VARs that are VAR 8-36, which can be called “**Expectations to MIS**” because from the meanings of these questions they reflect the expectations to MIS and hope to improve the skills from the learning of MIS; C_2 includes 4 VARs that are VAR 2, 3, 5, 6, which can be called “**Attitude to MIS**” for the four questions show the perception of learners about learning MIS and imply the difficulty level of MIS to the them; C_3 includes 3 VARs that are VAR 1, 4, 7, which can be called “**Perception of MIS**” which reflects the perception of value of the MIS from the learners.

Table 2: Rotated Component Matrix

	Component		
	1	2	3
VAR00001	-.231	.254	-.720
VAR00002	-.359	.681	.208
VAR00003-6.422E-02		.758	-.192
2			
VAR00004	-.221	.383	.481
VAR00005	.282	.637	-3.939E-02
VAR00006	.410	.769	.126
VAR00007	.534	6.049E-02	.536
VAR00008	.684	-.202	-.400
VAR00009	.597	.218	.448
VAR00010	.795	.229	.106
VAR00011	.846	-9.429E-03	5.099E-02

VAR00012	.805	.145	.236
VAR00013	.857	.293	9.346E-02
VAR00014	.920	6.695E-02	6.907E-02
VAR00015	.963	7.229E-03	8.071E-02
VAR00016	.978	-5.316E-02	-1.772E-02
VAR00017	.982	4.276E-02	4.077E-02
VAR00018	.970	3.432E-02	4.564E-02
VAR00019	.972	7.022E-02	3.263E-02
VAR00020	.961	-1.081E-02	2.841E-02
VAR00021	.969	1.304E-03	9.697E-02
VAR00022	.984	5.108E-03	3.601E-02
VAR00023	.985	7.879E-02	8.350E-02
VAR00024	.974	1.949E-02	9.944E-02
VAR00025	.967	4.486E-02	7.605E-02
VAR00026	.972	-3.503E-03	.151
VAR00027	.988	1.859E-02	4.146E-02
VAR00028	.978	-1.739E-02	.114
VAR00029	.984	1.268E-03	2.418E-02
VAR00030	.970	-4.210E-03	.116
VAR00031	.957	-5.602E-02	.192
VAR00032	.974	2.681E-02	.114
VAR00033	.987	-1.919E-02	.105

VAR00034 .980 4.127E-02 .130

VAR00035 .988 1.276E-02 8.468E-02

VAR00036 .980 5.645E-02 6.023E-02

Based on the 3 principle components, the influence of variables: experience, gender, race and status were also tested and the results are shown in Tables 3, 4, 5, 6, and 7.

Table 3: Analysis by Experience

EXPERIENCE		EXPECTATION	ATTITUDE	PERCEPTION
1.00 (less than 1 year)	Mean	3.7038	3.4583	3.6722
	N	30	30	30
	Std. Deviation	.4681	.7574	.4254
2.00 (1 to 2 years)	Mean	4.0966	3.7000	3.5333
	N	5	5	5
	Std. Deviation	.2331	.3260	.5578
4.00 (more than 3 years)	Mean	4.0081	3.9333	3.4333
	N	5	5	5
	Std. Deviation	.2783	.9955	.4944
Total	Mean	3.7909	3.5479	3.6250
	N	40	40	40
	Std. Deviation	.4475	.7532	.4462

Table 4: Analysis by Gender

GENDER		EXPECTATION	ATTITUDE	PERCEPTION
1.00 (Female)	Mean	3.8319	3.7188	3.6667
	N	8	8	8
	Std. Deviation	.3925	.3391	.5345
2.00 (Male)	Mean	3.7957	3.5278	3.6162
	N	33	33	33
	Std. Deviation	.4662	.8209	.4239
Total	Mean	3.8028	3.5650	3.6260
	N	41	41	41
	Std. Deviation	.4483	.7517	.4406

Table 5: Analysis by Status

STATUS		EXPECTATION	ATTITUDE	PERCEPTION
1.00 (Freshman)	Mean	3.9310	3.5500	4.0667
	N	5	5	5
	Std. Deviation	.4293	.5701	.2789
4.00 (Senior)	Mean	3.7069	3.8750	3.5000
	N	4	4	4
	Std. Deviation	.2397	.1443	.1925
5.00 (Graduate)	Mean	3.7947	3.5286	3.5729

	N	32	32	32
	Std. Deviation	.4755	.8194	.4479
Total	Mean	3.8028	3.5650	3.6260
	N	41	41	41
	Std. Deviation	.4483	.7517	.4406

Table 3 shows that those who have more experience in MIS-related fields have more expectations than those who have fewer experiences, and their attitudes to MIS are better. Table 4 shows that the means of the females are higher than that of the males in the study, which means that the female students have higher expectations, are more willing to learn, and consider MIS to be learned more easily than the male students. Table 5 shows that the means of expectations and acceptance of the freshman are higher than those of others who are the senior and graduates.

The students provided qualitative responses to questions 41-51. 13 of the participants have no or little experiences, 8 have work experience, 8 have project experience, and 8 have course or training experience. Whether participants had experience or not, most of them benefited from the case study teaching, and gave positive feedback.

The participants thought that multi-media case studies should be taught using group projects and lectures. This feedback tells course designers how to design the teaching style in order to improve teaching effectiveness.

The participants stated that participants can be provided “proper information on resources available, and what was most helpful to them in learning the material was “more emphasis on application rather than theory.” Participants “learned how to handle the problems in real life situations” by “being asked to come up with a solution to the problem.”

Different participants perceived different benefits of the use of multi-media case studies. Some studied how to filter out the necessary information from a lot of information in the materials, some increased their reasoning skills, and some improved their ability to work in group and presentation skills. Many participants wrote that they will use the skills for their future work.

All participants expressed that they liked working in groups. They perceived that using multi-media case studies is an appropriate instructional methodology that can teach students how to work in groups. Case studies provide the conditions participants need to interact with

others and help to learn better with help of examples from the real world. Almost all of the participants perceived that the use of student groups/teams to solving the problems presented in the case studies is helpful. They “enjoyed working together” and “shared ideas” or received a “contribution of ideas from all the members of the group”. The students suggested that learners need group work for improving learning experience in this course while the instructor need to have good communication skills, analyze and summarize the cases. In summary, “the case studies will be absolutely useful in my career,” as one of the students said.

4.4.2 Evaluation of NIT Calicut Workshop

The 54 participants in the NIT Calicut workshop were provided Questionnaire II. In Questionnaire II, we will assign A, B, C and D value 4, 3, 2 and 1, that means a=4,b=3,c=2 and d=1, which represents four ratings that Strongly Agree, Agree, Disagree and Strongly Disagree. Then we can get the means of feedback from the students and the faculties (Table 6).

Table 6: Descriptive Statistics for NIT Calicut Workshop

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
VAR00001	53	1.00	4.00	170.00	3.2075	.8629	.745
VAR00002	52	1.00	4.00	169.00	3.2500	.5899	.348
VAR00003	54	1.00	4.00	172.00	3.1852	.6750	.456
VAR00004	53	1.00	4.00	143.00	2.6981	.7228	.522
VAR00005	54	1.00	4.00	179.00	3.3148	.7727	.597
VAR00006	54	1.00	4.00	190.00	3.5185	.6366	.405
VAR00007	53	1.00	4.00	164.00	3.0943	.6868	.472

Table 6 shows that all means are above 3 which shows that the LITEE Workshop was perceived to be useful by the students and faculty members. We used SPSS 11.0 to analyze the data collected. After rotated, the Component Matrix is shown in Table 7.

Table 7: Rotated Component Matrix

	Component	
	1	2
VAR00001	.684	.309
VAR00002	.661	.306
VAR00003	6.959E-03	.896
VAR00004	.614	.247
VAR00005	.882	-.121
VAR00006	.525	.509
VAR00007	.339	.669

The VARs (Questions) 1, 2, 4, 5, and 6 can be classified as component 1 that can be named “usefulness of the information” for the 5 questions describe if the information is useful in practice. The VARs (Questions) 3, 7 as component 2 named “adequacy of the information” for the 2 questions ask if the information is enough to help the learner work more effectively by using LITEE workshop.

The means and standard deviation for these variables were computed. We find that the mean of component 1, “**usefulness of the information,**” is 3.140, and that the mean of component 2, “**adequacy of the information,**” is 3.198, and all the scores above 3 means that the usefulness and adequacy of the information that LITEE Workshop delivered were perceived to be good.

The qualitative feedback was also positive. Participants thought that the strengths of the workshop were the good presentation, the group interaction, and the case study. Some of them said that they obtained increased knowledge from the teachers. When they were asked if they would like to use the multi-media case studies, they gave affirmative answers. They even suggested more activities and thought the workshop should be conducted over a one week duration.

4.4.3 Findings

The above results show that the participants in India analyzed the cases similar to their American counterparts and came with the same conclusions. We answer the research questions in this section.

(1) *Are the learners in India favorable toward LITEE workshops?* In the quantitative feedback in the surveys, the learners in India are favorable toward LITEE workshops. They showed that LITEE case studies were useful in improving their abilities, such as communication skills, abilities to handle the problems in real life situations. They also expressed that they would use multi-media case studies in their future work. That means that these participants consider the case studies as valuable in teaching students which will help improve their competitiveness in their careers.

(2) *Did the information that LITEE workshops deliver meet the expectation of the learners in India?* We also get the affirmative answer for the second research question. Multi-media case studies are a new kind of methodology for most Indian students. They perceived that the case studies would assist them in decision-making or identifying various alternatives/solutions to a problem, and improving their abilities or skills.

(3) *Was the information that LITEE workshops delivered sufficient in helping learners improve the skills in teaching, lecturing and multi-media learning?* The third research question is also answered in the affirmative. The students and faculty members perceived that they could play roles effectively even though they were not in the actual work situation. The information that LITEE workshops delivered sufficient in helping learners improve the skills in teaching, lecturing and multi-media learning, as the means of scores of Questionnaires I & II reveals. Not only the quantitative evaluations but also the qualitative factors support the evaluation of LITEE workshops and show the value of the case studies. Not only those who had working experiences but also those who had no working experience perceived that they had benefited from the workshops. They found the value of the workshops and their personal abilities were improved in some aspects, and they expected to use the methodology in their future work. The qualitative feedbacks were positive.

5 Conclusion, Discussion & Implication

5.1 Conclusions and Limitations

From the evaluations, we find that the students and faculty members in India perceived LITEE case studies and workshop highly. They perceived the benefits from the methodology to be important to as improving presentation and communication skills and the ability to work in a group. The workshop also proved case studies to be useful in teaching what is going on in a real word setting and improving participants' abilities to solve problems. Many of the

learners expressed the willingness to use the case studies in the future. The participants perceived the presentation and communication skills and the ability to work in a group to be very important in their future work and careers. Multi-media case studies, as a new teaching style, actually simulate the real world and provide real-world situations to learners. During the whole process of case analysis, the faculty and student teams in India performed similarly to how U.S. teams performed irrespective of limitations in infrastructure conditions such as limited availability of computers, infrastructure, power etc.

So we can conclude that *(1) the learners in India are favorable about LITEE workshops; (2) the information that LITEE workshops delivers can meet the expectation of the learners in India; and (3) the information that LITEE workshops delivers are sufficient to the learners in India.*

Although engineering education in developing countries is still developing, multi-media case studies can be adopted broadly to improve the higher-order cognitive skills and team-working skills of learners in developing countries. Multi-media case studies have the potential to make learners more competitive in retaining jobs in their future career.

The limitation of this article is that the sample size is small. But we have planned to implement these case studies in other universities in India, China, and other developing countries and give more faculties and students the chance to use the multi-media case studies. This research team includes authors who are born in India and are from China. With the members who are from different countries and different backgrounds, it is possible to conduct LITEE workshops in multiple countries.

5.2 Implication & Discussions

According to feedback in the surveys in India and the surveys in U.S., the LITEE workshops can be applied not only in developed countries but also the developing ones. This methodology might help the developing countries to: (1) Expand education coverage to solve the problem of low enrollment due to teacher shortage; (2) Increase the training of teachers to improve the teachers' teaching ability; (3) Expand students' analytical and practical problem-solving skills; (4) improve engineering education and the ability of future engineers and technicians, which will be helpful in the development of industries.

These findings have further significance: India and other developing countries can have the chance of competing with developed countries globally in some areas in the future. Now, developing countries cannot win the competition with developed countries in many areas, such as engineering, for the educational systems are underdeveloped due to limited availability of computers, infrastructure, power, etc.. However, by introducing new teaching methods and instructional materials such as the multi-media case studies developed by LITEE, which can compensate for poor infrastructure, the students and faculties in

developing countries, like India, can learn more from them and can have the same effects as the students from U.S. And the results show us that the students not only in developed countries but also in developing countries can develop their higher-order cognitive skills as long as the right methodologies are adopted. And if these methodologies can be spread and used broadly in developing countries, those developing countries can have the opportunity to narrow the gaps between them and developed countries in engineering education and catching up with developed countries in some industries in the future by cultivating more teachers/faculties and students majoring in engineering.

As Schultz (1960, 1961, 1962, 1963, 1964) and Becker (1962, 1964) have proved that investment in human capital will help promote the development of economy, developing countries can enhance innovative capabilities by increasing investment in human capital. Although return on investment in human capital and enhancement of innovative capabilities is a long process, it is the only way that developing countries can prevent larger gaps, or even narrow the gaps with the developed countries.

As a methodology, multi-media case studies have been proven to be a good teaching style in engineering education in developed countries. This article shows that multi-media case studies have positive feedback and were welcome in India as a new methodology. This means that multi-media case studies have the potential to provide good benefits on investment in human capital. Once case studies, such as those offered by LITEE, spread all over India, India could potentially have better engineers who use their team working skills and higher-order skills to promote greater development of industries and induce success in economy.

Before the mid 1990s, almost all areas in developing countries were behind those in the developed countries. But those countries' development in IT engineering in the information era, beginning in the mid 1980s, enabled them to accelerate their development over the next decade. So we can see that India has achieved great success in IT industries and has become a large exporter of IT products. In the past, developing countries had no capabilities of competing with developed countries, but now they can compete with developed countries in some areas such as the IT industry. In the future, as engineering education in developing countries continues to grow and many engineers have been developed, developing countries will have more competitive capabilities in more areas and can compete with developed countries. Innovative instructional technologies, such as the multi-media case studies, might provide the advantage to the developing countries that IT provided in enhancing the engineering capability of these countries.

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Appendix I

Bringing Real-World Experiences to Classrooms through LITEE Case Studies

Program

Sponsored by: Laboratory for Innovative Technology and Engineering Education (LITEE), Auburn University, National Science Foundation, and NITC.

Educational Objectives: The purpose of this workshop is to train the faculty members through innovative instructional materials so that their students can:

(1) Practice soft skills such as team working, written and oral communication, and ethics in solving real-world problems;

(2) Apply technical, engineering, and business skills to solve real-world problems

Refine their problem solving and decision making skills.

Day One

09.00-10.00 Registration

Session 1 Opening Remarks

10.00 10.15	–	Opening remarks Educational Objectives of the workshop and how they will be achieved	Professor P.K. Raju, Department of Mechanical Engineering, AU
10.15 10.30	–	Need for NIT faculty members to impart life-long skills to students	Dr. Reddy, Director, NIT Calicut & Dr. Mohandas, International Programs
10.30 11.00	–	Working in teams & Personality Profiles	Chetan S. Sankar, Department of Management, AU

Session 2 Teaming Session and Case Study Assignment

11.15 – 11.45	Teaming Exercise	Chetan S. Sankar, Department of Management, AU
11.45 – 12.15	Assignment of Della Steam Plant Case Study	P.K. Raju, Chetan S. Sankar
12.15– 1.00	Analysis by teams	All participants of the workshop with assistance from LITEE team (4 teams)

1.00 p.m. – 2 p.m.: Lunch

Session 3 Della Steam Plant Case Study Analysis

2.00 – 2.50	Presentation by teams; Evaluation by faculty groups	Faculty teams
2.50 – 3.15	Actual decision made in the Della Case Study? Skills taught using this case study	Chetan S. Sankar & P.K. Raju
3.15-3.30	Description of Available LITEE case studies	Chetan S. Sankar & P.K. Raju

Session 4 Preparation to Implement a Case Study with Students

3.45-4.15	Pick a LITEE case study to be implemented with students	Faculty members
4.15 – 5.00	Assign case study to students	Faculty Members & Students

Day Two

Session 5A: Lesson Plan: for Faculty Members

10.00-1.00	Discussion of our experience	P. K. Raju, Chetan S. Sankar
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	in teaching with case studies; Lesson plan and assessment tools	
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Session 5B: Preparing for Presentation: Students

10.00 – 1.00	Discussion of a case study and preparation for presentation	Students
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1.00 p.m.-2.00 p.m.: LUNCH;

Session 6 Presentation of Case Study Analysis by Students

2.00 – 3.00	Student Presentations & Grading of presentations	Students & Faculty members
3.30-4.00	Evaluation of case study methodology	Students & Faculty members
4.00 – 4.15	Opportunities for Study Abroad at AU	P.K. Raju & Chetan S. Sankar

Session 7 Faculty Adaptation of LITEE Case Study in Individual Classrooms – Grant

4.15- 4.45	Adaptation of LITEE case study in individual classrooms: Grant opportunities	P.K. Raju, Chetan S. Sankar, Auburn University Dr. Mohandas, NIT Calicut
4.45 – 5.00	Concluding Remarks	

Appendix II

Survey of Attitudes and Perceptions toward Engineering

The questions below are designed to identify your attitudes about Engineering. Be as honest as possible; there are no correct or incorrect answers. Your responses will not impact your grade in this course or in other courses. You may be requested to enter a code to identify your responses in a pre and post survey. Please rate the degree to which you agree or disagree with the following statements in this questionnaire by bubbling in or clicking on the response according to the following 5- point scale.

A = Strongly Disagree (SD)

B = Disagree

C = Neutral (neither agree nor disagree)

D = Agree

E = Strongly Agree (SA)

Instructional materials are defined as the class lectures, text book, homework exercises, and multi-media case studies that have been used so far in this course.

1. Engineering is a subject learned quickly by most people. A B C D E

2. I have trouble understanding Engineering because of how I think. A B C D E

3. Engineering concepts are easy to understand. A B C D E

4. Engineering is irrelevant to my life. A B C D E

5. I get frustrated going over Engineering tests in class. A B C D E

6. I am under stress during Engineering classes. A B C D E

7. I understand how to apply analytical reasoning to Engineering. A B C D E

8. Learning Engineering requires a great deal of discipline. A B C D E

9. I have no idea of what's going on in Engineering.	A	B	C	D	E
10. I like Engineering.	A	B	C	D	E
11. Engineering is highly technical.	A	B	C	D	E
12. I feel insecure when I have to do Engineering homework.	A	B	C	D	E
13. I <i>can</i> learn Engineering.	A	B	C	D	E
14. Engineering skills will make me more employable.	A	B	C	D	E
15. I learned how to identify engineering tools that will assist me in decision-making using the instructional materials.	A	B	C	D	E
16. I learned how to inter-relate important topics and ideas using the instructional materials.	A	B	C	D	E
17. I learned how to identify various alternatives/solutions to a problem using the instructional materials.	A	B	C	D	E
18. I improved my problem solving skills using the instructional materials.	A	B	C	D	E
19. I learned how to sort relevant from irrelevant facts using the instructional materials.	A	B	C	D	E
20. The instructional materials, class activities, labs, and assignments were integrated in a way that made my learning easier.	A	B	C	D	E
21. The instructional materials emotionally engaged me in learning the course topics.	A	B	C	D	E
22. The instructional materials increased my self-confidence.	A	B	C	D	E
23. I achieved a sense of accomplishment in learning by using the instructional materials.	A	B	C	D	E
24. The instructional materials helped me assume a greater responsibility for personal learning.	A	B	C	D	E

25. If I ever were to become a high ranking engineer in a company I would hire other engineers to help with decision making A B C D E

26. The instructional materials helped me improve my team-building and interpersonal skills. A B C D E

27. The instructional materials helped me and my classmates listen carefully to each other's statements and ideas. A B C D E

28. The instructional materials helped me and my classmates arrive at decisions based on consensus building. A B C D E

29. The instructional materials helped me and my classmates share ideas with each other. A B C D E

30. The instructional materials enhanced my interactions with my classmates. A B C D E

31. My writing skills improved as a result of this Engineering course. A B C D E

32. My presentation skills improved as a result of this Engineering course. A B C D E

33. My confidence in applying Engineering concepts to real situations improved as a result of this Engineering course. A B C D E

34. I believe that an interdisciplinary focus is important in Engineering. A B C D E

35 The instructional materials improved my attitude toward Engineering. A B C D E

36. My informal communication skills improved as a result of this Engineering course. A B C D E

Scale: A = Strongly Disagree (SD); B = Disagree; C = Neutral (neither agree nor disagree); D = Agree;

E = Strongly Agree (SA)

Using the items provided below, indicate the item that best describes you

37. Please select one of the following for your years of work experience

- (a) less than 1 year (b) 1 to 2 years
- (c) 2 to 3 years (d) more than 3 years

38. Gender

- (a) Female (b) Male

39. Race

- (a) White (b) African-American
- (c) Hispanic (d) Asian-American
- (e) American Indian

40. Status

- (a) Freshman (b) Sophomore (c) Junior
- (d) Senior (e) Graduate

Please answer the following questions in as much detail as you can to enable us to improve the use of instructional materials in your course of study. We are interested in learning both what works and what needs improvement in the course. Your input will be kept confidential and will be used in our formative assessment to improve the program. *Please disregard any questions that are not applicable to your course.*

41. What experience do you have with the engineering field of study? (Include work experience, related courses or other experience with engineering)

42. What teaching styles do you find most helpful in learning new material? (for example, lecture, distance learning, power point presentations, multi-media case studies, group projects, etc.)

43. What learning styles (for example, independent working, team working, task oriented, intuitive, objective, sensitive) do you believe should be addressed to help you learn new material?

44. Do you prefer to work alone or in groups to solve problems?

45. What suggestions do you have for enhancing your learning experience in this course?

46. How do you perceive that you might use the information learned in this course in your future work environment?

47. What part(s) of this course did you find to be most interesting?

48. What part(s) of this course did you find to be most helpful to you in learning the material?

49. How beneficial would you rate the use of multi-media case studies in your learning the material presented in this course? (Please explain in detail the benefits or non-beneficial aspects)

50. How helpful did you find the use of student groups/teams to solving the problems presented in the case studies? (Please explain in detail the ways in which working with other students in groups was helpful or not in your learning the course materials)

51. at suggestions do you have for the instructor to improve his/her teaching in this course?

Thank you for completing the questionnaire.

Appendix III

LITEE Workshop

Bringing Real-World Experiences to Classrooms through LITEE Case Studies

August 8-9, 2009

NIT Calicut

For the following items, circle the choice that most closely indicates your extent of agreement using the following scale:

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

1. The workshop demonstrated how to bring theory and practice together in classrooms.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

2. The workshop provided educational strategies to develop higher level cognitive skills in students.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

3. The workshop provided sufficient information about LITEE case studies.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

4. The workshop provided instructional materials that help meet accreditation criteria and employer needs.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

5. The workshop has the potential to motivate students to pursue engineering education.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

6. This location of the workshop enabled me to attend it.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

7. The pedagogies to teach case studies were demonstrated well.

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree

Please respond in writing to the following prompts using the other side of this form if needed:

What are the strengths of the workshop?

What are the weaknesses of the workshop?

What are the suggestions for future?

Will you like to use the LITEE case studies in your classroom? If so, please provide your name, address, and e-mail.