

Beginning to Apply IUCEE Effective Teaching Strategies in India: An Experience in a Master of Computer Applications Program

Abstract

The Indo-US Collaboration for Engineering Education (IUCEE) initiative is focused on preparing the next generation of engineering faculty in India and the United States, and dramatically increasing the number of collaborations in research and teaching to better prepare engineers for the global economy. After two years of planning in India and the US involving almost 200 academic and business leaders from both countries, and raising close to US\$1M, the first Faculty Leadership Institute was offered on the Infosys Technologies' Global Education Center in Mysore, India for a six week period during the summer of 2008. Almost 585 Indian faculty members participated in 23 week-long Train-the-Trainer workshops led by 27 US faculty members and corporate representatives that covered general effective teaching techniques as well as best practices teaching within engineering disciplines. This paper describes a first experience by one of the Indian participants applying strategies taught at the IUCEE Faculty Leadership Institute to a course in a Master of Computer Applications program in India, and the students' reactions. The course was part of a two course sequence, the faculty member taught the first course before the Institute experience and the second after the Institute. The students assessed the difference in his teaching skills and the impact of using the new techniques in the second course.

Introduction

The Indo-US Collaboration for Engineering Education (IUCEE)¹ initiative started in 2007, with the assistance of the American Society for Engineering Education (ASEE) and the International Federation of Engineering Education (IFEES). The IUCEE vision is to improve the quality and global relevance of Engineering Education in India and in the United States by fostering collaborations. IUCEE aims to identify, promote, catalyze, add value to assist in the scale up and multiplication of promising practices for collaboration in

- Research and Development
- Curriculum and Technology Enhanced Delivery
- Innovation and Entrepreneurship
- Quality and Accreditation Processes
- Industry Participation

With this purpose under the leadership of Dr. Krishna Vedula, a Faculty Leadership Institute was developed jointly by US and Indian academic and industry leaders. The Institute consisted of 23 one week "Train-the-Trainer" workshops on effective teaching techniques, and discipline-based courses that took place at the InfoSys Technologies' Global Education Center in Mysore, India. The workshops were led by US experts known for their pedagogical skills. The Indian participants typically enrolled in a teaching methodology workshop and a discipline-based workshop, and had agreed to lead regional workshop throughout India. IUCEE agreed to pair the Indian participants to US mentors.

The Indian participants had the following profile¹:

- 585 participants were selected from a pool of 1400 applicants for their potential to be trainers in their own colleges and regions;
- All participants had at least a Master of Technology or Master of Engineering Degree. 25% had PhDs;
- 75% has more than 10 years teaching experience;
- 25% were senior administrators or heads of colleges;
- 24% were female
- 15% from AP, 7% from Gujarat, 26% from Karnataka; 16% Maharashtra; 20% from Tamil Nadu; and 15% from other states in India.
- 175 colleges were represented

Table 1. 2008 Summer Faculty Leadership Institute Workshops¹

Week of	Lead Presenter and Affiliation	Title of Workshop	Number of Participants
May 26	1. Richard Felder and Rebecca Brent, North Carolina State University 2. Ashok Saxena, University of Arkansas	1. Effective Teaching 2. Quality and Accreditation	84
June 2	3. Jorge Velez-Arocho and Rosa Buxeda, University of Puerto Rico – Mayagüez, Lueny Morell, Hewlett Packard Co.	3. Curriculum Innovation and Quality Assurance	60
June 9	4. Joseph Tront, Virginia Tech University 5. James Kurose, University of Massachusetts 6. P. R. Kumar, University of Illinois – Urbana 7. Veena Kumar, State University of New Jersey	4. Computer Engineering 5. Computer Networks 6. Wireless Networks 7. Effective Course Design and Delivery	104
June 30	8. Sidney Burrus, Rice University 9. Richard Anderson, University of Washington 10. Leon Osterweil and Lori Clarke, University of Massachusetts 11. Jack Davidson, University of Virginia 12. P. V. Krishnan, GIW Industries	8. Signal Processing 9. Algorithms and Data Structures 10. Software Engineering 11. Computer Security, and and Modern Compilation 12. Principles of Effective Teaching and Learning	129
July 7	13. Andrew Mason, Michigan State Univ. 14. William Oakes, Purdue University 15. Vijay Kanabar, Boston University 16. Mani Venkata, University of Washington 17. World Bank and World Bank Institute 18. M. P. Ravindra, Infosys Technologies	13. VLSI 14. Engineering Design Projects in Community Service 15. Project Management: Security 16. Electric Energy and Power 17. Autonomy and Accountability in Engineering Education 18. Academic Systems & Processes and Leadership	161
July 14	19. Alice Agogino, University of California – Berkeley 20. National Instruments 21. Xavier Fouger, Dassault Systems 22. Christopher Goh, Agilent Technologies 23. George Abraham, Autodesk	19. Project Based Learning and Sustainable Product Design 20. Hands-on Engineering using Labview 21. Product Life Management using CAD 22. Developing Leadership Skills 23. Engineering Drawing Using CAD	116

Significant follow up in the form of regional workshops conducted by the IUCEE participants are already taking place throughout India. Participants have been contacted several times to ensure they are practicing the techniques, are doing outcome based assessment, and are conducting seminars for other faculties in their colleges and regions. Over the next five years, IUCEE hopes to cover all the core courses in engineering and computer science and make the resources generated, easily accessible to faculty all over the world.

The Approach

One of the authors was fortunate to be selected as one of the faculties to be part of the IUCEE Faculty Leadership Institute and participated in the Effective Teaching workshop. The second author is his US mentor, who participated in all the planning phases of the Institute, and traveled to India to help promote the Institute in the State of Gujarat. Immediately after completing the workshop, the IUCEE participant decided to apply all the new techniques in the next course he taught to practice and see how they worked prior to conducting the Regional workshops to train other faculty. The course happened to be the second part of a two course sequence in a Master of Computer Application (MCA) program. He had taught all the students the previous semester, and now he would change his teaching methodologies adopting the IUCEE Effective Teaching strategies. This paper, and an earlier paper², describes the process of implementing the effective teaching methods, assesses the outcomes when applied to the MCA students, and describes the students' reactions to the changes in teaching methodologies.

In the next section, the Effective Teaching workshop is briefly described, followed by the impact of the workshop on the instructor, and the results of his application of the techniques learned in the Institute in the second MCA course. A brief summary of outcomes and conclusions are then presented.

The Felder and Beck workshop on Effective Teaching

The “Effective Teaching Workshop” by Dr. Richard M. Felder and Dr. Rebecca Brent^{2, 7, 9} was organized during 26-28 May 2008 in Infosys Training Campus, Mysore, India. The workshop was designed based on the following objectives³.

- Identify critical characteristics of different student learning styles and specify instructional methods that address the needs of students with different styles.
- Define learning objectives, write and classify them in terms of Bloom’s Taxonomy levels, and list pedagogical and curricular benefits of writing them for courses.
- Generate a set of handouts for the first day of a course (course syllabus, learning objectives, statement of policies and procedures) that provides the students with a full understanding of the course structure and ground rules.
- Devise preliminary course activities that capture interest and motivate learning.
- Identify characteristics of effective lectures, and techniques for obtaining active participation from most or all students in attendance.
- Define inductive teaching and learning⁴ and give examples of inductive teaching methods, and identify benefits of this instructional approach.
- Define and give examples of the higher-level (analytical, creative, critical) thinking skills of

- Bloom's Taxonomy, identify instructional conditions that induce students to develop and exercise these skills, and formulate exercises and problems that provide practice in the skills.
- Design tests that are both challenging and fair, and a grading system that provides positive motivation for learning without lowering standards.
 - Deal effectively with a variety of common classroom management and other student-related problems.
 - Identify problems associated with the teaching profession having to do with time management, starting and maintaining research programs, and assessing and improving teaching, and formulate plans to overcome these problems.

The above objectives were covered in the workshop with suitable examples and demonstrations, which had long lasting effect on all who attended the workshop. Demonstrations and interactive examples made learning enjoyable and time speed by.

More details of that workshop may be found by other sources^{2, 7, 9}, following is a quick summary:

1. On the first day the presenters covered the Learning Styles of students and shown how one can match his/her teaching styles to suit the need of all learning styles. Learning objectives and study guides were discussed.
2. On the second day how to kick start the learning process in the first week was discussed, Inductive teaching method was introduced, constructing less ambiguous and more student-friendly problems and assignments were demonstrated, and Active Learning techniques⁸ were discussed as well.
3. The third day was devoted to two important topics, outcomes based assessment and how to conduct effective teaching workshops.

The central ideas of the workshop were to understand the learner and suit accordingly, to be fair and legible at the time of assessment, and to step away from pure lecturing and innovatively engage students in some fruitful activities.

Impact of attending the workshop on the author and his teaching

As mentioned earlier, the first author was a participant in the Effective Teaching workshop. The impact is described in his own words as follows:

"Let me confess that now I realize mistakes that I have been making all these years. I was expecting students to do few things which are not reasonable (Like guessing what type of questions appear in the test, designing question papers, assignments, homework biased against few specific types of learners, not looking at outcomes for improvements etc.).

I had few burning questions like "is it not possible to increase the level of understanding of my students?" The problem of improving the underperforming student's grades was nailing me for years and I was frustrated not finding

answers to those. I also was surprised about my abilities when I can see that others are able to learn faster than me. In fact over the years I have learned that my learning, though late, is far more holistic than others. I learned that I am a global learner from the workshop and relaxed to a large extent.

Not only have I received answers to most of my questions, I am able to see new avenues to improve the performance of my students and have also learned to share it.”

Following are common problems he found teaching MCA students using traditional lecture technique:

1. Students have a short attention span. They lose their concentration and cannot describe nor properly write something explained in the later part of the session.
2. Students are not able to retain information for a longer period, particularly something which is taught in the later part of the session or when the lecture is scheduled in the later half of the day.
3. Students are not able to interact and feel shy about communication to instructors their doubts and problems
4. The result is usually poor and instructors have to usually scale up grades artificially.
5. Students are not able to work in a team and not able to express themselves

Some of the problems described above may be common with undergraduates, it is important for somebody to work with them to find out solutions.

In trying to find out solutions to the above problems, the first author adopted the following teaching in teaching the second course in the series:

1. **Inquiry and Problem Based Teaching⁵** was given additional stress. All three levels of questions; i.e. Knowledge, Application and Evaluation were asked and answers discussed in the class frequently. The Inquiry Based Teaching is usually augmented with **active learning methods**, like group activities and analogy.
2. The concept of **learning objectives** and **study guide** was introduced.
3. The sessions were re-designed and re-worked to better suit inquiry based and active learning mechanisms
4. The following **active learning mechanisms** were applied:
 - a. Minute paper at the end of every session were given to students and responses were considered in the next session

- b. Summarizing the contents of the previous lecture in the beginning by students after discussing that in a group
- c. Brainstorming for different problems
- d. Think individually and then pair discussion
- e. Discussion using group of two or three
- f. Study guides were distributed one week or more before the exam.

A few other suggestions from the workshop were also implemented:

1. Reduced usage of PowerPoint slides
2. Designing papers, homework and assignments, as suggested in workshop, to make them more readable and understandable (and more reasonable as well)
3. Be more student-centric. Realize that what I teach is not important but what student learn is important, so include lots of things to check what is learned -- results are surprising (and shocking sometimes)

All these methods were adopted from the Richard Felder and Rebecca Brent's Models which they discussed during their workshop in the IUCEE 2008 Faculty Leadership Institute. In the next sections evidence is presented showing that not only the effective teaching methods were found to be useful and working, but all students unanimously suggested that all other professors should also implement them!

Improvement in students' performance

There are two different subjects in our studies. All students are in the 5th Semester of the MCA Program at GLS Institute of Computer Technology. A total 47 respondents (students) participated in the process. At the end of first test, they were surveyed to test the effectiveness of these methods.

The first author experienced a massive impact on his students' performance after the application of effective teaching techniques in his class. Before attending the workshop he had taught the same batch of students the course Networking Technology 1 (NT-1). The subject basically deals with fundamentals of networking including the conventional models of networking and various layers and protocols in general. It starts with networking applications, physical, data link, network and transport layers and few applications. The subject also includes mechanisms for error handling, issues related to protocols of the network, encryption and other relevant topics. After attending the training he taught the subsequent subject, Networking Technology 2 (NT-2). This subject is a continuation of the Networking Technology 1 topics and deals with TCP/IP protocol stack, working of Internet, from addressing and IP and TCP layouts, to applications like DNS, FTP, SMTP, to burning issues like security.

The second subject was taught to the same set of students after the workshop, noting the following differences in performance and perceptions.

1. **Student interaction with the professor, and level of thinking:** Students have become so interactive that sometimes the professor found it difficult to control them. In the case of NT-1 he used to ask the conventional question “Any Queries?” at the end of the session, usually followed by a stony silence. In NT-2 he followed active learning techniques, where he divided students in groups and then gave them time to answer. Sometimes he would tell them to think individually and then compare their results with their friends (*Think-Pair-Share* Method). This resulted in suggestions and answers which sometimes amazed him. For example, he received the query: Why should HTTP only have controls like “only download when updated, otherwise refrain from doing so” and why not other protocols? The professor was not able to find the answer immediately! He occasionally received queries that surprise him, e.g. one student asked what will happen if we remove the network layer while working in broadcasting LAN? These were non-trivial questions that required the professor to think before he could answer that question. The level of thinking clearly rose as a result of using the new effective teaching methods in NT-2
2. **Students' approach to study:** In NT-1 students were interested in just passing the test and getting good marks. In NT-2 he found them to be more interested in the subject itself. Two examples were quoted earlier. One of the NT-2 students was so interested in learning Wireshark¹⁰ (an open source software to help study network operations by sniffing the network traffic to learn network troubleshooting, analysis, software and communications protocol development and education) that the student helped him conduct a workshop on “Network Monitoring and Security” by preparing and delivering a session on Wireshark. Quite a few of them showed desire to work in the field of networking and security. They also appeared to enjoy the lessons more. The professor conducted a survey on students regarding their perceptions and satisfaction. One previous paper by the authors presented in IEEFS-ISTE conference in Bhubaneswar, Orissa, India in 2008 describes the responses of these students and the outcomes of the survey².
3. **Students' understanding of the subject:** NT-2 students seemed to understand the subject much more than in the previous course. The survey outcome speaks for itself. The paper mentioned in² describes the point also to a greater length.

More interesting statistics relate to the results students' performance. This is the focus of this paper.

Comparison of first test results in both courses.

We compared results of the first test in both the subjects. We could have compared either the second test results or final results but first test results reflect better for the experiment for the following reasons.

1. Traditionally the first test in both classes is a strict test that is graded harshly, with no curving, with the aim of awakening those who are complaisant. Thus, results tend to be poor then the second test is traditionally easier to see that students get fair internal marks. Most of the time the second test requires being lenient while examining and curve the

result to some extent. Comparing such results may not give exact outcome of the effective teaching methods. There are no such constraints in the first test.

2. The students who does well in the first test, tends to be a little lethargic in the second test as the best of the two tests are considered. This again may skew the results and hence not preferred.

A comparison of the NT-1 and NT-2 results yielded the following observations:

- **Student test grade improved.** A total 53 students appeared in both the tests: the first test after implementing the effective teaching techniques (subject NT-2) and the first test before the workshop (subject NT-1). The marks of 37 students increased while 16 students have their marks reduced. This shows 70% of the students learned the subject better and also improved their test preparation.
- **Class total grade improved.** Total marks obtained by students in the NT-1 case was 223 (it was a 25 marks test) while the case of NT 2 is whopping 468, a difference of 245! Those who have their marks increased, the increment is 292, while those who have reduced their marks, the figure comes out to be 47. This shows that the students have not only get their marks increased, they get it done by a large margin! Those who have it reduced, most of their marks are reduced by a small margin only.
- **Class average improved.** There is one more parameter which shows the effectiveness of the effective teaching methods. The average marks on the first case were meager 4.21 and in the next case it is 8.8! More than a 110 percent increase!

Table 2 lists above information in tabular form.

Table 2. Survey Outcomes and Conclusions

	NT 1	NT 2
Total Marks obtained by all the students	223	468
Average marks	4.21	8.81
Students whose marks are decreased	16	
Students whose marks are increased	37	
Total marks increased (for students with increased marks)	292	
Total Marks decreased (For students with decreased marks)	47	
Total marks increased (For all)	245 (110%)	

Student Surveyed on their Preferences and Perception

The students after getting the above results were surveyed for their reaction to the increment or decrement of their marks, and how they felt about the role of effective teaching methods on their performance. Those whose marks increased were asked to choose one particular reason for their success and rate the effective teaching techniques in order of their contribution in their success.

Those whose marks decreased were asked to give one reason for their failure to score a higher mark, and comment on if the effective teaching methods were still useful to them and rank the techniques according to their preference using a scale from not useful to extremely useful. All the students were also asked if they preferred these techniques to be deployed by other faculties as well. A total of 30 respondents whose marks increased were available for surveying, and a total of 7 whose marks decreased were available for the survey. A few of the students were detained, as they could not clear the subsequent external exam. Most of these have marks that decreased. They were not available for the survey and a few others could not be contacted.

Student Assessment of Effective Teaching Techniques

The ranking of effective teaching methods by both the groups of students (those who have their marks improved and those who have them reduced) is almost identical.

- The unanimous first choice of preference is *Active Learning*.
- Second choice is *Summary in the Beginning of a Lecture*.
- Third is the *Inquiry Based Approach* where they have to work to find answers to queries and problems in the class.
- *Study Guides* is fourth for those who have their marks increased and *Minute Paper* is fourth for those who have their marks decreased.
- At the fifth position it is *Minute Paper* for the increased marks group and study guide for the decreased marks group.

The most important reason cited for increment in marks is through the combination of *Inquiry Based Approach* and the *Active Learning*.

The most important reason for decrement in marks is shared by three different reasons.

1. The first one is student's own *Inability to Study*,
2. second being *Inability to Talk to Others* and
3. third being *Complacency*.

It is important to note that NONE blamed any effective teaching methods for their decrement.

All students, whether their marks are increased or decreased, unanimously agreed that the effective teaching techniques are useful to them and more importantly, they encouraged that the techniques be deployed by other teachers as well.

Conclusions

All students unanimously agreed that the new teaching strategies learned by the instructor at the IUCEE Faculty Leadership Institute were very effective and recommended that other teachers should also implement the same. This was tested with 53 students that took the first of a sequence of two courses before the professor had been taught the techniques, and took the second course where the professor incorporated the techniques into his teaching methods. The results on the student performance showed that 70% of the students improved, and the class average improved by 110%. Improved marks were attributed to the combination of Inquiry Based Approach and Active Learning techniques. The instructor felt that he needed to work on the techniques learned to improve performance of students who did not fully engage in the

strategies. The 30% of the students that failed to engage in interactive techniques cited reasons such as: their discomfort mingling with others, their own inability, and complacency as the main factors that kept them from fully engaging. This problem requires other solutions other than making teaching more effective, perhaps addressing lack of socialization and lack of motivation. None attribute any negative perception to the new techniques that were applied.

The IUCEE Institute participant found that his experiences implementing the strategies learned in his own classroom, on a two part course, where the first part of the course was given prior to taking the IUCEE Institute and the second part utilizing the strategies learned in the Institute, have yielded results that have proven that the teaching strategies taught at the IUCEE Engineering Faculty Leadership Institutions are very effective and work in his own classroom. Collaboration and interaction with the US mentor have resulted in pedagogical publications in international conferences², and further technical research collaboration and publications are planned which focus on the effectiveness of Regional Workshops to disseminate the effective teaching techniques to other Indian faculty. Regional Centers support Regional Workshops with materials that were generated during the 2008 Institute.

IUCEE plans a Second Indo US Engineering Faculty Leadership Institute to be held Summer of 2009 from June 22 to July 10, 2009 at the Global Education Center of Infosys Technologies at Mysore, India, with the objective of building on the success of the First Summer Faculty Leadership Institute held in 2008 and the follow up work being done by the Regional Centers. This Second Institute will admit, in addition to the Indian faculty participants, a limited number of participants from other regions, such as Latin America and Africa, where the IUCEE model is being studied for replication¹¹. More applications and more detail on the Faculty Leadership Institute can be found at the IUCEE web site¹.

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