Instructional Methodology in Engineering: A Continuous Process

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Abstract

This paper highlights some general instructional methodologies for engineering educators. Teaching methods and teaching skills should be continuously assessed. It is essential that educators prepare students for the future work place. Teaching with enthusiasm can inspire student interest and love for the subject. Students retain more when actively involved in a classroom setup or laboratory environment. Another such active learning situation involves students working for the industry as part of their educational requirements and preparation for the future workplace. Engineering educators must recognize these important aspects of engineering education in preparing students for the future workplace. Instilling management skills and the ability to communicate effectively and prepare students to be future leaders are challenging tasks facing all educators.

Introduction

Poor quality teaching is still a common grievance of students. The problem is often cited as a lack of effective communication, such as talking fast, writing excessively, giving unclear concepts, reading from the textbook, not expressing some of the basic concepts, and not explaining the purpose of a particular item or how it is used in practice. Students complain about instructors that apparently lose direction in their presentations or who at the end of a presentation realizes he/she has made an error and must then go back to the beginning of the problem to rework it, thus hindering learning and undermining confidence in the instructor. Another complaint from students is that busy or uninterested professors often refer them to teacher assistants (TAs) or their classmates for discussions about class material.[1]

There is much to learn about teaching. It is a continual process of assessment and practice. An individual teaching assessment plan begins with establishing teaching goals, identifying specific objectives to attain goals, developing performance criteria for each objective, deciding how to put these into practice to achieve goals, measuring performance and effectiveness, reassessing the goals, etc., becoming a continual process of evaluation over time. Instructors must select appropriate assessment methods for each objective, conduct assessments, determine feedback channels, and evaluate whether the performance criteria were met and the objective achieved.[1] To present a subject clearly and effectively requires advance planning, preparation, and organization to ensure that objectives are stated and allotted time is utilized efficiently.

Getting students "turned on" to engineering requires that engineering teachers also demonstrate a love of the engineering profession. It is love and enthusiasm for the profession which triggers teachers to teach at a level that satisfies their students. Students are always anxious to learn fundamentals and love to experience the satisfaction of their application. It is the art of this "knowledge transfer" which is such a great challenge to educators.[2]

It is the author's experience that active learning situations, along with constant interaction with students, will stimulate interest in a course. Interaction between teachers and students encourages students to be independent and creative, and to develop critical thinking. Instructors need to update their knowledge of the subject on a constant basis. To stick with a textbook is not enough, and revising class notes is essential for continuous course improvement.

Preparing Students for the Future

Researchers have found that students retain approximately 70 percent of what is said in class and about 90 percent of what is both said and done. Emphasis on active learning rather than passive learning is therefore preferable. It is true that "chalk talk" is not dead in the classroom, but we, as instructors, must change the teaching process in such a way that students can learn to think and understand the big picture. Students must learn to be farsighted and have a global overview of where technology is going with an understanding of engineering solutions in a societal context. Also, instructors must utilize available resources such as new communications technology and invite experienced practitioners to class. Instructors must be aware of community and future market demands for constantly revising course materials. More progressive educational institutions and commercial firms take advantage of modern communication technologies, such as the World Wide Web. Television and videotaped lectures, as well as using guest speakers are utilized by some instructors as teaching aids other than textbooks and regular lecturing.[2]

Instructors have great responsibilities to encourage students in producing high quality work using their best intellectual capabilities beyond the realm of classroom subjects. Instructors must provide students with experiences and opportunities for insight and improved self-image which cannot be readily obtained via a computer screen. Engineering involves teamwork, and learning how to associate with others and how to work in teams is a necessity. Not only must these messages be conveyed clearly, but teachers must insist that what students learn is useful in their present and future careers. Instructors must advise students on how to survive in their future work place and inform them that regardless of past contributions to the workplace, when layoffs occur, the narrowly trained engineers are usually let go.[2]

To help build prestige in the field of engineering, engineering teachers, scholars, inventors and creative thinkers should be fully credited in the community arena for their contributions to the field. This could be promoted by politicians, institutions, and the society-at-large giving recognition and credit for engineering marvels and new inventions to those who invented and developed them rather than superficially and unemotionally giving associated company or individuals' names who happen to be famous but did not contribute to the engineering of the object(s).[2]

Industries, of course, desire to be profit-making and to grow. Colleges and industries must understand how industry transforms the latest technological breakthroughs into useful products and services, so that those advancements can also have a positive impact on education. Keeping those in education apprised of the latest developments is an important activity for any company that wants to employ skilled people on a sustained basis, and colleges and universities can also help companies provide internal education, as well as offer their research capabilities, thereby mutually benefitting each other. Building this type of bridge between industry and education helps educate students for the future. Another aspect of this type of preparation is that students, knowing before graduation which companies or industries may hire them, can select classes that will best prepare them for the awaiting jobs.[3] Industries and government must try to create direct links between their research departments and universities. The future agenda and research needs of all parties can be enhanced by developing links that will benefit everyone including students.

Benefits of a Joint Venture Between Educators and Industry

The gains of industry from university involvement, and vice versa, are significant. For instance, industry can gain access to university laboratories, faculty, and student resources; and by receiving the products, processes, software, and services that university students and faculty create, industry can further its own growth and prosperity. The results are often an increase in high-paying jobs, and new, expanded businesses which benefit the whole community.[4]

Students can benefit from the opportunity of industrial contact and access to state-of-art equipment of the industry, as well as hands-on-experience, teamwork, real-world application, and having to culminate their experiences and work in a final project report presentation, which helps students practice their writing and speaking skills in a very practical application. Faculty benefit from joint ventures with industry by being exposed to the latest needs and technological developments of the industry.[4]

These mutual benefits can only be accomplished by colleges and universities taking aggressive steps to incorporate these efforts into engineering curriculum and allotting sufficient time for faculty to do the following[4]:

- Visit companies and make presentations demonstrating the type of research your college can do.
- Invite prospective partnering companies to campus to make presentations on each company's research needs.
- Build a network of personal contacts with prospective partners.
- Enlist community organizations in marketing partnerships in the community.

Aggressive steps from both industry and universities could make such a joint venture work. For instance, a technical coordinator could be assigned by industry to constantly observe the progress of a research project and the student presentations at various stages of task completion. The instructor could work with the student body to make sure that the project proceeds in following the goals, objectives and performance criteria, and to assess each task, evaluating whether the performance criteria were met. This process might be course-type related, however, the process could be modified to fit the course subject. In a joint venture, responsibilities of each party must be mutually understood by the partners. It should be clear that the process must help both sides, despite being an academic program, and it should also be a professional service. Students know they must keep to a schedule, meet deadlines, make presentations, and write reports. It should be team work under the guidance of an instructor and an industrial professional engineer.[4]

In such a venture, each discipline within the college profession must work to identify the types of industry, government or consultant group that would best fit their subject. Although distance from the appropriate organizations might be a problem, with proper working relationships and planning, distance constraints can be handled.

The author witnessed a very interesting university/ industry partnership while he was on a Fulbright scholarship in Qatar during the 1993-94 academic year. The College of Engineering at Qatar University incorporated into the curriculum for each department three months of practical training. Students worked on a project and then wrote a final report on the project. From time to time according to schedule, faculty members went to student job sites and met with their professional advisors and students. Students provided scheduled briefings beneficial to their keeping up with their work on the project and the related project report for class. The instructor kept the industrial partnership climate cooperative and benefitted from contact with professional engineers and from witnessing his students in practice. The instructor, therefore, brings to future classes a more practical knowledge which can make his presentations more pragmatic as well as more clear and understandable to students. There are scattered data about how the university/industry partnership helps students and instructors. In general, the literature has cited great benefits to both instructors and students. Also, new curriculum and new courses have been introduced as a result of such partnerships.

As teachers we must evaluate our teaching skills constantly and continuously plan for each class. Teaching strategy and teaching assessment methods must be developed to determine if students are learning and where improvements must occur. Conscious efforts to teach clearly and to determine if students are truly learning is the most important challenge we teachers face today and in the future.

Students must be informed about technological progress, investment strategies, and the consequences of their assigned work on the environment. Engineering instructors need to gain a technical background to be able to make long-term forecasts about technological trends, and students need to achieve strong engineering backgrounds to ensure national and international marketplace survival. And, with the trends in today's work place, students must be capable of solving problems in team-type arrangements.

Today's industrial growth, fierce market competition, tough job competition, technological advancement, and international business climate put great pressure on colleges and universities to produce young educated engineers responsive to rapid market changes.

Conclusions

This paper has focused on several issues related to classroom education and student learning. Student complaints should be heard through a student-teacher evaluation process, through input received by the department chair from concerned students, and through direct communication between teachers and students. The goal of every college instructor should be to give basic concepts and wherever possible relate them to real life counterparts when lecturing students. Teaching goals should always be assessed with the changing times and the development of new technologies. Teaching-learning should be a continuous process. Objectives to attain teaching goals must always be assessed in light of new technology. Measuring performance and one's teaching effectiveness should be the sole concern of every instructor during and at the end of each semester. The love for both teaching and the engineering profession bring enthusiasm and interactive teaching that triggers active learning situations for students. Preparing students for the future is an important challenge that all instructors must strive to achieve. In this process government and industry can play major roles. Teachers can invite guest speakers from government and industry and make visits to government and industry to remain updated with the state of the art. Building a network of personal contacts with government and industry not only benefits the instructors and students but also benefits other prospective partners. Joint ventures are healthy for any prosperous community. Students will have opportunities to take projects in an industrial or government set up as part of their education requirements. Furthermore, instructors need to maintain a knowledge of the state-of-the-art in industry to be able to prepare students for these demanding global market growths and changes. Engineering educators must also cultivate a love for engineering in students. The student becomes very much like a product that the educator should be proud to deliver to society. Graduate engineers need to be practical and able to solve problems, as well as take pride in their work.

Finally, in preparing students for the workplace, instructors must nurture leadership and management skills in our students and prepare them to be strategic thinkers with the ability to conceptualize and communicate effectively, as well as possess practical business skills to become decision makers and leaders. In general, instructors need to make special strides in using their personal qualities and teaching skills toward the success of their courses.

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