PROCEEDINGS
Ingredients for Change

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Abstract

Engineering education must develop to keep pace with challenging demands of today. Even it has been much studied during the past fifty years, but still industry complaints about skill deficiencies in engineers. Thousands of research studies showing serious deficiencies in applied teaching methods have all provoked calls for changes in how engineering curriculum are structured, delivered, and assessed. Most of academic staff and administrators as might be expected are less than enthusiastic about the proposed changes, they argue that the system functions well and needs no radical revision. Four focal issues involves in this debate: a) how engineering curriculum should be structured b) how engineering courses should be taught and assessed, c) who should teach, and d) how the teachers should be prepared. We have tried to outline two conflicting paradigms for engineering education in this paper: the traditional one, which has dominated engineering education for at least a century, and the emerging one.

Keywords: Challenging demands of Engineering education, Skill Deficiencies in Engineers, Outcomes-based Engineering Program.

1. Introduction

Engineering education has seen tremendous growth over the past decade, both in number of students and number of colleges; however the average quality of the colleges and graduated students has become suspect. Employers of engineering graduates complain that their new hires lack high-level analytical and critical thinking skills, communication and teamwork skills, and understanding of engineering and business practice. On other hand university administrators and staff members still not aware of that traditional engineering jobs will increasingly be done in the future by either computers or engineers in countries with low labor costs. To be competitive, future engineers will need to be equipped with skills that have previously not been emphasized in engineering curriculum, including critical and creative thinking and entrepreneurship [1]. Response against these demands is still negligible, if we walk down the hall of an engineering building at most universities and glance into classrooms, we would still be likely to find teachers teaching the same topics that were taught three and four decades ago in the same way they were taught then.
This paper outlines two schools of thought the traditional one, which has dominated engineering education for at least a century, and the emerging one then contrasts their positions on three issues:

a. Redefining engineering curriculum
b. Teaching and constructive learning
c. How much is a teacher worth?

1.1. Redefining engineering curriculum

Engineers usually work in a business environment. Many companies or business formations are based on technology, making it essential that engineering students are introduced to the relevant principles, processes, and practices of technical entrepreneurship. Furthermore, the globalization of the economy has dramatically changed the environment in which engineers practice today. Institutions need to prepare students for this new world of opportunity and challenge [2]. The rigorous demands of engineers’ technical training, as mandated by engineering accreditation and the fundaments of examination required for licensing, and the university core requirements that apply to all students, leave little opportunity in engineering curriculum to prepare students to function effectively in this global, entrepreneurial environment. Its time of a joint initiative of Business and Engineering Institutions to replace the customary, stand-alone courses in engineering economics and technical writing with a carefully designed two-course sequence that fully integrates the teaching of engineering economics, professional communication, and global entrepreneurship to maximize the synergism and provide more realistic learning experiences that mimic entrepreneurial business practices in technical companies or start ups.

1.2. Teaching and constructive learning?

The disadvantages of the traditional teaching style are

- Places students in a passive rather than an active role, which hinders learning.
- Encourages one-way communication; therefore, the lecturer must make a conscious effort to become aware of student problems and student understanding of content without verbal feedback.
- Requires a considerable amount of unguided student time outside of the classroom to enable understanding and long-term retention of content. In contrast, interactive methods (discussion, problem-solving sessions) allow the instructor to influence students when they are actively working with the material.
- Requires the instructor to have or to learn effective writing and speaking skills

There are several ways to help students make the transition from passive listeners to active participants in their own learning [3].

- Start off slowly; students may not have much experience with active learning.
- Introduce change at the beginning of a course, rather than midway through it.
• Avoid giving students the impression that you are experimenting with them.
• Don’t give up lectures completely.
• Anticipate student’s anxiety, and be prepared to provide support and encouragement as they adapt to your expectations.
• Discuss your approach with colleagues, especially if you are teaching a well established course in a pre-professional curriculum.

Some suggestions for engineering institutions what they should do for this

• Engage students of engineering in their first year and help students to establish an early identity as an engineer through exposure to engineering coursework, early research experiences, experiential learning, and the context of engineering.

• Address poor teaching (some in non-engineering courses) and advising that is cited by many of the students leaving engineering.

• Provide opportunities to work for the public good, to take advantage of student interest in public service.

• Develop more active learning approaches to engineering and science, as well as practical exposure to broadening engineering education, through university-government-industry partnerships.

• Rethink the curriculum to include not just knowledge, but also skills and attitudes. There should be a focus on building an understanding of what it means to be a lifelong learner and building the related skills.

• Consider offering engineering courses to non-engineers.

• Reintroduce the history of engineering into the engineering curriculum. They should teach, for example, not only the Laplace transform but also teach who Laplace was and how he influenced math, engineering, and philosophy [4].

1.3. How much is a teacher worth?

Teaching excellence is an on-going engagement with the scholarship of learning and teaching, an understanding of how students learn a promotion of interactivity, and an all-round enhancement of student learning. Teaching is an important activity of engineering teachers, both in regard to content and in relation to students. New teachers are usually superbly trained in content, but often have very little idea of how students learn [5]. The common misconceptions in teaching

• I learned how to teach by watching my teachers.
• Good teachers are born and not made.
• If I am a good researcher, I will automatically be a good teacher.
Some of the characteristics of good teachers may well be inborn and not made, but the same can be said for engineers. We expect engineers to undergo rigorous training to become proficient. It is logical to require similar rigorous training in the teaching methods of engineering teachers. Secondly researchers who are also good teachers should continue to be the mainstay of faculties at universities. It is also important, however, for some staff members possibly in collaboration with researchers from other disciplines to conduct applied research, building on the discoveries of the frontier researchers to benefit industry and society [6]. Some suggested approaches for teachers to improve results

- Using content modules instead of courses to allow greater customization of curriculum.
- Focusing on threads of knowledge that connect different pieces of the engineering curriculum.
- Using student involvement in the design of the curriculum.
- Providing first year students with hands-on engineering and integrative experiences that involve design, imagination, and communication.
- Emphasizing social relevance, collaboration, and problem solving in the curriculum.
- Focusing on courses with some systems content in addition to component level content.
- Using more independent inquiry and open source learning.

A great teacher truly believes that her or his students are capable of great things.

Teaching is a highly skilled profession whose practitioners are not routinely given some training before or after they enter it. Common presumption is that if you have a degree in a subject you must also know how to teach it. Mostly this presumption is seriously defective. Effective instructional development for both current and future academic staff can take years off the usual to become as effective in teaching as they are capable of being [7].

2. We can afford all this?

Most of the practices listed in this paper require no resources to implement, but still in some matters cost is one barrier. Some of the proposed changes to engineering education involve investments in new curriculum and more faculty-student interaction. Another barrier is that the engineering curriculum is already very tight, and adding more courses requires taking out other courses or increasing the length of the degree. Taking material out of the curriculum leads to concern that the traditional curriculum is being
watered down, and there are concerns about how employers would react. Many of the proposed changes may require more faculty time in teaching, potentially detracting from research. Engineering education reforms need to come from the bottom up, but also need strong leadership and support from the top down [8]. It was also pointed out by some of the industry representatives that education does not stop at graduation and collectively industry and academia need to think about lifelong learning.

Another challenge is the increased burden that many of the activities for enriching the engineering education experience would place on faculty. Faculty members have a finite amount of time, and if they devote more time to these kinds of activities, what can get dropped from their workload? The issue is the culture of academic engineering which emphasizes research, teaching, and service, in that order.

- Get industry involved to provide advisors on a pro bono basis.
- Use engineers recently retired from industry as “Professors of Practice.”
- Use upper-class students for assistance in classes and extracurricular activities.
- Hire facilitators/assistants to complete administrative work that faculty do not need to do.
- Conduct a review of how faculty spends their time to see if time can be freed up.
- Submit proposals for funding to do innovative things.
- Ask the administration to define goals for each department, but let the department decide how to meet the goals by distributing research, teaching, and service activities among the faculty, considering faculty members’ interests and priorities at different stages of their careers [9].

3. Conclusion

As noted at the beginning of this paper, industry have been exerting increasing pressure on universities to pay more attention to the quality of their engineering teaching programs, and growing competition for a shrinking pool of applicants for engineering school has provided further impetus for change. Engineering is a key component of innovation and our technological society. Changes on a global scale are rapidly occurring for engineering, and it is needed to respond quickly and informatively. It needs a marketing facelift too. There is a need to craft messages that will attract students, parents, counselors, and teachers. The messages should emphasize that engineers work in teams, create jobs and value, are global innovators and leaders, and start companies. Engineering graduates succeed in many fields, from investment banking to medicine, and engineers will play a role in addressing the world’s biggest problems, from global warming to poverty to nuclear proliferation.
Limitless imagination, engineers imagine things and see possibilities. Freedom to explore, engineers are never bored; they are constantly being challenged. Life involves engineering, from medical equipment to safer water to microchips.

References


