Discovering Innovative strategies in teaching processes

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Abstract
Managing the educational design factory is the primary job of an educational administrator. Developing a versatile graduate in a record time (4 year) as a reliable product is the test of peak economic performance of the system. This paper would apply “lean logic” to achieve optimized teaching and peak performance strategies. Strategies, benchmarks and breakthrough methods to maximize return of the students’ investment and boosted graduation rates will be presumed as indication of improving teaching processes. This paper would elaborate on methods for broader basic knowledge and experiences in education of engineering courses. On making quick and accurate evaluations of educational methodology, to satisfy the “win now” or get the degree appetite of students and industries, a product development strategy will be obtained to assess the full value of engineering education and enhance corporate growth. Real world, “how to’s” from the emerging trends and measures for advanced teaching and research will be given. The paper will present how people learn from the point of view of students in two hundred level courses in Southern University. It would try to prescribe what works, what matters and what lasts in general, for all undergraduate engineering courses. Though, in this paper focus is derived from all engineering courses, it is possible that same conditions exist in teaching of many other STEM courses, thus, leading to identical conclusions for them too.

Introduction
Many industrial CEOs linked with research are now asking tough questions about their once cloistered R & D operations: “Why so few hit products and technologies are making it out of the labs into the market? How many of those pricey engineers are really creating game-changing products, and producing technology breakthroughs?”(Business Week 3/12/2005) but very few have got the right answer. On the other hand, in Undergraduate Schools too many repeats in difficult and core elective subjects suggest that attrition should be on the rise, and low graduation rates should be an inevitable consequence. Students think that test grading has to be improved, partial credits and quizzes should be increased and group work should be encouraged. Distinguished faculty and world’s leading experts have formulated three necessary ingredients in high quality learning and how to achieve success: A good student, a good professor and a good book. The main problem is in defining how best to apply these three ingredients including configuring for optional use and effectiveness in future trends.
Learning Objectives

In July, 2002 Bucknell University conducted (every year, for the last five years) a workshop for undergraduate engineering and science faculty to enhance their skills in (a) Using active, cooperative and problem based learning, (b) Using teams in class room, (c) Teaching problem solving, (d) Integrating technology and pedagogy and (e) Building faculty teams. However, it could not successfully introduce the faculty to principles of instructional design and emphasize hands-on-development of practical instructional materials for classrooms. Thus, it is of immense importance for educators to 1) learn and integrate effective instructional design techniques for their courses, 2) identifying specific learning outcomes for their courses 3) evaluate and discuss best practices in teaching and learning, 4) develop cooperative or problem based materials 5) develop effective communication, team work and problem solving skills to use with student teams, 6) identifying efficient and effective uses of information technology in their courseware, 7) develop appropriate assessment tools to measure the effectiveness of the learning materials and 8) find a support structure to continue educational innovations continuously.

How to improve Engineering Education?

The need of a strategy shift: Before we plan the strategies, let us define some of the attributes of an engineer. Traits of a good engineer are (a) Common sense (b) Basic knowledge and continuous learning (c) Ethical use of principles and intelligence (d) Hard work and good moral character. Every student who knows and conforms to these simple features would be able to have a profile of an excellent engineer. It is also important to define what some smart companies want. The core of the industry has not changed: They are trying to solve the problems of technology, and they want to do it in an upright, visible, and transparent fashion. People need to understand how important engineers are in the process, what their role is and what expectations are. To facilitate that implementation, trainers have developed the “Create and Win” program designed to spread the new sales and manufacturing techniques. It is just like doctors are trained in their residency period. As the adage goes, change is taking place everywhere, the only constant is change. Thus, new research questions were asked to engineering students to assess and improve the quality of education delivered at Southern University. The eight simple research questions were: 1) What is the impact of active learning on student retention in the electrical engineering department? 2) How does the prior knowledge, a student brings to our class affects the quality of understanding of solid state electronics? 3) Do computer projects improve learning in my course electronic properties of matter (ELEN212)? 4) How does part-time working affect the academic performance of students in Southern University? 5) Does a student’s grade point average indicate how well he/she has learned engineering concepts? 6) Does a student’s grade point average indicate how well he/she will perform in their first engineering job? 7) Does student’s cognitive development accelerate by solving open ended design problems? and 8) What level of cognitive development is required for our graduates to be successful in their job?

These questions were given to the ELEN212-electronic properties of matter class to reply in the form of a report, in order to give a feedback on how to improve teaching and suggest a breakthrough in face to face teaching methods. Most of them wrote that engineers often leave school with technical know how but without being workplace savvy. They are not able to act in a street
smart manner, are not able to write in a practical way, speak or listen effectively and act fast. This makes them engineer but not a successful one. Thus, a new course work has been introduced in Southern 2006-2008 Curriculum called as Technical Communication-ENGR230 for 2 credit hours, offered in the first semester of sophomore year. On the other hand IEEE Spectrum’s Careers site [http://www.spectrum.ieee.org/careers](http://www.spectrum.ieee.org/careers) gives entry level engineers more effective and creative training for the workplace. Another effort is made by ASEE in producing careers in fire protection engineering [http://www.FPEmag.com/careers](http://www.FPEmag.com/careers).

**Academic problems faced by the Customer:** Our students or customers often feel: (a) Graduation takes too long, (b) There is too much bureaucracy in the system, (c) New subjects aren’t happening properly (d) Good subjects aren’t getting the resources and infrastructure they deserve, and sometimes bad subjects linger around too long (e) too many courses in development pipeline (such as online courses) and often prove to be of low value and (f) many best practices – such as ABET criteria in senior design projects are lost. In such capstone projects getting the right product definition is sometimes missing with too many good students. These are major issues that plague many programs and seriously detract students from quality performance. The freshman year is crucial to retain engineering students in the program. Electrical engineering is known to have “gate keeper” courses such as calculus, physics, chemistry, introductory engineering courses and electrical circuits. Instead of using these to weed out our customers (students) we have to treat them as raw material and design these courses to motivate and master them. Molding them in the first semester will produce greater retention than incurring additional costs to revamp subsequent courses. The mathematical skills of freshman students particularly in calculus I and II require close monitoring to ensure greater success in engineering subjects. All professors should involve students in small scale computing problems, and in all such efforts attitude of the professor is most important. Students can figure out easily when professors care and when they really want them to succeed. Students like to feel welcome and accepted as individuals, both of which are difficult to manage in large classes.

**Program Strategies**

The most important thumb rule nature has taught us to use is one must never try to replace basic human needs with technology. It is the cognitive ability of a person that has to be enhanced and trained for doing a certain kind of engineering. Reduced cognitive ability requires human contact and interaction to build it up. Though cultural upbringing of a student is very important, one sees that socially engineers and humanists behave differently when interacting with their colleagues. **Nurturing / Mentoring:** It is a known fact that the engineering students look around and see non-engineering students not working hard. They say, “Why am I killing myself for this pleasure deferred program?” The reason that they chose engineering is that someone told them they are good in math and science. To nurture and engage those in a wee bit of research of some kind will help build their dream. A good mentor is needed for help, though the student may be a person who never asked for help in high school. Faculty should produce such a nurturing atmosphere – with open-door policies that it becomes a part of every day culture for the students to drop by faculty offices. We should get more involved in hands on mentoring, it need not be that the focus has to be on the subjects taught to them. It could be something very general such as engineering design. For example engineered systems operate by transforming input energy into output energy (see Fig. 1).
Students should know that in reality no product functions perfectly because every system is affected by noise, which results in energy transformation that is less than 100% efficient. Eventually loss in efficiency manifests as variation in performance and could get in the next phase of design. Effective interdisciplinary mentoring is important and essential for faculty members to form teams and ensure healthy participation and development of students. In 1998-ASEE-GSW Houston Conference Angela Patton and Richard Bannerot introduced Chindogu(shin-dough-goo) style of design to introduce art + engineering design aspects together. Chindogu was introduced in Japan in 1985, coined from “Chin” meaning unusual and “dogu” meaning tool. Chindogu are man made objects that have broken free from the chains of usefulness and represent freedom of thought and action. Thus, a chindogu must exist, inherent in every chindogu is the spirit of anarchy, chindogu is a tool for everyday life but not for sale, humor must not be the sole reason for creating a chindogu, it is not propaganda, prejudice or a taboo and cannot be patented. Such a design course at sophomore level will bring complementary subjects such as art close to engineering. Though introduction of new subjects such as nanotechnology and biotechnology lead a way to introduce interdisciplinary research, it is difficult to build such research centers without federal or NSF funds. Funds should be set aside and specially offered to HBCUs because of their lean budgets and need to enhance engineering growth. Such courseware will show how to solve difficult technical problems, enhance leadership skills and give a clear idea of an engineer’s career potential.

**Strategies for good teaching**

Education of pre-college students should be activity based or inquiry-oriented to prepare them for technology-oriented careers. Assuming that the high schools do their job and make their curriculum “design-oriented” and “student-focused”. Our work will start with a problem-solving and hands-on curriculum for learning enhancement of freshman engineers. The general principles and implementation plans will depend on the teacher, class sizes with small and large enrollments and assessment data. You will see that (Fig.2), to have an interactive learning process all the tools are important and must be used (see NRC(2000) Report- http://books.nap.edu/catalog/6453.html ).
Conclusions

According to ELEN212 students these tools would provide, firstly, a sound understanding of the subject so that their studies of electronic circuits and systems will be meaningful. Secondly, it would develop the basic tools with which they can later learn about newly developed devices and application. The ten rules they believe professors should consider for better teaching comes from a population of more than 47% of the class. Step one: Good teaching is as much about passion as it is about reason. A better teacher motivates students passionately and tells them how to learn, in a relevant, meaningful and memorable way. Step two: Good teaching is about the real substance and taking students as customers of knowledge. Step three: Good teaching is about listening, questioning and evaluating the student assuming each one is different. It is about developing oral communication and eliciting response. Step four: A good lecture is not always about a fixed agenda and being rigid, but being flexible and deviating from the course syllabus or schedule, if there is more and better learning elsewhere. Step five: Good teaching is about style and entertainment, for better assimilation of the text. Step six: Good teaching is about humor, for making jokes at your own expense and to break the ice for a more relaxed atmosphere. Step seven: Good teaching is about caring, nurturing and developing talents of each student in the class. Good grading and preparing materials to enhance instruction indeed helps Step eight: Good teaching is supported by strong and visionary leadership. Step nine: Good teaching is about mentoring between senior and junior faculty, teamwork and being recognized by peers. Step ten: Finally, good teaching is about having fun and experiencing pleasure. Good teachers practice their craft not for the money or because they are compelled to, but because they truly enjoy it and because they want to. Professors should make group work important and involving the students in a learning process of periodic review and questioning makes them respected for their achievements. These are the how to’s for improving teaching methods of a good teacher. A student is actually our client and the industry is our customer. We have to establish programs through which scholarship of engineering may realize its full potential.

Grades and Graduates: While very many large US engineering schools have the problem of too many students, which is dealt with enrollment management divisions, our focus is not to keep enrollment levels down but give a chance to Afro-American population in this geographic region and maintain or increase enrollment to a satisfactory level. Recently, highly fluctuating enrollment rates were visible due to a natural disaster, movement of ethnic population and resistance of manufacturing or industrial complexes to come up in the south. Even then a modest increase of 12% was visible. The graduation rates per semester were about 20% of the enrollment. Due to beginning of selective admission and a fresh policy of recruiting and retention our growth rate has been noteworthy.

Industries: Industries have taken steps (TI-Adtran- Raytheon and Freescale) to collaborate with active learning efforts and participated in curriculum development and senior design projects. Our graduates have been adaptable to changing engineering profession and have moved to higher corporate levels; still we are strengthening and modifying our curriculum.
References


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