Critical and Unconventional Analysis of General Education Requirements for Engineering Students

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Abstract

Engineers are deemed "logical problem-solvers", a trait that attracts students to the field. However, the students' confidence-building skills in their ability to solve generalized "flow or balance" problems, requiring "follow-through" and "logical set-up" are being ignored throughout their college years. Outside of the realm of end-of-the chapter problems, ABET sets protocol on design and capstone content, allowing universities to set their own general education requirements (GER). Hypothesis: the biggest constraint to student growth and maturation in college is posed by university GER. This presentation serves as a formal "call for action" to delineate and discuss the engineering students' best interest in a university education, GER in particular, and discuss the feasibility of change in liberal/social arts –dominated universities. What are the basic skills required of an engineering graduate, for whom math and natural sciences are already superb? Consider the following: (1.) nonfiction ACS-style writing and presentation skills for various audiences, particularly MBA and legal backgrounds; (2.) healthy ways to balance long hours, travel, families, career, finances; (3.) time management, ability to identify and prioritize; and (4.) continued professional development. These are four probable expectations in our graduates' near future. Hence, concise survival skills that address these issues should be developed. Personalized choices for (1.) healthy exercise; (2.) healthy eating/cooking; (3.) ability to evaluate mortgage, building materials, contractor choices; (4.) evaluating legal and investment choices; (5.) marriage/relationship survival and theology; (6.) tips for success in small or large corporate offices; (7) healthy hobby and R&R choices, art/music/dance classes; and (8.) basic home and auto repair should be offered and encouraged. Instead, categories of limited classes that address objectives written by faculty predominately in the college of arts & science focus on fictional writing and subjective-based classes, often with politically-correct liberal thought genre. These choices do not address our engineering graduates' most important needs.

Introduction

Higher education in general, and general education in particular, is assumed to produce graduates "learned" and generally "aware", and provoked into a yearning for a lifetime of learning. This is a daunting feat when the university as a whole is served by one general education (gen ed) committee, often dominated by faculty from humanities, social sciences, and liberal arts. The

curriculum and gen ed committees, as well as other groups responsible for "certifying" courses as satisfying critical thinking, writing, and speech requirements, are usually not well-represented by engineering and other professional schools such as business. Hence, the needs of each unique school or college within the university are not equally served. The thesis of this paper is as follows: the current general education curriculum, typically a set number of required semester hours (sh) under an umbrella of categories, does not serve the present or future needs of a typical engineering (or other professional) student, particularly if they were designed toward the "typical" liberal arts major. General education *is* needed to accomplish the "total education" of a "typical" engineering graduate. However, the choice of categories, the courses in these categories, and the typical student they should serve should be markedly different for engineers compared to general arts and science graduates. Professional organizations such as ASEE (American Society of Engineering Education) and ABET (Accreditation Board of Engineering and Technology), as well as specialized areas such as AIChE (American Institute of Chemical Engineers), must assume a leadership role in academics to ensure engineering graduates are being served in their best interest, and to the best ability of engineering professionals in a position of leadership, rather than simply supporting the status quo in universities. The large number of faculty in Arts and Sciences are dependent upon current general education "rules", written by themselves, to provide their workload, particularly in "underenrolled programs". Currently, ABET defers to university general education requirements.[1] One exception to this is Olin College, where ABET, ASEE, and professional engineering organizations appear to have significant input in what serves the best needs of their engineering students. [2]

Diversity and retention are important issues on university campuses. Many universities' specifically state these as goals in their gen ed component. Interested readers may peruse these lists by accessing the CAGLS (Council for Administration of General and Liberal Studies) lists assembled at their website [3]; this organization establishes criteria with AAC&U (Association of American Colleges and Universities), accessible at their website [4]. From the CAGLS website, AGLS may be accessed (Association for General and Liberal Studies).[5] These references provide an overwhelming collection of pedagogy, semantics, and self-serving rationale for the current gen ed offerings at most universities. Few, if any, engineering faculty are members of these teams. The AIChE website lists approved programs,[6] and these can be cross-referenced with the lists from CAGLS for comparison of the general education programs.

Defining the Typical Engineering Student

A "standard state" is always a good place to start. By defining a typical engineering student, and exploring what likely serves this students' best interest in present and future needs, a logical comprehensive general education model can be formulated. Assumptions are made with this model, as with any model. Table 1 indicates one possible model of a student; it is this profile that should be well-served by general education.

Table 1. Model of a typical engineering student

Typically, a devoted student, scores well on ACT, SAT, likely to be in top percentile of high school graduating class, study and work are likely near top of priority list

Likely to be analytical, organized, and thorough in nature, hence appreciative of a "correct answer" that is "checkable" by reverse operation, or substitution

Likely to be uncomfortable with "gray" areas where personal opinion, subjectivity, or argument based on a "chosen" set of "facts" or interpretation occurs

Likely to be a member of high school debate teams, science/math achievement clubs

Likely to have taken music and/or dance lessons, and/or participate in high school concert or marching bands; likely to wish there was more time to take artistic classes if AP calculus and physics weren't so time consuming!

Although physical fitness is likely important, these activities are on "personal time" rather than in organized sports in college, only because the threat to academic achievement is daunting

Likely to participate in scouting, childcare/babysitting, church/religious activities, and responsible afterschool jobs; commuters likely care for ailing parents/grandparents, siblings, spouses, and take on other responsibilities of commuters

Likely are bent more toward conservative behavior and thoughts rather than liberal

Like most other people, engineers enjoy good-tasting foods and balanced diets, but often lack the opportunity to perform well in this area themselves

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When the traits of a typical incoming engineering student, as presented in Table 1, is compared with the requirements of their most probable "life circumstance" after graduation, the charge of a general education program becomes apparent. Stress from being unprepared and overwhelmed can be a cause of failure in our top graduates. Table 2 lists the probable obligations of an engineering graduate from our universities.

Table 2. Probable Post-graduation Requirements and Needs of Engineering Graduates

Rather than write fictional stories with style and feeling, typical of freshman English courses, the engineering professional must conform to ACS Styleguide,[7] The Elements of Style,[8] or Chicago Manual of Style.[9] Concise, non-stylistic text is required. Often a good fantasy writer has difficulty with technical writing

Speaking skills in front of MBA's, lawyers, fellow engineers, and the general public with PowerPoint slides properly "filled" are critical to presenting one's work to an audience who may

not be familiar with a particular aspect of engineering; often an engineer's presentation in written and oral communication affects future opportunities than the quality of the actual work performed itself

Travel is often required of graduating engineers, and life on the road can be miserable for an unprepared engineer; this can be the reason why a good engineer leaves an otherwise good job

Many engineers marry (or have relationships with) other professionals, and need to move from family and friends, requiring building a new network of social life and cannot rely on "mom" to help with the kids; hence, finding a position for at least one of the engineers with a "family friendly" company is important

Many engineers would participate in public service if possible; many would feel "more accomplished" coming home after a long trip if such volunteer work was performed

Many engineers like to "relax" in another highly skilled area, a hobby. Making time and getting started in a hobby, whether alone or with the family, can be very important

Acquiring a sense of "politics" in an organization is important and sometimes a subtlety that needs to be "learned"

Appreciating history, art, music, dance, woodworking, antiquing; participating in YMCA/YWCA "3 on 3" basketball pickup games or lap-swimming, the meals-on-wheels and soup kitchen networks – are some examples of getting out of the hotel or office and serve as a healthy alternative to stress (and alcohol) on the road and after a rough day at work, BEFORE returning home

As monetarily successful professionals, an engineer should have knowledge of legal and financial choices and upcoming obligations as a homeowner, investor, spouse (and/or partner), self-employed businessman, and employee of a company that may make controversial decisions

An engineer often drives a car, and knowledge of simple repairs should be taught; an engineer often owns a home and simple home repairs should be taught. Considering that "dad" is likely to not live in the same community and that it is potentially embarrassing for an engineer to be "taken" in these repairs, a sense of being able to trouble shoot and/or solve one's own simple problems is gratifying

An engineer should know how to mix batch systems, hence cook to at least a moderate proficiency, a healthy menu

All college graduates should know how to swim, how to participate in simple sports, to know the relationship between basal metabolic weight, resting pulse rate, blood pressure, and general health with diet and exercise – not to mention healthy state of mind

"Is there a college graduate in the house?" – the use of cardiac arrest paddles, simple first aid, emergency medical skills should be known

Given that industry and business today is truly international, and that world-wide diversity exists, knowledge in geography, as well as various customs, practices, and language is essential so as not to embarrass oneself. For example, the relationship between Taiwan and China with Korea and Vietnam is intricate and full of history – some may say a natural "pecking order" or "prejudice" exists. This is learned by engineers in graduate school because of the wonderful gift an internationally diverse student body provides

Graduates of most engineering programs would be happy to be contacted by scouting groups, church groups, and science/math high school teachers to give a guest lecture or career day seminar, and help recruitment efforts of their alma mater

Women engineers are often committed to their careers and spouses, and sometimes put off childbearing, under the belief that it is in their best interest career-wise, or that they cannot expect "the best of two worlds", then find themselves in their 30's with difficulty in having a family, creating a major crisis in their family life [10]

Solid foundation of engineering fundamentals and mastery of their discipline

Recruitment and retention would also be improved if the selection of general education courses was more in-line with the student needs. Fewer men (white especially) than women are entering college and graduate school. [11,12,13,14] Courses that are personally exciting and relevant outside of the students' major will likely inspire true interest to continue a program in undergraduate school as well as entice the student to continue onto graduate school. Diversity of the student body in engineering graduate programs is natural, assuming diversity is interpreted as a collection of people of all walks of life, of all nationality, from all over the world. This enriching experience often found in graduate school should be available to undergraduates. Should diversity in university gen ed curricula be restricted to specific under-represented groups in America, or should it include cultural differences and an awareness of the actual relationships that exist worldwide between different groups of people? Considering that most business and trade interests are global, understanding the reluctance and acceptance of different cultures toward one another may be more helpful to the success of engineering graduates than indoctrination of the way things *should* be, but aren't now, and are not likely to occur any time soon, on a global scale. The programs in diversity offered by AAC&U are not in step with this vein of thinking. [15]

Will an engineering graduate be expected to be versed in the rationale of Tom Sawyer's relationships with the other fictional characters in the book, in "queer theory", or difficulties of Thoreau in multiculturalism? [16,17] Do course offerings such as these assist the engineering professional? The political left is well-represented on campuses in a higher proportion than

society in general, or in the population of engineers graduating.[18] Do these circumstances help or hurt our engineering student recruitment, retention, and after-graduation success? Engineering students are becoming more interested in ROTC programs,[19] forensics,[20] family-friendly benefits from employers,[21] and advanced materials for sports equipment.[22] The goal of general of education, diversity, and ethics is brought together by R.J. Sternberg, who simply states that "it's not what you know, but how you use it: teaching for wisdom".[23] Vi Brown discusses an intelligent "segregation of memory" example of the Tulsa Race Riot of 1921 in a manner that an engineer would read, become inspired, and likely discuss with peers even without a class assignment![24] These are two examples of stimulating work that are self-promoting.

Engineering students would generally appreciate letting the following "count" for gen ed credit, although many programs (CAGLS)[3] do not currently embrace these: sports classes; music lessons; voice lessons; art; marching band and concert band; dance teams; activity in volunteer organizations such as meals-on-wheels and youth groups in schools and through the Y; whatever history classes they choose; and many more. Because engineering students typically have so many interests and are academically driven, given the choice, the straw poll would likely indicate a preference toward "shorter", but more in number, general education electives rather than "full semester" 3 sh courses in subjects of insignificant importance to their life.

Conclusion

A radical change to the current general education model would involve the development of a set of 1 sh to 2 sh courses available to all engineers (and other students), with topics that address the aforementioned issues, meeting the needs of the typical engineering student that enters a university program, and meeting the needs likely to be forthcoming upon graduation. Since these classes are not currently available, and may be perceived as "radical" by the arts and sciences faculty, who have been comfortable for years teaching classes very different (and perhaps even self-serving to their research or political interests), ASEE or a similar organization may need to serve as a central collection point of individuals willing to develop such specialized courses that address these deficits in the current general education course offerings. These courses could be offered through ASEE via distance learning. These courses could be continued to be offered through distance learning until this method becomes the new status quo, or the current university faculty in arts and sciences, or engineering, at each individual institution learn the needs of engineering students and teach these courses directly.

The new course descriptions would have to go through the university curriculum committees, general education committees, and the academic senate. Supporters of these courses might have difficulty passing through these steps without the concerted efforts and support of ASEE, ABET, and other professional organizations. A central collection agency could be formed for the purpose of sharing comments and outcomes of these committees at various universities with other participating universities, and suggest solutions and productive arguments for improved general education requirements and the needs of our graduating engineers.

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