Introduction

In a proactive approach to the development of new and unique accreditation criteria for engineering programs, the Accreditation Board for Engineering and Technology (ABET), through the adoption of Engineering Criteria 2000, affirmed that engineering graduates must have “a recognition of the need for, and an ability to engage in lifelong learning” (p. 40). In an attempt to realize this goal, researchers and educators have invested much effort toward understanding the relationships between: (a) adult learning, (b) lifelong learning, and (c) engineering education.

Adult Learning and Lifelong Learning

To begin to understand the significance of adult learning, one must set the metacognitive switch to global mode. In a report from the Commission of the European Communities, the importance of lifelong learning was emphasized not only for competitiveness and employability, but also for social inclusion, active citizenship and personal development. The Commission members understood that the ability to educate adults was a vital component of lifelong learning. Furthermore, in a report from the Joint Task Force of the National Research Council and the Japan Society for the Promotion of Science, the group used a lifelong learning approach in examining the two countries' educational systems.

Why is the ability to learn over a lifetime so important to the wellbeing of nations, their citizenry and the global market place? Recent research from the Organisation for Economic Co-Operation and Development confirmed the global importance of investing in adult learning through its thematic review of adult education in 17 countries between 1999 and 2004. The public and private sector benefits identified in the OECD study included: (a) greater employability; (b) increased productivity and better quality employment; and (c) reduced expenditure in areas such as unemployment benefits, welfare payments, and early retirement pensions. In addition, OECD listed the following social benefits to adult learning: (a) improved civic participation, (b) better health, (c) lower incidences of crime, and (d) greater individual well-being and fulfillment.

The Global Economy and Lifelong Learning

Highly industrialized societies have undergone an enormous shift in their economic structures in the last 3 decades. One of the key factors in this transformation is that many citizens now live...
in countries where the proportion of workers that earn their living from manual or physical labor is a distinct minority. Learning and knowledge drive the information society of today.

In the new workforce, there will be increased proportions of professional and technical knowledge workers.  Professional workers will require high levels of education, such as baccalaureate and advanced degrees, while technical workers will generally train in 2 year colleges and continue with training on the job. The confluence of the changing nature of the economy, occupational requirements, and employer to employee contract relations will make frequent job and career changes much more probable. Education and preparation for new careers and, possibly, second careers may be more demanding than the qualifying education that was required for initial career preparation, particularly for adult workers with competing role demands.

For the European communities, the general levels of competence must increase, to meet both the needs of the labor market and to allow citizens to function well in society today. However, there are some 72 million low-skilled workers in Europe, one third of the labor force. Estimates show that, by 2010, only 15% of newly created jobs will be for those with low skills, and 50% of new jobs will require tertiary level qualifications. For the U.S., the general levels of competence must increase, as only 39% of the population ages 25-64 had secured a postsecondary education in 2004.

**Demographic Trends and Lifelong Learning**

In the U.S., there are three noticeable demographic trends that will increase the demand for adult education and lifelong learning: (a) the aging of the population, (b) immigration, and (c) the proportion of minorities in the population.

Trends in higher education are related to trends in the population. The number of young students has grown more rapidly than the number of older students, but this pattern is expected to shift. According to NCES, between 1990-2005, the enrollment of students under age 25 increased by 33%. Enrollment of students age 25 and over rose by 18% during the same period. From 2005-2016, NCES staff projects a rise of 15% in the enrollment of people under 25, and a rise of 21% in enrollment of people 25 and over. The proportion of students ages 25 years and older has risen from 28% of total enrollments in 1970 to 39% in 2005, with a projection to 40% in 2016. In raw numbers, the projection from 2005-2016 amounts to an increase of 1.4 million older students. With the aging of the student population and the increased cost of full time enrollment, part time enrollment has also increased dramatically. The number of total part time students has grown from 2.8 million in 1970 to 6.7 million in 2005 with a projection to 7.1 million in 2016. From data reported by NCES, part time students were more likely to: (a) be enrolled in 2 year public schools, (b) not be enrolled in degree programs, (c) be independent students with dependents, (d) be ages 24 years or older, (e) be married, (f) have parents who did not attend higher education, and (g) work full time.
Providers of Lifelong Learning

Community and technical colleges are unique in higher education for several reasons: (a) they have relatively few admission requirements, (b) they are comparatively inexpensive, (c) most students enroll on a part time basis, and (d) state and local governments do not typically restrict or cap enrollment.\(^{11}\) As a diverse provider, community colleges cover a range of training needs from remediation coursework, to retraining and assistance for displaced workers, to local economic development initiatives.\(^{11}\) According to the National Center for Education Statistics, 2.7 million students ages 25 and older attended 2 year institutions in 2005, while more than 4 million people ages 25 and older enrolled in a 4 year institution of higher education.\(^{10}\) Adults in this age group constituted 38% of all those enrolled in either public or private 4 year institutions. Also, this age group comprised 61% of all part time and about one-fourth of full time (24.8%) students.

Engineering and Lifelong Learning

The engineer as the professional knowledge worker must be prepared for the changing nature of the: (a) economy, (b) occupational requirements, and (c) employer to employee relations.\(^{13}\) Continuing education is the key to sustainability. The U.S. Bureau of Labor Statistics estimated that, today, a worker will have an average of 11 jobs between the ages of 18-42.\(^{3}\) Moreover, the Bureau estimated that the median number of years that a worker will stay with his or her current employer is 4.1 years. Given these career dynamics, engineering educators must follow the ABET directive and help students to become lifelong learners.\(^{1}\)

According to Smerdon, the half-life of an engineer's technical skills ranged between 7.5-2.5 years, dependent upon the engineer’s area of expertise.\(^{13}\) Even in the slower-paced engineering fields, he estimated that engineers must reinvent themselves at least once a decade. Moreover, Smerdon reasoned that the economic health and vitality of a country depends, not so much on its natural resources, its military might, or its political strength, as it does on its intellectual capital, and engineers are the keepers of the most important part of that intellectual capital: the knowledge needed to create and advance the technology that runs the world.

How, then, can the intellectual capital be preserved and increased? The key is to have engineers who constantly learn, upgrade their skills, and adapt to new situations. Engineers must learn to treat their professional skills as a dynamic project that needs continuous upkeep and upgrading. This shift demands a new way of thinking from engineers and their employers.\(^{13}\) Similarly, engineering educators and students must adopt and practice this philosophy.

Many studies of engineering education and the skills required of practicing engineers identifies the ability to learn over a lifetime as a necessary ingredient for success.\(^{2}\) Yet, there has been little developed in the way of formal preparation for engineering students so that they will become such learners. In fact, Beston et al., synthesized that the overloaded curriculum presented in most engineering programs worked against development of the skills required to be successful learners for a lifetime.\(^{2}\) Jiusto and DiBiasio contended that lifelong learning suddenly
became part of engineering education when ABET included it as one of its desired learning outcomes.\textsuperscript{6}

A successful lifelong learning program incorporates self-directed learning skills. Jiusto and DiBiasio recognized that strict definitions of lifelong learning and self-directed learning will have overlapping, as well as, distinct parts.\textsuperscript{6} Areas of overlap include: (a) critical thinking; (b) research skills, particularly in regard to information use, retrieval, and synthesis; and (c) basic interpersonal skills (i.e., communication). To be successful, self-directed learning must have two components. First, it must motivate the students to aspire to be self-directed learners. Second, critical skills must be developed for self-directed learning in order for the students to practice, master, and adopt them as the natural approach to learning any new topic.\textsuperscript{2} Jiusto and DiBiasio believed that self-directed learners have exemplary attributes like: (a) curious/motivated, (b) methodical/disciplined, (c) logical/analytical, (d) reflective/self-aware, (e) flexible, (f) interdependent/internally competent, (g) persistent/responsible, (h) venturesome/creative, (i) confident, and (j) independent/self-sufficient. Furthermore, Jiusto and DiBiasio listed skills like: (a) highly developed information seeking and retrieval skills; (b) have knowledge about and skill at the learning process; and (c) develop and use criteria for evaluation (e.g., critical thinking).\textsuperscript{5}

At two recent American Society for Engineering Education (ASEE) meetings, Litzinger, Wise, Lee and Bjorklund and Litzinger, Lee and Wise presented studies of engineering students’ readiness for self-directed learning.\textsuperscript{8-9} The groups demonstrated that the traditional engineering education over a 4 year period, including capstone design courses, had little positive effect on students’ readiness. They concluded that most courses that students take in the undergraduate engineering programs do not require them to undertake tasks that increased their readiness for self-directed learning.

In an effort to promote lifelong learning in the engineering curriculum, educators at all levels, faculty and adjuncts alike, need to receive information and support in order to transform their curriculum into one that supports these learning concepts. As educators understand and incorporate lifelong learning into their own lives, they become better equipped to provide these opportunities to students.

In the preparation of engineering students for self-directed learning, Beston et al., determined that a vital component was to help students identify the basic learning skills required for academic survival.\textsuperscript{2} These include time management and effective learning skills, the ability to take notes, read a technical book, prepare for an examination and produce logical, intelligible homework.

Engineering educators can provide lifelong learning information to their students through lectures, reference materials, internet resources or combinations thereof. As students are introduced to these learning concepts, they approach instruction in a strategic manner and incorporate these concepts into their thinking.
Most of the tasks students are engaged in can encourage lifelong learning. For example, engineering students are engaged in complex tasks. Educators can equip them with a variety of approach strategies and critical thinking paths to provide for: (a) extended learning by moving the student out of their comfort zone with focus, (b) goal setting, (c) task identification, (d) milestone monitoring, (e) peer review, and (f) process iteration as needed. Wide latitude exists in the design of complex tasks, thus allowing the educator the flexibility to address individual needs.

Discussion

Community and technical college engineering programs are focused in their mission to teach technical skills and may neglect the importance of integrating lifelong learning concepts into the curriculum. Exposure to these concepts through discussion, at a minimum, promotes a realization and better understanding of the attributes of a lifelong learner and the importance thereof. Ideally, curriculum designers of engineering coursework should create opportunities for students to become exposed to self-directed learning philosophies, attributes and skills.

The author incorporated self-directed learning aspects into Fall 2009 semester kickoff lectures and has observed a positive trend in motivation, autonomy, persistence and confidence. As topics are introduced, self-directed learning is reinforced as fundamental to the task. Additionally, through the introduction of a variety of Webquest activities, self-directed learning, and hence, lifelong learning skills are practiced and reinforced. Webquest activities are being successfully integrated into courses where foundational information is changing rapidly, thereby requiring students to become engaged in their area of interest and become discerning consumers of information through research, analysis and synthesis.

Conclusion

Lifelong learning is a difficult attribute to quantify, and perhaps even more difficult to develop in students. Engineering educators at community and technical colleges must instruct beyond the foundation coursework level and equip students with self-directed and lifelong learning skills. The author believes that one way to fulfill ABET’s lifelong learning criteria is to incorporate such philosophies into lectures strategically delivered throughout the semester along with reinforcement through Webquest learning activities that require increasing levels of autonomous critical thinking. These skills are necessary for all adults if they seek to become useful and productive citizens in a global economy. Ultimately, if educators have not taught graduates the importance of self-directed and lifelong learning, then academia has has done the students, and society, a great disservice.
References:


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