

Lifelong Learning: A Preliminary Look at the Literature in View of EC 2000

Rose M. Marra, Kristin Z. Camplese, Thomas A. Litzinger
Penn State University
University Park, PA 16801

Abstract - ABET EC2000 and the "ABET 11" outcomes have initiated tremendous activity as engineering schools prepare for accreditation under the new criteria. While the new process and outcomes present many challenges to engineering faculty and administrators, the outcome on lifelong learning represents perhaps the greatest challenge; it states that graduates must demonstrate "a recognition of the need for, and an ability to engage in life-long learning". This outcome raises many questions including What constitutes life-long learning? How will we demonstrate that our graduates recognize the need for and have the ability to lifelong learn? And last but not least, how will we measure this attribute in our graduates? This paper summarizes the results of a preliminary literature review of lifelong learning as it pertains to engineering education and discusses plans for assessing lifelong learning of Penn State students, along with some data gathered in a survey of recent graduates.

Introduction

ABET's Engineering Criteria 2000 has lit a lot of fires in engineering programs across the country. While efforts to prepare for the "ABET 11" are hatching everywhere, at least one of those 11 is perhaps receiving less action-oriented attention than the others. Item (i) states that graduates must demonstrate "a recognition of the need for, and an ability to engage in life-long learning". What does this mean? How will we demonstrate that our graduates recognize the need for and have the ability to lifelong learn? And last but not least, how will we measure this attribute in our graduates? These questions can't be responded to easily; like many real engineering problems, the answers are not in the back of the book. However, the engineering education community doesn't need to start at the beginning to address these questions about lifelong learning. Existing research, literature and statistics on engineers' participation in lifelong learning will give us, at the very least, a good start on answering many of these questions. This paper

- summarizes the results of a preliminary literature review of lifelong learning as it pertains to engineering education,
- discusses plans and a methodology for defining predictor behaviors for participating in lifelong learning, with the intent to develop an instrument to assess these behaviors during undergraduate education, and
- presents a subset of results from a survey of recent Penn State engineering graduates on informal and formal lifelong learning.

Literature Review

While definitions of lifelong learning differ [1-4], a fairly standard one comes from Candy [5]. "Lifelong learning takes, as one of its principal aims, equipping people with skills and competencies required to continue their own "self-education" beyond the end of formal schooling" (p. 15). Amidst the variance in definitions, authors agree on several things. First, lifelong learning is critical for today's engineer because of the fast-changing nature of engineering content knowledge and the numerous job responsibilities that are common in engineers' careers. And secondly, although employers provided on-going employee training (which certainly is not the only type of lifelong learning) in the past, lifelong learning must be accomplished via other means -- both formal and informal -- in the future [3, 6]. Our literature review further explores the reasons for being concerned about lifelong learning, and information in the literature about key factors in lifelong learning as well as attempts to measure them.

The Case for Lifelong Learning

Although ABET has certainly increased the "popularity" of lifelong learning of late, they are not the only voices in the engineering community addressing this topic. Ernest Smerdon, current president of ASEE tell us that " engineers must stop thinking of education as what they did for 4 years in college and come to see it as a lifetime project" [6] (p 22). Accreditation always drives conversation and action, but several other factors demand that educators help graduates be lifelong learners. We begin with the work environment.

The work scene is changing for engineers. Engineers no longer carve out a niche and stick with it for a lifetime. Because of the fast changing nature of technology, the shortened product lifecycle, and global competition engineers experience rapidly changing job responsibilities, and more frequently switch jobs. Many companies tend to maintain an engineering cohort for only those skills that are critical to their company. They fill their needs for other competencies by hiring temporary or contract employees [3, 6]. All of which adds up to engineers operating in a more fluid market where their skills need to be constantly honed and updated to meet the demand of the moment.

The nature of engineering technology also heightens the need for lifelong learning. For instance, in addressing the need for lifelong learning in electrical engineering, Adam [7]

notes that a few years ago microprocessor applications and design were "hot". Now this field, while clearly still important, has slipped into the main stream displaced by whatever today's "hot" topic may be. Smerdon [6] backs up this trend citing experts' decade-old opinions about the "half-life" of an engineer's technical skills – that is, how long it would take for half of everything an engineer knew about his/her field to become obsolete. Estimates ranged from 7.5 years for mechanical engineers to a mere 2.5 years for software engineers (less time than it takes to earn an undergraduate degree). Today, these numbers are almost certainly smaller.

Concerns about "keeping current" go beyond the technical domain. Hecker [8], writing from the standpoint of a consulting engineer, posits that most engineering curriculum will not be able to adequately address both the technical and non-technical skills that are necessary for an engineer to be successful. She proposes that lifelong learning should be used to address the non-technical skills – and emphasizes their necessity for consulting engineering.

The fact is, there is no way an engineering curriculum can do it all in 4 or 5 years – nor should we expect it to. We must do as ABET has asked us – help students become lifelong learners. Further, we *can* make changes in our curriculum to support development of awareness for and propensity to engage in lifelong learning.

Smith and Gast, in their discussion of the senior year experience and its effect on students' choices to pursue further education, tell us: "By reconceptualizing the senior year experience, specific career development activities inside and outside the classroom can help focus and encourage student interest in further education. Seniors can develop a more realistic picture of graduate or professional education and at the same time focus their career interests through increased opportunities to engage in research projects with faculty, capstone classes that incorporate modules on current research in the discipline . . ." [9] (p. 192). This suggests that opportunities to work on undergraduate research and other "real-world" focused projects can encourage students to pursue further formal education – one of many types of lifelong learning activities.

Contributing Factors in Lifelong Learning

The literature on lifelong learning tells us a lot more than simply the definition. McCombs [2] makes the strong statement that the "motivated person is a lifelong learner, and the lifelong learner is a motivated person" (p 117). This relates closely to ABET's statement about lifelong learning; graduates must have "a recognition of the need for, and an ability to engage in life-long learning" [10]. What we have to figure out then, is how to instill that motivation in our graduates.

McCombs suggests that schooling environments that will promote this motivation and ultimately lifelong learning choices must not simply address learners' cognitive

dimension by throwing content at them, but must develop more diverse aspects of individuals such as their metacognitive and affective dimensions. She specifically argues that for students to be optimally motivated they must:

1. "see schooling and education as personally relevant to their interests and goals.
2. believe that they possess the skills and competencies to successfully accomplish their goals
3. see themselves as responsible agents in the definition and accomplishment of personal goals
4. understand the higher level thinking and self-regulation skills that lead to goal attainment
5. call into play processes for effectively and efficiently encoding, processing and recalling information
6. control emotions and moods that can facilitate or interfere with learning and motivation, and
7. produce the performance outcomes that signal successfully goal attainment." (p. 124)

Essentially, McCombs tells us that if we want to teach students how to learn, we must focus our learning activities on more than simply engineering content, but also on

- helping students to understand their own learning processes,
- creating a learning atmosphere where students take on responsibility for their learning
- creating a learning atmosphere where students feel they can succeed, and
- designing learning activities that are relevant and interesting.

Cropley [4] writes about a systematic, goal oriented process of lifelong learning. He discusses characteristics of successful lifelong learners that include affective and meta-cognitive items similar to those offered by McCombs, but with additions of skills. These skills include

1. use of different learning strategies and learning in different settings,
2. basic learning skills and basic "intellectual powers" such as critical thinking,
3. use of learning devices.

He goes on to discuss specific suggestions for learning methods and materials, as well as teacher and student activities to support the development of the attitudes and skills needed for lifelong learning.

Measuring Lifelong Learning

While there have been attempts to develop lifelong learning predictive instruments in other fields, little has been done in engineering. Studies by Livneh [1, 11, 12] from the human service professions have produced inconclusive results. None of these studies found learner characteristics that consistently predicted lifelong learning behaviors later in life. Livneh approached the problem from two basic research paradigms. In order to develop a profile of lifelong learning, she created an instrument, Characteristics of

November 10 - 13, 1999 San Juan, Puerto Rico

Lifelong Learning in the Professions (CLLP), [1] in order to predict continuing education potential in others in those same professions. A factor analysis of the results did not predict enough of the actual measured variance in lifelong learning to create a usable profile, however factors labeled "educability" and "future orientation"¹ were significantly different between high and low participants in lifelong learning. In her 1989 work, Livneh [11] uses the "Adjective Checklist" as a predictor for lifelong learning. A factor analysis showed that only one factor – organized – significantly correlated with time spent on learning activities during the past year.

Gunzburger's [13] study sought to determine which facts, if any, collected about medical school applicants were valid predictors of the extent each applicant will later be a continuing professional learner. To answer this question, Gunzburger correlated aspects of the admissions test with survey results collected 22 years after students were admitted to medical school. The study found that the 1956 Medical College Admission Test did not identify the extent individuals will later become continuing learners.

Perhaps the most successful research for predicting lifelong learning behaviors came from Oddi [14]. In initial design and validation efforts, his Oddi Continuing Learning Inventory (OCLI) was found to correlate highly with existing measures of self-directed continuing learning behaviors in adults, however subsequent validation efforts for the instrument have produced inconsistent results [15, 16].

Not all of the aforementioned researchers achieved the results they desired, but their results do serve as a basis for our work. For instance, Livneh's instrument (1988) assesses attitudes towards learning, e.g. "I enjoy reading". A future instrument may wish to focus on behaviors – "I read 10 hours a week" – thus gathering a more accurate picture of lifelong learning behaviors. Livneh also points out that her research may have been compromised by the broad set of professionals included in the study. Human service professionals include persons in many different types of careers. The unfocused nature of the population would make it much more difficult to develop an accurate predictive instrument. Our plans would of course focus on lifelong learning for engineers, which would hopefully alleviate this issue. Finally, all three researchers used existing instruments to either measure lifelong learning (see Livneh [11]), or validate new instruments. Gunzburger [13] and Oddi [14] both drew heavily upon the Leisure Activities Survey (LAS) [17]. These instruments could then be used to measure lifelong learning participation in engineers. Our

plans for assessing lifelong learning are described in the next section.

Plans for Assessment of Lifelong Learning

ABET wants us to graduate students who "have an ability to" lifelong learn. If we can develop and validate an instrument that measures aspects of our curricula that support lifelong learning behaviors, we would have some evidence that our graduates are meeting this ABET requirement. Our plan focuses not so much on developing an actual "predictive" instrument, but rather on measuring the current curricular activities that may contribute to choices to engage in lifelong learning as well as the tools to undertake it. The form of our plan is as follows:

- Complete our review of the literature to determine a set of undergraduate curricular and extra-curricular experiences that can positively contribute to the understanding of the need for and an ability to engage in lifelong learning.
- Using the set of experiences defined in the previous step, we propose a multi-pronged plan for assessing the extent of the existence of these experiences in our curriculum. The best implementation would include *all* of these items; however, we anticipate that limited resources may force us to choose only one or two methods.
 - Analyze, via syllabi and course assignment/project descriptions, the existing curriculum for evidence of the experiences we hypothesize will positively contribute to lifelong learning choices. The work of Astin [18], who reports on undergraduate experiences that are predictors for attending graduate school, and McCombs [2] who describes learning conditions that contribute to overall lifelong learning choices, will be important starting points.
 - Determine, via a student-report instrument, how students understand the curriculum in terms of these lifelong learning-promoting curricular experiences. These efforts will probe the affective and meta-cognitive aspects of success in lifelong learning.
 - As an alternative or an addition to collecting student impressions via a survey, recruit a sample of students from all engineering programs to produce portfolios of their undergraduate experiences. These portfolios would contain representative work from their courses as well as a log of extra-curricular experiences. Analysis of these portfolios would provide not simply a self-report by students of their undergraduate experiences, but actual evidence of the work they have been asked to produce. Once again, these would be analyzed for evidence of experiences that

¹ Educability refers to an interest in reading, having appropriate learning skills and being able to learn by themselves. Future orientation indicated a desire to advance on the job, inquisitiveness, possessing long-term educational goals, and a view of oneself as a learner.

contributed to lifelong learning and the development of the requisite skills and attitudes.

- Having collected data regarding the extent to which the undergraduate curriculum provides lifelong learning promoting experiences, we can then track the effect of this curriculum on our graduates via a combination of our existing alumni survey (approximately 10 items directly address lifelong learning), and existing instruments such as the OCLI [14], and the LAS [17]. It is important to assess participation in formal life-long learning activities such as graduate studies or employer-training as well as in informal activities such as learning "on the job."
- The final step in the process is, of course, to use the assessment results to improve our programs in ways that enhance the ability of our graduates to engage in lifelong learning.

Results from Survey of Recent Graduates

As an initial step in our investigation of lifelong learning among our undergraduates, items related to lifelong learning were included in a recent survey of engineering graduates, who were 3 to 5 years post-graduation. 3300 surveys were sent out and 1367 were returned for a response rate of 42%. One set of questions explored informal learning by the graduates. Specifically students were asked to give their assessment of the importance of the ability to "Teach yourself new skills for your work" as well as how well their undergraduate studies prepared them for this. Slightly over 90% indicated that the ability to teach themselves was important or very important. Table 1 presents the average preparedness rating versus the level of importance indicated by the respondent. The data show that the graduates who rated the ability to teach themselves as "very important" show the largest difference between their importance and preparedness ratings. However, their responses indicate that most felt that they were adequately or very prepared. A related question asked for an "agreement" rating on the item "I can teach myself new skills that I need for my job." Over 95% agreed or strongly agreed to this statement.

Table 1. Response data for "Teach yourself new skills for your work."

| Importance Rating | Average Preparedness Rating | Number Responding |
|----------------------|-----------------------------|-------------------|
| Very important (5) | 4.17 | 748 |
| Important (4) | 3.74 | 457 |
| Neutral (3) | 3.55 | 104 |
| Unimportant (2) | 3.43* | 14 |
| Very Unimportant (1) | 2.33* | 3 |

* Not meaningful given the small number responding.

The survey also included questions on the participation in professional societies and subscription to professional journals. Approximately 50% of the respondents answered in the affirmative to each of these items.

Another set of questions explored participation in formal learning activities including graduate studies, employer training and "other" activities; this data is presented in Table 2. By far the greatest participation was in employer training with approximately 80% of the graduates indicating that they were engaged in this activity. The lowest participation was in formal graduate study at 25%. Also explored was the motivation behind the choice to participate in formal educational experiences. The results summarized in Figure 1 show that major motivations were to learn new technology or non-engineering skills regardless of the source of the training.

Table 2. Participation in formal lifelong learning activities

| Activity | Number Participating | % Participation |
|---------------------------|----------------------|-----------------|
| College/University course | 337 | 25 |
| Employer training | 1081 | 79 |
| Other | 551 | 40 |

These data demonstrate that our graduates understand the need to engage in lifelong learning and that they are pursuing it in a number of ways. However, they do not tell us how the students developed the necessary attitudes and skills. That information must await the development of other assessment instruments.

Summary

We have described the results of our preliminary look at the literature on lifelong learning and our plan for assessing students' attitudes and ability to engage in lifelong learning, along with some early assessment data. In addition we hope to identify those parts of our curriculum and also extra-curricular activities that develop the requisite attitudes and skills. The authors are quite aware of the effort to make this plan a reality. However, we believe that this data will not only help institutions identify what portions of their curricular and extra-curricular experiences are contributing towards lifelong learning, but also provide additional support for current curricular reform trends, such as smaller class sizes, and first-year seminars which provide increased faculty contact for students.

Lifelong learning is almost certainly a tough attribute to quantify, and perhaps even tougher to develop in our students. For as long as we as educators see our main task as "covering" the material, we will never pause long enough to help our students learn to learn on their own. Berman [19] tells us that "Lifelong education is necessary if one is to be a

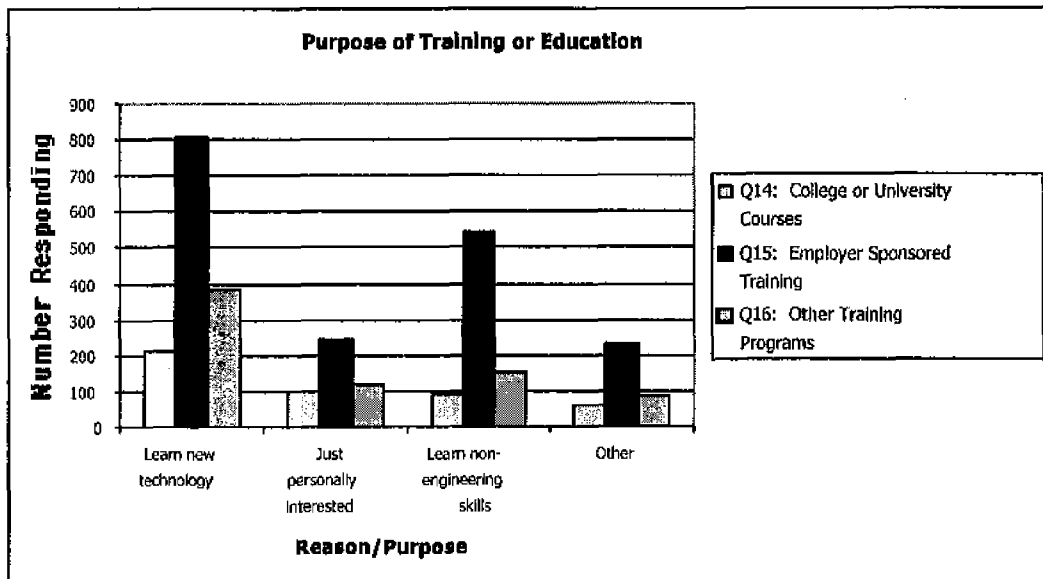


Figure 1.

useful and productive citizen both of the immediate and the broader community" (p. 105). Ultimately, if we haven't taught our graduates how to learn independently, we have done both them and ourselves (as a society) a great disservice.

References

- [1] C. Livneh, "Characteristics of lifelong learners in the human services professions," *Adult Education Quarterly*, vol. 38, pp. 149-159, 1988.
- [2] B. L. McCombs, "Motivation and lifelong learning," *Educational Psychologist*, vol. 26, pp. 117-127, 1991.
- [3] J. A. Haddad, "The evolution of the engineering community: Pressures, opportunities, and challenges," *Journal of Engineering Education*, vol. 85, pp. 5-9, 1996.
- [4] A. J. Cropley, "Some guidelines for the reform of school curricula in the perspective of lifelong education," *International Review of Education*, pp. 21-33, 1978.
- [5] P. Candy, *Self-Direction for Lifelong Learning: A Comprehensive Guide to Theory and Practice*. San Francisco: Jossey-Bass, 1991.
- [6] E. T. Smerdon, "Lifelong learning for engineers: Riding the whirlwind," *Cost Engineering*, vol. 39, pp. 21-22, 1997.
- [7] J. A. Adam, "EEs on lifelong learning," *IEEE Spectrum*, vol. 21, pp. 92-98, 1984.
- [8] P. A. Hecker, "Successful consulting engineering: A lifetime of learning," *Journal of Management in Engineering*, vol. 13, pp. 62-65, 1997.
- [9] D. D. Smith and L. K. Gast, "Comprehensive Career Services for Seniors," in *The Senior Experience*, J. N. Gardner and G. Van der Veer, Eds. San Francisco, CA: Jossey-Bass, 1998, pp. 187-209.
- [10] ABET, "Engineering criteria 2000: Criteria for accrediting programs in Engineering in the United States," *ASEE Prism*, vol. 6, pp. 41-42, 1997.
- [11] C. Livneh, "The Adjective check list as a predictor of lifelong learning in the human services professions," *Psychological Reports*, vol. 65, pp. 603-610, 1989.
- [12] C. Livneh and H. Livneh, "Factors differentiating high and low participants in lifelong learning," *Educational and Psychological Measurement*, vol. 48, pp. 637-646, 1988.
- [13] L. Gunzburger, "Characteristics identified upon entrance to medical school associated with future participation in professional education (Doctoral dissertation, University of Chicago, 1980)," *Dissertation Abstracts International*, vol. 41, pp. 2572A, 1980.
- [14] L. F. Oddi, "Development and validation of an instrument to identify self-directed continuing learners," *Adult Education Quarterly*, vol. 36, pp. 97-107, 1986.
- [15] J. Six, "The generality of the underlying dimensions of the Oddi Continuing Learning Inventory.," *Adult Education Quarterly*, vol. 40, pp. 43-51, 1989.
- [16] L. Oddi, "Construct validation of the Oddi Continuing Learning Inventory," *Adult Education Quarterly*, vol. 40, pp. 139-145, 1990.
- [17] A. Litchfield, "The nature and pattern of participation in adult education activities (Doctoral dissertation, University of Chicago, 1965)," *American Doctoral Dissertations*, vol. 1965-1966, pp. 74, 1965.

Session 11a1

- [18] A. W. Astin, *What Matters in College?* San Francisco, CA: Jossey-Bass, 1993.
- [19] L. M. Berman, "Educating children for lifelong learning and a learning society," *Childhood Education*, vol. 61, pp. 99-106, 1984.