Session 2793

Life Long Learning: Implications for Curricular Change and Assessment

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Abstract

EC 2000 brings lifelong learning to the forefront for engineering educators. In the past, our role in lifelong learning was primarily offering courses and degree programs for practicing engineers; now EC2000 demands that we prepare engineering students to engage in lifelong learning. These demands immediately raise a number of questions, including

- What are the critical skills and attributes needed for lifelong learning?
- What changes can be made in our curricula and approaches to teaching and learning that will develop these skills and attributes in our students?
- How can we assess the extent to which our students have the ability to engage in lifelong learning and whether their abilities improve?

In this paper, we build upon our earlier, preliminary review of the literature (Marra, et. al, 1999). We begin with a discussion of the characteristics of lifelong learners by Flammer, who suggested that two key categories were "will do" and "can do," referring to skills and attitudes necessary for lifelong learning (Flammer, 1978). These two categories are discussed in greater detail based upon more recent literature. Having identified key skills and attitudes for lifelong learning, we address three approaches to help students develop them and describe a recent implementation of one of the approaches in a junior level thermodynamics course. Finally, we discuss possible assessment methods, focusing on the Self-directed Learning Readiness Scale developed by Gugliemino (1978). Since its development, this instrument has been widely used to investigate students' self-concept as learners and their perception of their skills related to self-directed learning. Preliminary data from senior engineering students is presented.

Introduction

The ABET Engineering Criteria 2000 bring lifelong learning to the forefront for engineering educators. In the past, our role in lifelong learning was primarily offering courses and degree programs for practicing engineers through continuing education and on our campuses. Now EC2000 demands that we prepare engineering students to engage in lifelong learning. While this demand on faculty and curricula to prepare students for lifelong learning is new, the significance attached to lifelong learning, and in particular continuing education, within the engineering profession is not.

Lifelong learning in engineering has been recognized as critical for decades. The Final Report of the Goals Committee on Engineering Education, written in 1968, contained a discussion of the importance of lifelong learning [1]. In 1978 the theme of the ASEE Annual Conference was "Career Management – Lifelong Learning." Over the years there have been a number of studies to investigate the types of activities involved in lifelong learning, their frequency of use, the types of support systems required for lifelong learning, barriers to lifelong learning, and impact of lifelong learning for individual engineers. Many of these studies are summarized in a 1985 report by an NRC panel [2].

Lifelong learning is an issue of importance for engineers around the world. UNESCO sponsored several significant studies including "Advances in the continuing education of engineers" [3]. The report resulting from this study summarizes practices in continuing education in a number of countries, both developed and developing, and also delivery systems. UNESCO played a central role in the formation of the International Society for Continuing Engineering Education in 1986.

Clearly, however, lifelong learning occurs through more channels than just continuing education. In 1986, Cervero *et al.* interviewed nearly 500 engineers in the area of Rockport, IL by telephone [4]. Seventy-two percent of the engineers surveyed were at the BS level and more than one half were under the age of 35. Due to the nature of the businesses in the area, the sample contained predominantly mechanical engineers, 53%, with electrical engineers accounting for an additional 22%. The survey was structured to investigate the participation of the engineers in the three modes of learning proposed by Houle: instruction, inquiry, and performance [5]. Cervero *et al.* summarize these three modes of learning as follows:

> "Instruction is the process of disseminating established skills or knowledge in traditional formats such as formal courses or seminars. Inquiry is the process of creating a new synthesis of ideas, techniques, policies or strategies. … The mode of performance is the process of internalizing an idea or using a practice habitually so that it becomes basic to the way a professional practices." (p. 112)

They note that learning is usually a by-product of inquiry, rather than an expected outcome of the process. In terms of frequency of participation, the authors divide their findings into formal (instruction) and informal (inquiry and performance) and note that informal modes are more frequently used, "perhaps because most of these activities are embedded in the daily routines of work."

The three broad categories of Houle, instruction, inquiry, and performance, provide an interesting way to frame our thinking about lifelong learning. Certainly, our students have significant experience with learning in traditional classes, so they should be prepared for lifelong learning through classroom-based instruction. However, traditional classroom teaching provides little preparation for independent learning where the learner is much more responsible for the pace and quality of learning. Traditional courses provide almost no preparation for learning through inquiry, nor do they emphasize “performance” of high level tasks such as synthesis and evaluation, which will be critical to success in the work place.

These observations suggest that we need to enhance our curricula in ways that allow students to more fully engage in modes of independent learning that require more responsibility on the part of learners and to perform the higher level type of tasks that they will engage in after graduation. Much of what can be suggested about key skills and attributes required for independent learning and approaches to preparing students for taking more responsibility in their learning comes from studies in the areas of adult education. Especially fruitful is the literature on the topic of “self-directed learning,” which will form the basis of much of the discussion in the remainder of this paper on the three key questions presented in the abstract.

Attributes and Skills Required for Lifelong Learning

In his paper, “Undergraduate Foundations for Lifelong Learning,” Gordon Flammer proposes a model for successful lifelong learning that has two aspects: motivation and ability. He divided each parameter into two areas [6]. For motivation, these were “won’t do” and “will do,” and for ability, they were “can do” and “can’t do.” The successful life long learner was then one who “will do” and “can do.” This model brings out quite clearly the two critical factors in lifelong learning, the motivation and skills. His discussion and insights were quite consistent with the current literature on self-directed learning that identifies these same factors. For example, Garrison includes these very same factors, albeit at a more detailed level, in her model for self-directed learning [7].

Candy in his extensive review of self-directed learning summarizes the characteristics of the self-directed learner from many sources [8]. These characteristics fall into two sets, personal attributes and skills, that quite clearly correspond to Flammer’s “will do” and can do.” Candy’s lists are:

> <u>“Will do” Attributes</u>: curious/motivated, methodical/disciplined, logical/analytical, reflective/self-aware, flexible, interdependent/interpersonally competent, persistent/responsible, venturesome/creative, confident, independent/self-sufficient.
>
> <u>“Can do” Skills</u>: have highly developed information seeking and retrieval skills, have knowledge about and skill at the learning process, develop and use criteria for evaluating (critical thinking).

Beyond the skills and attributes, Candy argues that the ability to engage in self-directed learning requires a sufficient framework of knowledge and skills within which to construct more detailed and sophisticated knowledge and skills. Following a constructivist model for learning, he is not proposing that one must lay a foundation of fundamental knowledge prior to building to higher levels, but rather simply acknowledging the critical role of prior knowledge in learning. Because of the importance of prior knowledge, he argues that self-directed learning is highly contextual and that the ability of an individual to engage in self-directed learning will vary depending upon prior knowledge and skills. So having an outstanding ability to engage in self-directed learning in one area does transfer directly to another unrelated area.

Approaches to Preparing Students to Engage in Lifelong Learning

Candy summarizes a range of strategies for increasing independence in learning based upon his extensive review of the literature [8]. These include making use of learner's existing knowledge structures, encouraging deep learning, increasing question asking by the learner, developing critical thinking, enhancing reading skills, improving comprehension monitoring, and creating a supportive learning environment. These approaches speak mainly to developing "skills," although the final item addresses developing motivation for learning.

Candy goes on to discusses three broad approaches to implementing these strategies. They are:

1. courses that focus on developing skills that are important to self-directed learning such as information literacy, self-management, and critical thinking, in a context-free manner;
2. approaches that give students opportunities to develop and practice these skills in context;
3. approaches that give students opportunities to develop and practice these skills in context and further seek to make learning itself an object of reflection.

Significant criticism of the first approach has appeared in the literature. Candy notes that the approach has been criticized as being "based upon an inadequate understanding of the complexity of learning." Simply providing students with tools for self-directed learning, such as study skills and time management, is not sufficient to ensure that they can use them effectively in domains of importance to them. This argument leads to the second category of approaches in which the students acquire and practice the skills needed for self-directed learning in an appropriate context. Candy notes that while these approaches are more consistent with the context-dependent nature of learning, they may still not achieve the desired outcomes. Thus a third approach exists which recognizes the critical role of context, but seeks to make the process of learning itself the object of reflection so that it can be "the object of conscious planning and analysis." This final approach has three key elements: "the need for the facilitator to take into account the learner's existing knowledge structures and previous knowledge, the need for the learner to gain an understanding of the syntactic structure of the field that he or she is learning, and the learner's development of metacognitive awareness or conscious control over his or her learning." [8]

Which of these three approaches might we as engineering educators use to allow our student to develop the critical skills and attributes? It would appear that second and third approaches, which take into account the importance of context, are the preferred methods. Early work in this area by engineering educators, including Flammer and Fuchs, advocate the use of the second method. Flammer suggested that we "provide more opportunity for students to encounter real-life, open ended problems." He also points to the need to have our students become comfortable in using the library in their work, presaging the critical area of information literacy for today's engineers [6]. This set of skills is critical to the inquiry mode of lifelong learning. Also at the 1979 ASEE conference, Fuchs suggested the use of case studies as one method to develop lifelong learning skills and attitudes [9]. He argues that the case study approach motivates the learner, "teaches learning," and provides a bridge between the academic world of concentrated learning and the outside world of applying what one has learned.

Before leaving the area of curricular approaches to prepare students to engage in lifelong learning, it is worth revisiting the list of "will do" attributes that included reflective/self-aware, interdependent/interpersonally competent, venturesome/creative, and confident. These attributes lie within the affective domain where many engineering faculty do not feel feel comfortable nor competent in their roles as educators. Indeed, some among us feel that the students should arrive in our classrooms with all of the "will do" attributes, and that we have no responsibility to help students develop them. However, if we are to prepare our students to be successful lifelong learners, we must find ways to prepare <u>ourselves</u> to venture into these areas.

Integration of Lifelong Learning "Practice" into a Thermodynamics Course

One of the authors (Litzinger) recently experimented with a method for helping students in a junior level thermodynamics course develop lifelong learning skills in a meaningful context. The assignment, which required the students to practice the inquiry method of learning in a largely self-directed manner, approximates Candy's third broad approach to developing self-directed learning skills. In the initial part of the task, the students wrote a short essay on the relationship between an area of personal interest and the course topic of thermodynamics and energy. Topics of the essays ranged from artificial hearts to rocket propulsion. Based upon these essays, student teams were formed around common interests, which set the general area of their papers. The selection of themes based upon students' interests was aimed at increasing the students' motivation to engage in the task, and the use of teams was intended to provide a supportive environment. The teams were charged with selecting a paper topic and writing a single term paper based upon independent research. The motivation for this assignment in terms of self-directed learning was explicitly discussed with the students, and upon completion of the project, they were asked to reflect on their experience and discuss what was most valuable to them and why it was valuable. Student reflections on the task were most rewarding to read. The following sample comments indicate that the assignment had positive impacts on skills and attitudes, including confidence in their abilities.

> "I think that being able to pick a topic out of your mind that is interesting to you, and being able to research that topic, and become knowledgeable on your own effort is a great confidence booster in school. This is true because we become accustomed to only learning through a professor at times, and this skill helps us realize that after school we will be able to function independently of our superiors to complete our job."

> "The research aspect of 'self-directed learning' was most valuable to me. First, I had to find a subject that both interested myself and related to my group's overall topic. Then I

had to select what type of references and materials that would be best to use. I became better acquainted with library sources and deciphered between "real" and "false" information on the Internet. By doing these things myself, I gained confidence. I was able to prove to my group members, and more importantly myself, that I can successfully complete my part of the paper."

The students were also asked about the effect that working in a team had on their ability to carry out the task. Typical comments included:

> "Working as a team enhanced the "self-directed learning" because it created an audience to which the material you are learning must be explained. …"

> "…, working as a team enhanced the amount of overall knowledge each person gained. Rather than learning about one topic or learning through one point of view, you were able to learn more things through views, other than your own."

Thus, based upon the students' responses, the initial attempt at using an approach to allowing students to develop and practice the skills necessary for self-directed learning appears to have been successful. Additionally, the quality of the technical information in the students' papers indicates that the students were successful. It was hoped that a standardized instrument for assessing readiness for self-directed learning could be used as part of the assessment of the impact of this assignment on the students: however, it could not be acquired in time. The available standardized instruments are discussed in the next section.

Assessment of Ability, and Willingness, to Engage in Lifelong Learning

A major issue in lifelong learning is how to assess the extent to which students are prepared to engage in it and also their willingness to do so, i.e., Flammer's "can do" and "will do" characteristics of the lifelong learner. Two instruments for assessing lifelong learning are Gugliemino's Self-directed Learning Readiness Scale (SDLRS) [10], developed in 1978, and Oddi's Continuing Learning Inventory (OCLI), developed in 1984 [11]. Candy notes that the SDLRS is widely used, especially in the area of adult education. During the development of the SDLRS eight factors were identified that contribute significantly to the ability to engage successfully in lifelong learning. These factors were labeled as: openness to learning opportunities, self-concept as an effective learner, initiative and independence in learning, informed acceptance of responsibility for one's own learning, a love to learn, creativity, future orientation, and the ability to use basic study skills and problem-solving skills. Thus, the scale includes factors related to skills and personal attributes related to self-directed learning.

Candy notes that in spite of its widespread use, the SDLRS has not escaped criticism in the literature [8]. Other researchers have even questioned the original analysis that was used to identify the eight factors identified by Gugliemino. The creator of the SDLRS is now recommending that only the total score be used as an indicator of readiness to engage in self-directed learning. Based upon the assertion that the ability to engage in self-directed learning is highly contextual, Candy raises the issue that both the SDLRS and the OCLI treat self-directed learning as context-free. He appears to question whether either instrument is a good measure of self-directed learning ability.

Even given the criticism of the SDLRS, we were curious to see how it might work for our students, so we obtained a self-scoring version of the instrument and administered it to a group of seniors, who serve as teaching interns in the College of Engineering [12]. These students were all selected by their departments based upon their academic records and expected ability to be effective in helping other students learn through office hours and help sessions. The results for the students are summarized in Table 1 in terms of the percentile rank. The percentile ranks are supplied with the instrument and are based upon results for "all adults." While nearly two-thirds of the students scored at a 70% or higher rank, one-third scored below this level with almost one-quarter scoring below 50%.

Table 1. Results of SDLRS instrument for senior engineering students

SDLRS %ile	Student Count	Fraction
90-99	10	0.27
80-89	8	0.22
70-79	6	0.16
60-69	2	0.05
50-59	2	0.05
40-49	3	0.08
<40	6	0.16

The results were somewhat surprising given that these students are highly successful by usual academic standards. We will have access to the students' academic records, once the semester is over and grades are submitted. With this information, we will attempt to identify factors that correlate with these scores to better understand the results. If the results from the SDLRS are a reliable measure of readiness for self-directed learning among this relatively homogeneous group of students, many of them are in need of work to improve their ability to engage in self-directed learning. Given the assertion by Candy that the ability to engage in self-directed learning is highly contextual, an interesting question is whether the students' responses would have changed much if we had asked them to respond to the survey in the context of their technical courses. The answer to that question will have to wait until we do some additional studies.

Conclusion

Our continuing investigation of the literature related to lifelong learning has revealed its enormous complexity; lifelong learning can occur through instruction, inquiry, and performance. The number of skills and personal attributes involved are substantial, and likely differ depending upon the mode of learning involved. Further, there is disagreement about the best way to help students develop these skills and attributes. On top of this, the SDLRS, the most widely used measure related to self-directed learning, has been the subject of debate regarding its utility in measuring self-directed learning readiness. One begins to wonder whether ABET understood the complexity of this area when they wrote the outcome – "a recognition of the need for, and an ability to engage in life-long learning," and asked us to give them a reliable measure of the success of our students in achieving it.

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