Incorporating Lifelong Learning Skills into a Computer Applications Course

Kenneth P. Brannan[1], Kaitlin H. Marley[2], Dennis J. Fallon[3], Kevin C. Bower[4]

Abstract – Instructors added a two-week self-directed learning module to a sophomore computer applications course to teach students about lifelong learning. The instructional approach for the module involved problem – based learning with independent student work. In 2012, the students explored lifelong learning through self-directed learning of the programming feature, ***while*** loops. In 2013, a new surveying topic focused the self-directed learning. Students indicated improvement in lifelong learning after the completion of the module through responses to survey questions. The student rating on "ability to perform lifelong learning as it applies to Civil Engineering" improved 1 point after incorporating the module in the course (question was based on a scale of 1 to 5). Further evidence of the success of the lifelong learning module may be found in the survey completed by students who took the course in the fall 2013 semester. These students rated their overall experience with the module as 4.1 out of 5. The paper discusses the results of the survey and the lifelong learning modules used in greater detail.

Keywords: lifelong learning, self-directed, programming.

INTRODUCTION

Students benefit from studying computer programming by developing skills to create a logical plan to solve a problem. Within the scope of a computer applications course, problem solving might be seen as specific to the software environment and language. However, in a broader sense, a student can apply the problem-solving process to problems in other courses or in the workplace following graduation. For this reason, a lifelong learning module was incorporated into a computer applications course taught in the sophomore year. Lifelong learning is required as part of ABET's "General Criteria 3. Student Outcomes," part 3 (i), which specifies that graduates should attain "a recognition of the need for, and an ability to engage in life-long learning." In addition, the American Society of Civil Engineers' (ASCE) Body of Knowledge 2 suggests that students should be able to "demonstrate the ability for self-directed learning." As part of the teaching module, students in the computer applications course study lifelong learning and independently complete a mini-project that requires information not previously covered in the curriculum to obtain an accurate solution. There is not a unique solution, so the problem may be considered to be open-ended. This paper discusses the type of lifelong learning problem assigned, activities of students and instructors, student self-assessment, and rubrics for assessment of student performance.

[1] The Citadel, Civil and Environmental Engineering Dept, 171 Moultrie St., Charleston, SC 29409, ken.brannan@citadel.edu.

[2] The Citadel, Civil and Environmental Engineering Dept, 171 Moultrie St., Charleston, SC 29409, kmarley@citadel.edu.

[3] The Citadel, Civil and Environmental Engineering Dept, 171 Moultrie St., Charleston, SC 29409, fallond@citadel.edu.

[4] The Citadel, Civil and Environmental Engineering Dept, 171 Moultrie St., Charleston, SC 29409, bowerk1@citadel.edu.

BACKGROUND

Five of the eleven outcomes listed in ABET's General Criteria 3 Student Outcomes [1] include technical skills and the remaining six consist of professional skills. Lifelong learning represents one of the professional skills part of the following from Criteria 3(a) through 3(k):

- 3d - an ability to function on multidisciplinary teams
- 3f - an understanding of professional and ethical responsibility
- 3g - an ability to communicate effectively
- 3h - the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- 3i - a recognition of the need for, and an ability to engage in life-long learning
- 3j - a knowledge of contemporary issues.

In contrast, ASCE's Body of Knowledge 2 (BOK2), designed for a number of uses including assisting Civil Engineering Programs with establishing courses and curricula, developed 24 outcomes [2]. The 24 outcomes are divided into three categories: foundational, technical, and professional. Lifelong learning is included as one of the nine outcomes that make up the professional component:

- 16 - communication
- 17 - public policy
- 18 - business and public administration
- 19 - globalization
- 20 - leadership
- 21 - teamwork
- 22 - attitudes
- 23 - lifelong learning
- 24 - professional and ethical responsibility.

In its explanation of the lifelong learning outcome, the BOK2 [2] describes the motivation for incorporating a lifelong learning outcome: "Given the ever-increasing quantity of technical and nontechnical knowledge required of practicing civil engineers, the ability to engage in lifelong learning is essential. Lifelong learning is defined as the ability to acquire knowledge, understanding, or skill throughout one's life." According to the BOK2 [2], undergraduate civil engineering students should be able to define lifelong learning, explain why lifelong learning is critical for engineers, describe the skills that a lifelong learner needs, and show that they have the ability for self-directed learning.

An early definition of self-directed learning (SDL) was provided by Knowles [3]: "In its broadest meaning, 'self-directed learning' describes a process by which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes." The BOK2 indicates that SDL is a mode of lifelong learning "because it is the ability to learn on one's own with the aid of formal education." [4]

Another process described in the literature which has implications valuable for self-directed learning is called self-regulated learning (SRL). According to Zimmerman [5], SRL "refers to learners beliefs about their capability to engage in appropriate actions, thoughts, feelings, and behaviors in order to pursue valuable academic goals while self-monitoring and self-reflecting on their progress toward goal completion." Skills related to SRL are highly important to both undergraduate students and to graduates in the workplace [6]. Bembenutty [6], in drawing upon his previous work [7] and that of Schunk and Zimmerman [8], puts this persuasively: "It is hard to think about the academic success of students in our colleges and universities if the students are not self-directed and self-motivated and cannot sustain cognition, affect, and behavior in order to assist in pursuing their academic and professional goals."

The potential for students to become lifelong learners may be fostered by the self-regulated use of learning strategies [9]. Weinstein, Acee, and Jung [9], describe three interacting components of effective strategic learning. These components are skill (e.g., knowing a variety of learning strategies that can be applied in different situations), will

(e.g., success-promoting elements such as setting and analyzing goals), and self-regulation (e.g., time and anxiety management or keeping on-task). Additional information and examples of these components are given in Reference [9].

SRL may also be conceptualized as having three cyclical processes [5]. In this model, there is a forethought phase (e.g., goal-setting, strategic planning, focusing on self-efficacy beliefs), performance phase (e.g., using strategies such as self-instruction, self-monitoring, and maintaining attention), and self-reflective phase (e.g., self-evaluating performance and making adjustments). Bembenuty [6] summarized the processes by stating, "Self-regulation of learning is cyclically initiated when learners set valuable academic goals, select learning strategies, and assess their feelings and motivational beliefs necessary to attain the goals."

Based on a thorough review of earlier research [10, 11], Zimmerman and Schunk [12] concluded that SRL had a positive impact on academic performance. Further, improvements resulting from the use of SRL were found in a variety of fields, including health, sports, business, music, and professional writing [12, 13]. The significant role that SRL occupies in the college environment in which students are held to higher levels of accountability in the learning process was noted by Lichtinger and Kaplan [14]. Referencing the work of a number of researchers [15, 16, 17, 18], they recognized that the literature focusing on the value of self-regulation for college-level learners was expanding. Clearly, the benefits of SRL to all learners and particularly to college students underscore the potential of SRL to prepare students for lifelong learning.

A general approach for incorporating lifelong learning into the classroom has been suggested by Felder and Brent [19]. The approach involved assigning realistic problems, selecting a problem-solving method that shifts the responsibility for learning from the professor to the student, and ensuring that students are exposed multiple times to this type of experience. Two instructional methods were discussed for helping students develop skills to promote success with such problems – problem-based learning and cooperative learning. The authors also included familiarizing students with their learning styles in the instructional methodology.

Problem-based learning (PBL) has continued to grow following research conducted in the medical program at McMaster University in the 1960's and 1970's [20, 21]. It is now used in a variety of other fields, including engineering [22, 23, 24]. In contrast to traditional lecture-based classes (lecture first, followed by students learning and working problems), PBL classes are arranged with students first encountering a problem, followed by students identifying what is needed, learning the material, and applying what they have learned [25]. Some of the advantages of PBL are that the subject material is learned in the context of solving a problem; student learning may be deeper because of genuine interest in the material; skills such as problem-solving, inquiry, and thinking can be learned while learning the subject material; and PBL can promote principles that enhance learning such as rapid feedback, accountability, and designing activities for individual learning preferences [25, 26]. Apparent disadvantages include student discomfort with PBL because of being accustomed to the traditional lecture format, student desire to learn more on a given problem than time permits, and the overall subject material learned in a course is less [25].

Woods [26] asserts that the primary role of the instructor in PBL is to facilitate. He lists several methods a facilitator can use to manage students as they work: ask questions designed to help students progress, help students develop reflective skills, help students monitor their efforts, promote growth in critical thinking and learning, make sure students are considering all important issues, and promote the type of learning environment which will encourage students to succeed without fear of derision. These represent a summary; Reference [26] contains additional information on effective facilitation.

Eight steps are provided by Woods [25] to guide individuals and groups involved in solving problems with PBL. These are summarized below. Specific group tasks would be omitted for individual application of PBL.

- Investigate the problem, suggest ideas or theories, and develop the details.
- Check to see if the problem can be solved with the current information, then identify what is applicable.
- Identify missing information that is preventing the problem from being solved.
- Prioritize information that must be learned, then set goals and objectives for learning. Identify and distribute resources. For a group, determine what each member must do.
- Study and prepare.
- For a group, communicate the information from previous step to each member.

- Solve the problem using the information
- Assess the new information, the solution, and the effectiveness of the process used; then reflect on the entire process.

The initial topic in Chapter 1 of Woods [25] text, "Problem-based Learning: How to Gain the Most from PBL" is coping with change. Students who are forced into change similar to encountering a problem-based learning approach instead of a traditional lecture class may be subject to significant emotional swings which Woods refers to as a grieving process. Woods' eight-step model is similar to the eight-step model by Taylor [27], which is also presented in the text. The presentation of this topic in the initial chapter indicates the importance of students understanding and managing change if they are beginning a new journey with PBL.

One of the most widely recognized instruments for measuring self-directed learning is the Self-Directed Learning Readiness Scale (SDLRS). The instrument is available in three forms: the SDLRS-A for the general adult category, the SDLRS-ABE for those adults who have low reading levels or whose native language is not English, and the SDLRS-E for children who are in elementary school. Some 58 Likert-type items are on the adult form [28]. Eight factors associated with self-directed learning were recognized upon analysis of the results as the instrument was being developed. These 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, love of learning, creativity, future orientation, and ability to use basic study and problem-solving skills."[29] Litzinger, *et al*. [30] recognized that the factors address both attitudes (first seven factors) and skills (final factor). Further, Litzinger, *et al*., who also references a thorough review by Maltby, *et al*. [31], reported on the reliability and validity of the SDLRS based on a large number of studies.

During the 2012 – 2013 academic year, collection of data on student readiness for self-directed learning was initiated. As part of a National Science Foundation S-STEM grant [32], the SDLRS-A was administered to all freshman Civil and Environmental Engineering students. Most of the 76 students who were enrolled in the fall semester 2013 computer applications course took the SDLRS during the 2012-2013 year. In the future, the SDLRS-A will continue to be administered to students when they are freshmen.

The preliminary results associated with the students who took the computer applications course in the fall of 2013 are presented here as an indication of the students' preparedness for lifelong learning when they entered the curriculum. Of 108 students who took the test when they were freshmen, only 40 achieved a score at or above the 70^{th} percentile for adults with scores ranging from the 4^{th} percentile to the 99^{th} percentile. The average score of the group of students who enrolled in the computer applications course was 220, which falls in the range considered to be the adult average (202-226). Guglielmino and Guglielmino [33] state that adults scoring in this range are more likely to be successful in independent situations, but are not fully comfortable with handling the entire process of identifying their learning needs and planning and implementing the learning. It has been shown that adults who score below average on the SDLRS-A can, with appropriate training, increase their SDLRS score. The preliminary results indicate that a lifelong learning module in courses such as the computer applications course could be valuable in preparing students to engage in self-directed learning because the students fall into the range of average adults that would be successful at self-directed learning, but are not yet comfortable handling the process. The SDLRS-A will be administered again to these students during their senior year when they have been exposed to several lifelong learning activities built into the curriculum.

COMPUTER APPLICATIONS COURSE

Civil Engineering students complete a computer applications course during the sophomore year. All sections of the course are taught in 50-minute periods on a Monday-Wednesday-Friday schedule. The course is designed to accommodate both traditional lecture and competitive active learning activities. Assessment of student performance includes regularly assigned homework, mini-projects, weekly quizzes, and two comprehensive tests. Typically, two weeks are provided for the mini-projects, many of which involve writing programs in a computer language.

During the late 1980s and early 1990s, the Department of Civil and Environmental Engineering taught its computer applications course with several programming languages, including FORTRAN, QuickBasic, and Turbo C++. Since 1996, Mathcad has been used for teaching programming and as a tool for graphing, symbolic manipulation, numerical solutions, documenting problems, and providing units with computations. In addition to these topics, the

course has included a module on computer ethics. Professional and ethical responsibility is an outcome in the ABET and BOK2 professional skills lists discussed previously. Recently, lifelong learning, another of the professional skills, was added to the list of topics for the course. In the next section, the lifelong learning modules developed for computer applications course during Fall 2012 and Fall 2013 will be discussed.

LIFELONG LEARNING MODULES

As indicated in the Introduction, problem-solving skills developed in a programming course are valuable in the workplace following graduation. Further, benefits from skills learned can be enhanced by including instruction designed to promote lifelong learning. Activities that help develop self-directed learning skills are particularly constructive in preparing students to engage in lifelong learning. With this in mind, a lifelong learning module was added to the computer applications course that was designed to emphasize SDL by using a PBL approach.

Fall 2012 Module

The primary goal of creating a lifelong learning module was to shift the responsibility of learning from the course instructor to the student. To assist in accomplishing this goal, it was necessary for the course instructor to adopt a different role, becoming a facilitator throughout the two-week module rather than a traditional lecturer. The instructional approach adopted for the module was PBL, with students working individually rather than in groups.

On the initial class of the lifelong learning module, prior to being introduced to the problem, students were provided with information on lifelong learning and self-directed learning. The self-directed learning process used was adapted from Woods' [25] eight-step PBL process discussed previously. Information on setting goals and learning objectives was also provided. Setting goals and learning objectives is one of the steps of the PBL process. Recognizing that students may not have encountered an instructional approach like this before and may have a strong reaction to the change, students were made aware of Woods' [25] model for coping with change and encouraged in taking a positive approach in their response to the change.

The problem assigned to the students was to create a user-defined function in Mathcad that will calculate the square root of any number, n. Students were not permitted to use exponents, the built-in square-root function, or a ***for*** loop in their solution. With regard to the precision of the answer, the difference between the square root generated by the function squared and the actual number, n, was required to be less than 0.00001.

At the point in the semester where the module was introduced, students had worked with ***if*** statements and with single ***for*** loops. Nested ***for*** loops had not yet been covered. There were a number of approaches that students could use to solve the problem. All of these required use of a ***while*** statement and ***while*** statements had not been previously taught in the course. Students were permitted to use books, the Internet, and other similar resources in working on the solution. These resources were readily available, including resources on the Internet.

To help pace the students through the two-week module, to monitor their progress, and to provide feedback on progress, three meetings between students and the facilitator were scheduled on regular class days. When necessary, meetings were held with groups of three or four students to ensure that there would be enough time to meet with each student. In each meeting, progress on specific steps of the self-directed learning process was assessed and discussed. During the first meeting students discussed what they learned while exploring the problem, what they realized that they already knew that was pertinent, information that they felt they needed to be able to solve the problem, their learning objectives for completing the assignment, and the method they planned to use for meeting their learning objectives. By the second meeting, students were to have begun to acquire and organize the new information needed and to apply it in solving the problem. Students did not work at the same speed, so the main purpose of the second meeting was to make sure that students were making adequate progress. By the third meeting, students ideally would have begun to assess the new information, the solution, and the effectiveness of the process used. In all of the meetings, a key task for the facilitator was to provide students with a lot of encouragement as they worked through the process.

Two elements were required as part of the project submission. One was a well-documented solution in Mathcad that met all the requirements and was accurate and appropriately tested. The second element was to show, in flow chart format, what had been done at each step in the self-directed learning process. Students were also asked to assess

how well they accomplished each step. Along with the assessment, a paragraph had to be included that discussed the value of the self-directed learning process and why it is important to Civil Engineers.

Project grading was based on three components: performance and participation at the meetings, the solution to the problem, and the flow chart outlining and assessing the self-directed learning process. A rubric was developed to assist the grading of the projects. The rubric is shown in Table 1. Student performance on the project was very good, with students from the combined sections averaging 84.5/100. Overall, performance and participation improved with time as students began to understand what they needed to do and that they were able to accomplish the goals. Some students were not as successful with the flow chart as with the other two components. It is possible that some of these students placed emphasis on completion of the programming part of the project and did not spend as much time as needed on the flow chart or did not understand exactly what was expected.

It should also be noted that two sections of the computer applications course were taught during the fall 2012 semester, each class taught by a different instructor. The teaching schedule for the semester allowed both professors to attend both classes. This was valuable in helping to ensure consistency in the way the module was facilitated and in coordinating meetings with the students.

Fall 2013 Module

The project assigned during the fall 2013 semester differed from the 2012 project in that the topic the students explored in 2013 was surveying instead of programming. Programming features needed to solve the problem had been covered previously in class, but not to the degree of difficulty necessary for the project solution. The solution required at least two ***for*** loops to be used in the same function (although not nested for loops). Combining ***for*** loops in a user-defined function is a feature that had not been emphasized at that point in the course.

Two weeks were again scheduled for the lifelong learning module. Instruction on the initial day was similar to that described for the fall 2012 module. Provisions were also made for monitoring student progress during the two-week period. More students registered for the course in 2013 and four sections were created to accommodate the larger numbers. Two instructors taught the four sections, with each instructor teaching two sections. Two sections were taught during the same class period, so it was not possible for instructors to coordinate with each other during class as had been done in 2012, resulting in some differences in the facilitation of the module.

The assignment required students to take a five-column matrix containing surveying bearings and lengths of a perimeter and compute the balanced latitudes and departures using the Compass (Bowditch) Rule. A user-defined function was required for the computations. Format of input and output matrices was specified and information for handling alphanumeric data (north, south, east, west) and custom units in the input matrix was provided in the problem description. During the fall 2013 semester, students were taking their first surveying course at the same time as the computer applications course. However, the Compass Rule was not covered in the surveying course until after the lifelong learning module had been completed. Therefore, each student had to research the surveying topic prior to developing a solution.

Assessment of the student projects was accomplished in the same manner as in 2012, except that the grading rubric modified to reflect the Compass Rule. The rubric is shown in Table 2. Student performance on the module for the combined fall 2013 classes was comparable to the performance for the fall 2012 semester, with students averaging 85.7. As in the fall 2012 semester, some students did not do as well on the flow chart portion of the project. However, the instructors were confident that the performance on the flow chart for future offerings of the module could be improved through better communication of the expectations.

SURVEYS

To help assess the effectiveness of the lifelong learning module, students in the 2013 course completed the survey shown in the Appendix after completing the module. Surveys to assess the course were also administered in 2012 to students who took the course in 2012 and to students who took the course prior to 2012, but the emphasis in those surveys focused on a variety of changes made in the course, and there was only one question on lifelong learning [34]. That question was included on the 2013 survey for comparative purposes. During the fall 2013 semester,

Table 1. Grading Rubric for Fall 2012 Lifelong Learning Module

Assessment Rubric for Problem Solution					
0 points	**20 points**	**40 points**	**60 points**	**80 points**	**100 points**
No attempt has been made to write a function that will determine the square root of a number within the specified tolerance.	The solution contains a function that does not determine the square root of a number within the specified tolerance. The function has no resemblance to a correct solution; however, an attempt has been made to solve the problem.	The solution contains a function that does not determine the square root of a number within the specified tolerance. The function has more than 3 errors that prevent the program from functioning properly.	The solution contains a function that does not determine the square root of a number within the specified tolerance. The function has more than 1 error but less than 3 errors that prevent the program from functioning properly.	The solution contains a function that determines the square root of a number with one small error, not within the specified tolerance, or does not work for any number.	The solution contains a function that determines the square root of any number within the specified tolerance.
Assessment Rubric for Flow Chart					
0 points	**20 points**	**40 points**	**60 points**	**80 points**	**100 points**
No attempt has been made to write a flowchart of the student's progress or assessment of the Self-Directed Learning Process.	The flowchart omits the student's progress or assessment at nearly all of the Self-Directed Learning Steps.	The flowchart omits the student's progress or assessment at more than one of the Self-Directed Learning Steps, or addresses the progress or assessment at each step with more than 3 errors.	The flowchart omits the student's progress or assessment at one of the Self-Directed Learning Steps, or addresses the progress or assessment at each step with more than 1 error but less than 3 errors.	The flowchart addresses the student's process at all of the Self-Directed Learning Steps with 1 small error, or provides an assessment of his/her performance at each step with 1 small error.	The flowchart addresses the student's process at all of the Self-Directed Learning Steps without error, and provides an assessment of his/her performance at that step without error.

Table 2. Grading Rubric for Fall 2013 Lifelong Learning Module

Assessment Rubric for Problem Solution					
0 points	**20 points**	**40 points**	**60 points**	**80 points**	**100 points**
No attempt has been made to write a function that will determine the corrected latitudes and departures based on the Compass (Bowditch) Rule.	The solution contains a function that does not determine the corrected latitudes and departures based on the Compass (Bowditch) Rule. The function has no resemblance to a correct solution; however, an attempt has been made to solve the problem.	The solution contains a function that does not determine the corrected latitudes and departures based on the Compass (Bowditch) Rule. The function has more than 3 errors that prevent the program from functioning properly.	The solution contains a function that does not determine the corrected latitudes and departures based on the Compass (Bowditch) Rule. The function has more than 1 error but less than 3 errors that prevent the program from functioning properly.	The solution contains a function that determines the corrected latitudes and departures based on the Compass (Bowditch) Rule with one small error, or the function works for the example data but would not work for any data.	The solution contains a function that determines the corrected latitudes and departures based on the Compass (Bowditch) Rule.
Assessment Rubric for Flow Chart					
0 points	**20 points**	**40 points**	**60 points**	**80 points**	**100 points**
No attempt has been made to write a flowchart of the student's progress or assessment of the Self-Directed Learning Process.	The flowchart omits the student's progress or assessment at nearly all of the Self-Directed Learning Steps.	The flowchart omits the student's progress or assessment at more than one of the Self-Directed Learning Steps, or addresses the progress or assessment at each step with more than 3 errors.	The flowchart omits the student's progress or assessment at one of the Self-Directed Learning Steps, or addresses the progress or assessment at each step with more than 1 error but less than 3 errors.	The flowchart addresses the student's process at all of the Self-Directed Learning Steps with 1 small error, or provides an assessment of his/her performance at each step with 1 small error.	The flowchart addresses the student's process at all of the Self-Directed Learning Steps without error, and provides an assessment of his/her performance at that step without error.

Professor Kaitlin Marley taught two sections of the computer applications course and Dr. Dennis Fallon taught two sections. In the fall of 2012, Professor Kaitlin Marley and Dr. Kenneth Brannan each taught one section.

Results of the 2013 survey are shown in Table 3. Most of the survey questions ask students to provide a ranking from 1 to 5. The other question asks for a Yes or No response. There was no substantial difference in the results based on the instructor and the average rankings of the students from the combined classes are shown in Table 3. The numbers of the survey questions shown in Table 3 correspond with the numbers shown in the actual survey in the Appendix. Questions related to lifelong learning and self-directed learning are discussed first (Questions 1-5, 10-11), followed by discussion of two questions related to the impact of the module on difficult course material and overall course performance (Questions 6-7), and discussion of the overall experience with the module (Question 8). Discussion of questions is not in the same order as listed in Table 3.

Questions 2 and 3 focus on the students' acquisition of lifelong learning. In Question 2, students were asked to rate their ability to perform lifelong learning as it applies to civil engineering. With 5 representing a very strong ability, the average ranking by students during the fall 2013 semester was 4.0. Question 3 concentrated on how well the students' understanding of lifelong learning was helped by the lifelong learning module. An average ranking of 4.2 out of 5 indicated the high value the students placed on the module in contributing to their understanding.

Question 2 on the 2013 survey is effectively the same as a question asked of students in 2012 [34]. The question on the 2012 survey was, "ASCE defines lifelong learning in BOK 2 as, 'the ability to acquire knowledge, understanding, or skill throughout one's life.' Using a scale of 1 to 5, rate your ability to perform lifelong learning as it applies to Civil Engineering **(5 is a very strong ability to perform lifelong learning)**." Students taking the course in 2012, when a lifelong learning module comparable to that in 2013 was taught, provided an average response on this question of 4.2 out of 5. As noted above, the average ranking on this question in 2013 was 4.0. This resulted in an average ranking of 4.1 for the two years the lifelong learning module was included in the course. Students taking the course prior to 2012, when a comparable lifelong learning module was not taught, provided an average response of 3.1. On the average, an improvement of 1 point in the student response resulted from incorporating a lifelong learning module in the course, indicating a positive impact on the teaching of lifelong learning in the course that has been sustained for two years. Unfortunately, other than Question 2, no other questions on the 2013 survey appeared on the 2012 survey. The remainder of the 2013 survey questions is discussed below.

In order for students to continue to learn about lifelong learning throughout their undergraduate experiences, it is important that they maintain a positive outlook on lifelong learning. Question 1 asked students about the importance to their preparation for becoming a practicing engineer it was to learn to acquire knowledge, understanding, and skill on their own. The result was the highest among the survey questions (4.8 out of 5). As shown by the results of Question 4, the lifelong learning assignment contributed significantly to the students' understanding of why lifelong learning is important to the practice of civil engineering (4.3 out of 5).

One of the most important aspects of the lifelong learning outcome described in the BOK2, is for students to show that they have the ability for self-directed learning. Question 5 asked students to rate how well they believed the lifelong learning assignment helped them to improve their self-directed learning skills. With a rating of 5 representing that it helped students to improve their SDL skills very well, the students responded with an average rating of 4.2. However, many of the students reported in Question 9 that self-directed learning problems had been included in some of their other courses. Approximately 69 percent of the respondents said that they had used self-directed learning in solving problems in other courses. On the survey form there was a second part to Question 9 not shown on Table 3 which asked students how many courses had they taken where they had worked SDL problems. The responses ranged from 1 to 7, with some students responding "most," or "all." These results were somewhat surprising since it had not been expected that students would have had many significant SDL experiences at this point in their program. It may be worthwhile in the future to revise the question or add additional questions to determine what prior experiences in SDL the students have had.

Questions 10 and 11 were intended to determine if student motivation to use self-directed learning improved throughout the two-week experience. By considering the difference in motivation between the two questions, each of which were based on a rating of 5 representing very motivated, it may be seen that the improvement in motivation from the beginning of the project to the end was greater than 1 point.

Questions 6 and 7 are related to the students' performance in the course. Although the students had been working with ***for*** loops for three weeks prior to beginning the lifelong learning module and had been working with multi-line user-defined functions for even longer, the students indicated in the results from Question 6 that the module contributed significantly toward their ability to write user-defined function using loops (4.1 out of 5). Improvement

Table 3 – Summary of Student Responses (n = 70)

	Question	**Average Rankings of Students during Fall 2013**
1	How important do you think it is for a student to learn to acquire knowledge, understanding, and skill on your own as preparation for becoming a practicing engineer? (**5 is very important**)	4.8
2	ASCE defines lifelong learning as "the ability to acquire knowledge, understanding, or skill throughout one's life." Using a scale of 1 to 5, how would you rate your ability to perform lifelong learning as it applies to Civil Engineering. (**5 is a very strong ability to perform lifelong learning**)	4.0
3	How well did the lifelong learning assignment help you to understand what lifelong learning is? (**5 is very well**)	4.2
4	How well did the lifelong learning assignment help you to understand why lifelong learning is essential for the practice of civil engineering? (**5 is very well**)	4.3
5	How well did the lifelong learning assignment help you to improve your self-directed learning skills? ASCE uses the following definition for self-directed learning: "the ability to learn on one's own with the aid of a formal education." (**5 is very well**)	4.2
6	How well did the lifelong learning assignment contribute to your ability to write user defined functions (programs) using loops in Mathcad? (**5 is very well**)	4.1
7	How well did the lifelong learning assignment help you to improve your overall performance in this course? (**5 is very well**)	4.0
8	Rate your overall experience with the lifetime learning assignment (**5 is excellent**)	4.1
9	Have you used self-directed learning to solve problems in any other courses? (**Circle either "Yes" or "No"**)	Yes = 48 No = 22
10	At the beginning of the lifelong learning assignment, how motivated did you feel about using self-directed learning to solve a problem? (**5 is very motivated**)	2.9
11	Now that the lifetime learning assignment has been completed and submitted, how motivated do you feel about using self-directed learning to solve problems in this or any course? (**5 is very motivated**)	4.2

in overall course performance is shown in Question 7. Students attributed an average improvement rating of 4.0 out of 5 to the lifetime learning assignment.

Finally, the students rated their overall experience with the lifetime learning module through their response to Question 8. Based on a rating of 5 representing excellent, the average student rating was 4.1.

CONCLUDING COMMENTS

Based on experience gained from teaching lifelong learning modules the past two years in a computer applications course, those designing lifelong learning modules for a course in which programming is taught should be able to select information from either the programming language or from another appropriate course for students to explore in a self-directed learning format. In addition, the results of a survey conducted during the 2013 course indicate a SDL module in the course offers the potential to help students understand and perform life-long learning; to help teach students the importance of acquiring knowledge, understanding, and skills on their own; to help students improve their self-directed learning skills; to help students improve their motivation to do self-directed learning; and to improve their performance in the course. Overall, the SDL module appears to have been very successful. One way to improve the module for future offerings would be to establish goals, learning objectives, instructional procedures, and expected benefits as soon as possible and to begin the conversation on these items with all instructors well in advance of the time to teach the module. It should also be noted that although the results of the survey indicate that the module had been successful, two weeks is not enough time to accomplish all that is needed in teaching lifelong learning and self-directed learning to undergraduates. Ideally, instruction in this area should extend well past a two-week module taught in a single course. For example, a curriculum might include a number of courses with lifelong learning modules that together provide the foundation to produce graduates who will benefit from lifelong learning and self-directed learning throughout their professional careers.

REFERENCES

[1] ABET Engineering Accreditation Commission, *Criteria for Accrediting Engineering Programs: Effective for Reviews During the 2013-2014 Accreditation Cycle*, ABET, Baltimore, Md., 2012, 24 pg.

[2] Body of Knowledge Committee of the Committee on Academic Prerequisites for Professional Practice, *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*, American Society of Civil Engineers, Reston, VA, 2008.

[3] Knowles, M., *Self-directed learning: A Guide for Learners and Teachers*, Association Press, New York, 1975.

[4] Knowles, M. S., *Self-Directed Learning*, Follett, Chicago, IL, 1975, as cited in Body of Knowledge Committee of the Committee on Academic Prerequisites for Professional Practice, *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*, American Society of Civil Engineers, Reston, VA, 2008.

[5] Zimmerman, B. J., "Attaining Self-Regulation: A Social Cognitive Perspective," in *Handbook of Self-Regulation*, M. Boekaerts, P. R. Pintrich, and M Zeidner (eds.), Academic Press, San Diego, CA, 2000. Cited in Bembenutty, Héfer, "Introduction: Self-Regulation of Learning in Postsecondary Education," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[6] Bembenutty, Héfer, "Introduction: Self-Regulation of Learning in Postsecondary Education," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[7] Bembenutty, H., "Academic Delay of Gratification, Self-regulation of Learning, Gender Differences, and Expectancy-Value" in Personality and Individual Differences, Volume 46, Issue 3, February 2009. Cited in Bembenutty, Héfer, "Introduction: Self-Regulation of Learning in Postsecondary Education," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[8] Schunk, D. H. and B. J. Zimmerman (eds.), Motivation and Self-Regulated Learning: Theory, Research, and Applications, Taylor and Francis, New York, 2008. Cited in Bembenutty, Héfer, "Introduction: Self-Regulation of Learning in Postsecondary Education," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[9] Weinstein, Claire Ellen, Taylor W. Acee, and JaeHak Jung, "Self-Regulation and Learning Strategies," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[10] Schunk, D. H. and B. J Zimmerman (eds.), *Self-Regulation of Learning and Performance: Issues and Educational Applications*, Erlbaum, Inc. Hillsdale, NJ, 1994. Cited in Zimmerman, Barry J. and Dale H. Schunk, "Reflections on Theories of Self-Regulated Learning and Academic Achievement," in *Self-Regulated Learning and Academic Achievement: Theoretical Perspectives*, Second edition, Barry J. Zimmerman and Dale H. Schunk (eds), Lawrence Erlbaum Associates, Inc., Mahwah, NJ, 2001.

[11] Schunk, D. H. and B. J. Zimmerman (eds.), *Self-Regulated Learning: From Teaching to Self Reflective Practice*, Guilford Press, New York, 1998. Cited in Zimmerman, Barry J. and Dale H. Schunk, "Reflections on Theories of Self-Regulated Learning and Academic Achievement," in *Self-Regulated Learning and Academic Achievement: Theoretical Perspectives*, Second edition, Barry J. Zimmerman and Dale H. Schunk (eds), Lawrence Erlbaum Associates, Inc., Mahwah, NJ, 2001.

[12] Zimmerman, Barry J. and Dale H. Schunk, "Reflections on Theories of Self-Regulated Learning and Academic Achievement," in *Self-Regulated Learning and Academic Achievement: Theoretical Perspectives*, Second edition, Barry J. Zimmerman and Dale H. Schunk (eds), Lawrence Erlbaum Associates, Inc., Mahwah, NJ, 2001.

[13] Bandura, A. *Self-Efficacy: The Exercise of Control*, W. H. Freeman, New York, 1997. Cited in Zimmerman, Barry J. and Dale H. Schunk, "Reflections on Theories of Self-Regulated Learning and Academic Achievement," in *Self-Regulated Learning and Academic Achievement: Theoretical Perspectives*, Second edition, Barry J. Zimmerman and Dale H. Schunk (eds), Lawrence Erlbaum Associates, Inc., Mahwah, NJ, 2001.

[14] Lichtinger, Einat and Avi Kaplan, "Purpose of Engagement in Academic Self-Regulation," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[15] Bembenutty, H., "Self-Regulation of Learning and Academic Delay of Gratification: Gender and Ethnic Differences among College Students," *Journal of Advanced Academics*, 18, 586-616, August 2007. Cited in Lichtinger, Einat and Avi Kaplan, "Purpose of Engagement in Academic Self-Regulation," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[16] Pintrich, P. R. and A. Zusho, "Student Motivation and Self-Regulated Learning in the College Classroom" in *The Scholarship of Teaching and Learning in Higher Education: An Evidence-Based Perspective*, R. P. Perry and J. C. Smart (eds.) Springer, Dordrecht, The Netherlands, 731-810, 2007. Cited in Lichtinger, Einat and Avi Kaplan, "Purpose of Engagement in Academic Self-Regulation," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[17] VanderStoep, S. W., P. R. Pintrich, and A. Fagerlin, "Disciplinary Differences in Self-Regulated Learning in College Students," *Contemporary Educational Psychology*, 21, 345-362, 1996. Cited in Lichtinger, Einat and Avi Kaplan, "Purpose of Engagement in Academic Self-Regulation," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[18] Wolters, C., "Self-Regulated Learning and College Students' Regulation of Motivation," *Journal of Educational Psychology*, 90, 224-235, 1998. Cited in Lichtinger, Einat and Avi Kaplan, "Purpose of Engagement in Academic Self-Regulation," in *Self-Regulated Learning*, Héfer Bermenutty (ed.), *New Directions for Teaching and Learning*, Catherine M. Wehlburg, Editor-in-Chief, Wiley Subscription Services, Inc. at Jossey-Bass, San Francisco, no. 126, Summer 2011.

[19] Felder, Richard M. and Rebecca Brent, "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria," *Journal of Engineering Education*, American Society for Engineering Education, Washington, D.C., 92, 1, 7-25, January, 2003.

[20] Barrows, H. S. and R. M. Tamblyn, *Problem-Based Learning, An Approach to Medical Education*, Springer, New York, 1980.
[21] Savin-Baden, Maggi, *Problem-based Learning in Higher Education: Untold Stories*, The Society for Research into Higher Education & Open University Press, Philadelphia, PA, 2000.
[22] Savin-Baden, M., and C. H. Major, Foundations of Problem-Based Learning, Open University Press, Maidenhead, Berkshire England: 2004. Cited in Prince, Michael J. and Richard M. Felder, "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases," *Journal of Engineering Education*, American Society for Engineering Education, Washington, D.C., 95, 2, 123-138, 2006.
[23] Tan, O. S., *Problem-Based Learning Innovation*, Thomson, Singapore, 2003. Cited in Prince, Michael J. and Richard M. Felder, "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases," *Journal of Engineering Education*, American Society for Engineering Education, Washington, D.C., 95, 2, 123-138, 2006.
[24] Tan, O. S., P. Little, S. Y. Hee, and J. Coway, (eds.), *Problem-Based Learning: Educational Innovation across Disciplines*, Temasek Center for Problem-Based Learning, Singapore, 2000. Cited in Prince, Michael J. and Richard M. Felder, "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases," *Journal of Engineering Education*, American Society for Engineering Education, Washington, D.C., 95, 2, 123-138, 2006.
[25] Woods, Donald R., *Problem-based Learning: How to Gain the Most from PBL*, Donald R. Woods, Waterdown, Ontario, 1994.
[26] Woods, Donald R., *Problem-based Learning: Helping your Students Gain the Most from PBL*, Second Ed., Donald R. Woods, Waterdown, Ontario, 1995.
[27] Taylor, M. "Learning for Self-Direction in the Classroom: the Pattern of a Transition Process," Studies in Higher Education, Routledge, 11, 1, 55-72, 1986.
[28] Guglielmino and Associates, http://www.guglielmino734.com, posted March 5, 2012 and accessed November 4, 2013.
[29] Candy, Philip C., *Self-Direction for Lifelong Learning: A Comprehensive Guide to Theory and Practice*, Jossey-Bass Publishers, San Francisco, CA, 1991.
[30] Litzinger, Thomas A., John C. Wise, and Sang Ha Lee, "Self-directed Learning Readiness Among Engineering Undergraduate Students," *Journal of Engineering Education*, American Society for Engineering Education, Washington, D.C., 94, 2, 215-221, 2005.
[31] Matlby, J., C. Lewis, and A. Hill (eds), Commissioned Reviews of 250 Psychological Tests, Edwin Mellen Press, Wales, U. K., 2000.
[32] Bower, Kevin C., William J. Davis, and Jane Warner, "Enhancing Undergraduate Civil Engineering Opportunities for Socioeconomically Disadvantaged, Minorities and Female Students in South Carolina," National Science Foundation S-STEM Grant, 2011.
[33] Guglielmino and Guglielmino, http://www.lpasdlrs.com posted March 5, 2012 and accessed November 25, 2013.
[34] Brannan, Kenneth P., Kaitlin H. Marley, and John A. Murden, "Using Mathcad Prime 2.0 to Restructure a Computer Applications Course," *Proceedings of the 2012 ASEE Southeast Section Conference*, Cookeville, TN, 2012.

Kenneth P. Brannan

Kenneth P. Brannan is a Professor of the Civil and Environmental Engineering Department at The Citadel. He was President of the Southeastern Section of ASEE during 1998-1999, co-recipient of the Thomas C. Evans Instructional Paper Award for 1990, and co-recipient of the Best Paper Award at the 2005 ASEE Annual Conference. He earned B.C.E. and M.S. degrees from Auburn University and the Ph.D. from Virginia Tech. A registered professional engineer, Dr. Brannan has interests in freshman engineering education, computers in engineering education, water supply, and wastewater treatment systems.

Kaitlin H. Marley

Kaitlin Marley is an Instructor in the Department of Civil and Environmental Engineering at The Citadel. She earned her Bachelor of Science degree in Civil Engineering from North Carolina State University in 2008, and her Master of Science degree in Geotechnical Engineering from the University of California at Berkeley in 2009. Prior

to her employment at The Citadel, she helped develop textbooks and courseware for mathematics courses. She currently serves as an assistant advisor for the Society of Women Engineers at The Citadel.

Dennis J. Fallon

Dennis J. Fallon is presently The Citadel Distinguished Professor of Engineering Education. In 2011, he completed an eight year term as the Dean of the School of Engineering and Louis S. LeTellier Chair and is now serving on the faculty of the Civil and Environmental Engineering Department. He received his BSE from Old Dominion University (ODU) with honors in 1970, and his MSCE and PhD. from North Carolina State University in 1972 and 1980, respectively. Dr. Fallon is a Fellow of ASEE and ASCE. As an active member of the Southeastern Section of ASEE, Dr. Fallon has held numerous leadership positions within the organization including President of the Southeastern Section from 1996 to 1997 and then again from 2003 to 2004.

Kevin C. Bower

Kevin C. Bower is an Associate Professor of and Department Head of Civil and Environmental Engineering at The Citadel, Charleston, South Carolina. He recently received the ASEE Environmental Engineering Meritorious Service Award and he was the 2011 Harry C. Saxe teaching award recipient awarded for outstanding undergraduate engineering teaching at The Citadel. Dr. Bower's teaching research interests are in improving active learning environments, recruiting and retaining underrepresented populations to civil engineering, and the development of classroom pedagogy to improve moral and ethical development in engineering students.

APPENDIX

LIFELONG LEARNING SURVEY

CIVL 210
FALL 2013

Please respond to each of the following survey questions concerning lifelong learning.

1)	How important do you think it is for a student to learn to acquire knowledge, understanding, and skill on your own as preparation for becoming a practicing engineer? (**5 is very important**)	1	2	3	4	5
2)	ASCE defines lifelong learning as "the ability to acquire knowledge, understanding, or skill throughout one's life." Using a scale of 1 to 5, how would you rate your ability to perform lifelong learning as it applies to Civil Engineering. (**5 is a very strong ability to perform lifelong learning**)	1	2	3	4	5
3)	How well did the lifelong learning assignment help you to understand what lifelong learning is? (**5 is very well**)	1	2	3	4	5
4)	How well did the lifelong learning assignment help you to understand why lifelong learning is essential for the practice of civil engineering? (**5 is very well**)	1	2	3	4	5
5)	How well did the lifelong learning assignment help you to improve your self-directed learning skills? ASCE uses the following definition for self-directed learning: "the ability to learn on one's own with the aid of a formal education." (**5 is very well**)	1	2	3	4	5
6)	How well did the lifelong learning assignment contribute to your ability to write user defined functions (programs) using loops in Mathcad? (**5 is very well**)	1	2	3	4	5
7)	How well did the lifelong learning assignment help you to improve your overall performance in this course? (**5 is very well**)	1	2	3	4	5
8)	Rate your overall experience with the lifetime learning assignment (**5 is excellent**)	1	2	3	4	5
9)	Have you used self-directed learning to solve problems in any other courses? (Circle either "Yes" or "No") If so, how many courses? _____	Yes		No		
10)	At the beginning of the lifelong learning assignment, how motivated did you feel about using self-directed learning to solve a problem? (**5 is very motivated**)	1	2	3	4	5
11)	Now that the lifetime learning assignment has been completed and submitted, how motivated do you feel about using self-directed learning to solve problems in this or any course? (**5 is very motivated**)	1	2	3	4	5