Short, Instructional Modules for Lifelong Learning, Project Management, Teaming, and Time Management

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Abstract

Criteria 3 of ABET 2000 includes professional skills that have not traditionally been explicitly taught in undergraduate engineering programs. In addition the criterion related to "modern engineering tools necessary for engineering practice" provides for the instruction of a wide range of topics that are useful for the young engineer. Engineering faculty have limited experience and resources on teaching professional skills. Most engineering programs do not have the luxury of adding a professional skills course to their already overcrowded curriculum. Therefore, a suite of modules has been developed for the professional skills of lifelong learning, project management, teaming, and time management. Each module has been designed to fit within three 50-minute class periods in a standard course and includes bridge material to transition back to the original course. Each module was beta-tested by another instructor with a multi-disciplinary group of student evaluators. The beta-testing was done as a highly controlled stand-alone experience instead of part of a regular class. Many of these modules have not yet been used in the traditional classroom. Overall, the students had a positive reaction to each of the modules. Details of each of the modules and specific results of the beta-testing are included in the paper. While the modules are still undergoing improvement, they are at a stage where they can be used by other faculty. Thus, the modules are available at http://ece.ua.edu/faculty/rpimmel/public_html/ec2000-modules.

Introduction

With the evolution of ABET 2000 and the development of Criteria 3 (a)-(k), every engineering program must demonstrate their graduates' abilities in certain areas. (ABET, 2000) Some of the skills included in these criteria have not traditionally been taught in undergraduate engineering curricula, and faculty have limited experience and resources in trying to teach these skills. The mandate for "modern engineering tools necessary for engineering practice" leads to the need for exposure to additional professional skills. In particular, professional skills such as lifelong learning, project management, teaming, and time management are often difficult to demonstrate in our curricula.

Since most engineering programs do not have the luxury of adding an additional course on professional skills, a short module on each of these topics has been developed. Each module has

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been designed to fit in three 50-minute class periods in a standard course. So, for instance, the module on time management could be included in the first engineering course. The module on teaming could be included in the first course where team projects are assigned. The lifelong learning module could be included in a junior year course, and the project management module could be used in the first semester of the senior year. Although each of these modules would take about a week of lecture away from a course, an improvement in the students' abilities should be seen further along in the curriculum that would justify the time spent.

Each module is organized to provide instruction on the skill and associated tools as well as an opportunity to practice using the skill. This progressive development follows the format for teaching skills suggested by Woods et al (1997), where a skill is introduced in a context-free environment and then bridged and extended into the discipline material. Each module also provides for instruction followed by practice with evaluation and feedback—an approach considered essential in teaching a skill (Seat et al, 1999).

Each module contains a set of PowerPoint slides to be used or adapted for direct use in the classroom. The classroom material incorporates active and cooperative learning exercises. There is an instructor's guide with background information on the topic, suggested in-class and homework assignments, and some suggestions for grading assignments on "soft" skills. Description of the contents of each of the four modules is presented below.

Lifelong Learning

The lifelong learning module consists of three sets of PowerPoint slides and the instructor's guide. The introductory portion of the module has significantly more material than most instructors can cover in three 50-minute class periods, so it is up to the instructor to select material at his or her own discretion. This module assumes that the student has not had any previous instruction in the area of lifelong learning. However, experience with using this material in the classroom has shown that older, non-traditional students approach this material with additional wisdom than students in their early 20's. Several example topics for homework assignments are included in the instructor's guide, and the instructor may want to consider the background of the students before making an assignment.

After discussion with other faculty and practicing engineers, we decided that there are two fundamental aspects of lifelong learning: 1) knowing how to learn new material without taking a formal course or earning another degree, and 2) understanding what types of continuing education are available after graduation. The lifelong learning module was developed to focus on both of these issues. After completing this module, students should be able to:

a. Explain the importance of lifelong learning in an engineering or computer science career

b. Describe a process for learning new material

c. Identify what they need to learn for a given situation

d. Find appropriate resources in the library and on the web

e. List sources for continuing education opportunities

f. Assess their academic and professional development

g. Demonstrate that they can learn material on their own for a given assignment

The class-periods are organized such that objectives a, b, and d are covered the first day, objectives c, e, and f are covered during the second and third days, and objective g is related to the bridge assignment to take them back to their course material.

The justification for the study of lifelong learning includes avoiding obsolescence (Marra et al, 1999; SAE International, 2001), the need to adapt to a changing society, annual employment evaluations (Wolff, 2000), employer surveys (Benefield et al, 1997), and ABET (ABET, 2000). This portion of the PowerPoint slides becomes quite repetitive, and the instructor will probably want to use a subset of the justification provided.

Following the justification and learning objectives, the first day's class continues with the development of the steps in the process of self-learning. Students are divided into teams for a cooperative learning exercise where they brainstorm on what these steps might be. After several teams report back to the class, a list of 'expert' steps in the process of self-learning is presented. The first class period ends with a discussion of sources of information and places to find sources of information. We are defining sources as things such as building codes, journal articles, newspaper articles, trade magazines, vendor catalogs, etc. Students tend to think of sources of information as the Internet and the library. It is crucial for the instructor to emphasize that 1) there are a wide variety of sources of information that are useful to engineers and computer scientists, and 2) not all of the world's knowledge is contained on the Internet. The assignment at the end of the first class is a non-technical learning assignment where students are required to describe the process that they go through to complete the assignment and list the specific sources that they used as well as the location of those sources. Six examples of non-technical learning assignments are included in the instructor's guide and they include "Finding an apartment in a new city" and "Investing a large sum of money".

The second class period begins by discussing the results of the non-technical learning assignment and reviewing the important points of the first class period. This is followed by a discussion of the process for becoming a Professional Engineer, types of continuing education that are available following graduation, and the importance of using technical societies as a source of continuing education. This is followed by an active learning exercise where students are presented with a technical learning problem in which they must determine what needs to be learned and what type of continuing education can be used to learn that information. Six example topics are included in the instructor's guide, and these topics will vary by major and level of student. The topics include "automotive safety" and "nuclear power generation". Their homework assignment for the second day is to find specific places for continuing education for the problem that they discussed in class. They are also asked to bring copies of their resumes for the third class.

The third class period begins with a discussion of the last homework assignment and reviewing the main points of the second class period. This is followed by a discussion of what employers look for when hiring entry-level engineers. A couple of sample student resumes for John N. Gine and Sally R. Tide are included with the module, so that students can compare what John or Sally have to offer with what may be required in a position. An active learning exercise is given to plan for the types of professional development John or Sally need to be more competitive in the job market. The students are asked to go through a similar exercise with their own resume and begin to plan their own career development.

The instructor's guide concludes with a discussion of grading rubrics for in-class and homework assignments. It is important when using in-class exercises that the students feel that this assignment will impact their grade in some way so that the assignment is completed. There is also discussion on assessing the impact of the lifelong learning module on the student's appreciation of lifelong learning. The instructor's guide concludes with a listing of references that were used during module development.

Project Management

The project management module consists of a set of PowerPoint slides that can be divided into three 50-minute class periods and the instructor's guide. This module assumes that the student has not had any previous instruction in the area of project management, but having had a project assignment in a previous class will give them some perspective on the skills that they are learning.

After completing this module, students should be able to:

a. Discuss the importance of project management techniques in modern industry

b. Define a project

c. Describe measures used to evaluate a project's success, a project life-cycle, and the tools used in planning and managing a project

d. Define, describe, and use work breakdown structures and linear responsibility charts

e. Define, describe, and use activity networks and Gantt charts

Justification for the study of project management skills comes from the needs of industry, as well as the fact that many engineering courses contain projects. Although ABET does not explicitly require our students to receive exposure to project management, it does require a capstone design experience, which typically is given to students in the form of a project. Project management skills also fall under the "ability to use the techniques, skills, and modern engineering tools necessary for engineering practice".

In the first class, the instructor introduces students to project management, measures of project success, the project life-cycle, and management tools. This material is introduced with a set of PowerPoint slides and three in-class team exercises. Each of these team exercises will require about ten minutes to complete. In the first exercise, students are asked to write a one-sentence definition of a project. They are then presented with a variety of definitions as well as a list of project features. The second exercise asks students to list several measures of a project's success. Again, they are presented with lists developed by professionals in project management. Following a mini-lecture on life cycle and time and resource management, students are asked to list types of management tools for planning and monitoring projects. They are then presented with a list of tools that will be discussed during the second and third classes. Several suggested homework assignments for either individuals or teams are included in the instructor's guide.

Project management tools that are studied in the second class period are work breakdown structures and linear responsibility charts. There are several PowerPoint slides that discuss each of these tools, and students begin to use them in team exercises related to a hypothetical project. These advanced project management tools require more in depth explanation, so it takes some time to cover these two topics.

The third class period continues with the study of activity networks and Gantt charts. Several PowerPoint slides contain a description of each of these tools along with a team exercise on each. Once again it takes some time to explore each of these advanced tools in depth.

The instructor's guide concludes with a discussion of grading rubrics for in-class and homework assignments. Students will take the in-class exercises much more seriously if individual accountability is built into the activity. Randomly selecting a few students to report the result of their

team's deliberations to the entire class is a simple approach for providing individual accountability. There is also discussion on assessing the impact of the project management module. The instructor's guide concludes with a listing of web sites that were used during module development.

Teaming

The teaming module contains the same type of information as the other three modules, but it is organized somewhat differently. It contains an instructor's guide, a set of student handouts, and a lesson plan and set of PowerPoint slides for each of the three class periods. The three class periods are arranged around the topics of 1) Why Learn Team Skills?, 2) work styles, and 3) team norms. The main purpose of these three class periods is to train the students to work in teams. The instructor's guide provides additional material to assist the instructor with the challenges of teaching teams of students.

After completing the module, the students should be able to

a. Explain why it's important to learn team skills

b. Discuss the advantages of people with diverse abilities and work styles working together

c. Explain that i) people have different work styles and ii) team members with different work styles may miscommunicate and clash initially

d. Discuss potential conflicts that may occur due to different work styles

e. Describe several strategies for avoiding or controlling these conflicts

f. Explain what team norms are and what they do

g. List several typical team norms

h. Develop explicit team norms for their team

The class-periods are organized such that objectives a and b are covered the first day, objectives c-e are covered on the second day, and objectives f-h are covered on the third day.

The justification for team skills is demonstrated to the students through an exercise. The first class begins with a mini-lecture on why engineers need team skills and attributes of effective and ineffective teams. The class is then given the "Lost on the Moon" exercise to complete first as individuals and then in teams. (A copy of the "Lost on the Moon" exercise is included in the module.) The class concludes with a discussion of why the teams scored better than the individuals on this exercise. The assignment for the second class includes readings on work styles and active listening, the Myers-Briggs personality inventory, and the Work Style Questionnaire, which are included with the module.

The second class begins by the instructor collecting the homework and showing the class the diversity of personality types among the students. It is important that the instructor use this as an opportunity to emphasize the importance of having diverse personalities on a team so that no one feels that their personality is inferior or inappropriate for engineering. This includes a mini-lecture on the meaning of the personality indicators. The class is divided into eight teams (assuming that there are enough students), one for each of the eight personality types. The teams are each asked to list what they like about the personality type represented by their team and what they don't like about the opposite type. Then the teams are asked to develop strategies for dealing with conflicts between these personality

types. Each team then makes a two-minute presentation on their strategy for dealing with conflict. The assignment for the third class includes readings on Meetings, Structure your Meetings, and Resolve Conflicts.

The third class begins with a mini-lecture on developing team norms. Students are then asked to imagine that they have been assigned a three-week project in class and to list the characteristics of their "dream team". An example of such a characteristic is "My team begins and ends meetings on time". Then students are asked to list the team member characteristics that support the team characteristics on their list. For instance, "staying focused on meeting tasks" would support the team characteristic mentioned previously. After listing these characteristics, students share them with others in the class.

Time Management

The time management module consists of three sets of PowerPoint slides. This module assumes that the student has not had any formal instruction in time management. The module consists of a series of exercises on scheduling and goal setting. To be most effective, the module should not be taught in three consecutive class periods. This will give students the opportunity to reflect on how they manage their time as they go about the business of their regular coursework.

After completing this module, students should be able to:

a. Set long term and short term goals

b. Know how they are spending their time

c. Arrange typical tasks according to priorities

d. Distinguish between 'urgent' and 'important' tasks using 4 quadrants

e. Recognize the need to schedule blocks of time

f. Monitor and evaluate their time usage

g. Apply these skills to typical student time demands

The first assignment in this module is given before the first class. In this assignment, students are asked to track their usage of time for two days on 15-minute intervals. It is important that this assignment be given so that their record is for two consecutive week days. Then they are asked to categorize these small blocks of time so that they can see how they use their time for certain aspects of their life.

In one class, students learn about goal setting. There is a mini-lecture on the characteristics of good goals. For homework, they are asked to develop a list of their own goals according to the criteria that they learned about in class. Then they are to look at their time diary and see if the way that they spend their time is consistent in meeting their goals.

In another class period, students' goals are categorized according to urgency and importance. They spend time discussing in which of these categories they spend the greatest amount of their time. The third class period is completed with a discussion of scheduling, prioritizing, and to do lists.

Module Testing

A testing program was created for these modules. In this program, each module was taught by an instructor who did not develop the module. A group of engineering students in the sophomore through senior level with a range of GPAs and a variety of majors was hired to be the evaluators of the module. Six to 12 students took each of the modules. In addition the module developer and another faculty evaluator sat quietly in the back of the room and evaluated the module. Students and evaluators were given a series questionnaires for the particular module that they were working on. Some evaluators were given a series of questionnaires for a different module so that they would act as a control group. Many of the questions were rated on a 5-point strongly disagree (1) to strongly agree (5) scale. Results from the evaluation are presented below.

As we evaluated these and other modules, a series of pre-module and post-module questionnaires were developed based on the learning objectives of the module. Primarily students were asked about their confidence in performing each of the objectives and whether or not they thought that these objectives were important in the practice of engineering. The lifelong learning module and project management module were the first modules evaluated. At this point in time, we had not considered the importance of having a pre-module questionnaire. Therefore only post-module and control group results are available for these two modules.

The student evaluations for all of the objectives were averaged and plotted in Figure 1 to show the overall results. Students clearly felt more confident about the module objectives following participation in the project management, time management, and teaming modules. For the lifelong learning module, there is practically no difference between the results of the control and post-module groups. However, note that the post-module groups for all of the modules are above 4. Students do believe that they have a level of competence related to these professional skills after completing the modules.

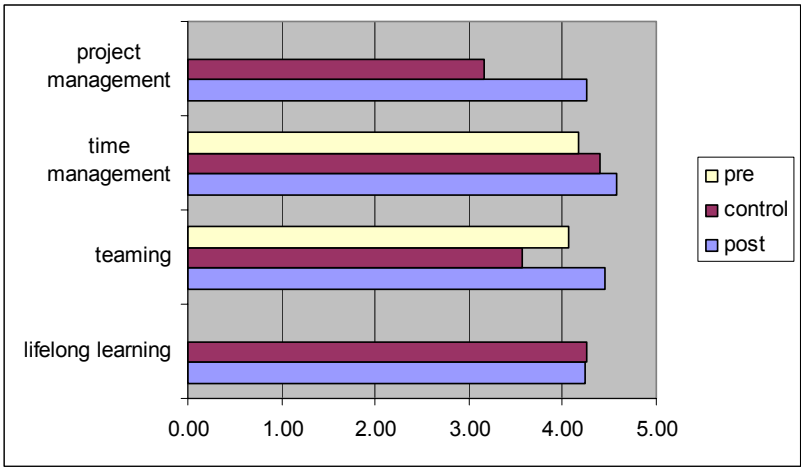

Figure 1. Overall evaluation of the professional skills modules.

Results from the project management module are shown in Figure 2. The objectives from this module have been placed into three categories—each from one of the class days of the module. Students who took the module show much more confidence in using the project management tools than the control group students. Twelve students completed the module, and ten students were in the control group.

Material from the project management module has been used in the Electrical and Computer Engineering Capstone Design course. The material made an important contribution to the students' development in enabling them to better manage their semester-long project. In particular, it helped in the identification of subtask sequences and in estimation of the time and effort needed to complete the subtasks.

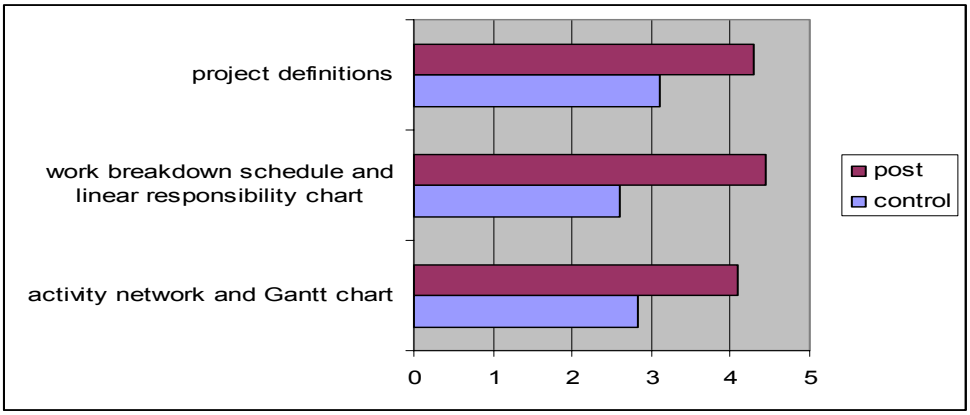

Figure 2. Student evaluations of their confidence to perform the project management module objectives.

Results from the time management module are shown in Figure 3. The objectives from this module have been placed into three categories. The greatest increase in confidence in this module was with the objectives related to goal setting. Seven students completed this module, and six were in the control group.

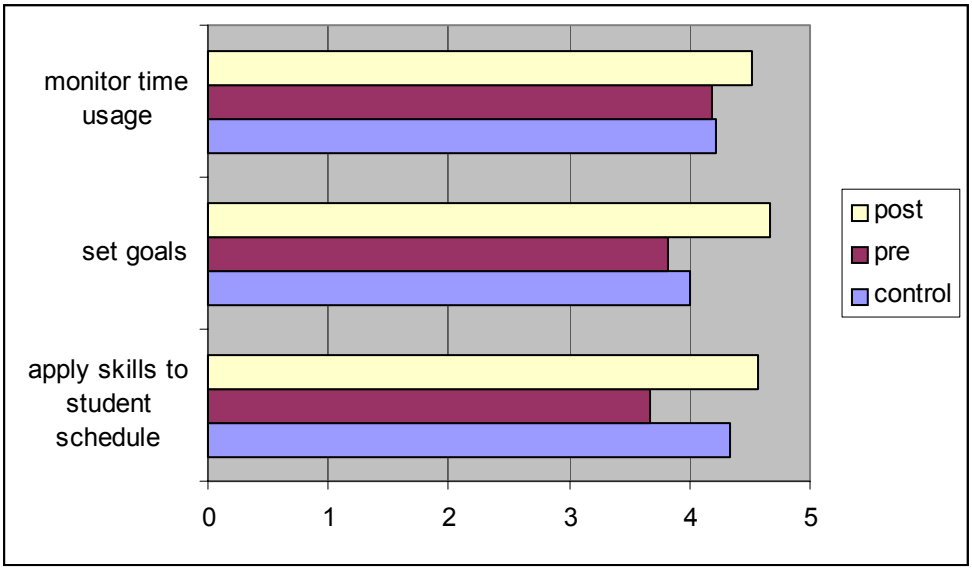

Figure 3. Student evaluations of their confidence to perform the time management module objectives.

Results from the teaming module are shown in Figure 4. The objectives from this module have been placed into three categories--each from one of the class days of the module. The greatest increase in

confidence in this module was with the understanding of the value of working in a team. Nine students completed this module, and ten were in the control group.

Material from the teaming module has been used in the Electrical and Computer Engineering Capstone Design course as well as a senior level course in computer architecture. The projects in these courses progressed better with the team training than in earlier semesters when it was not done.

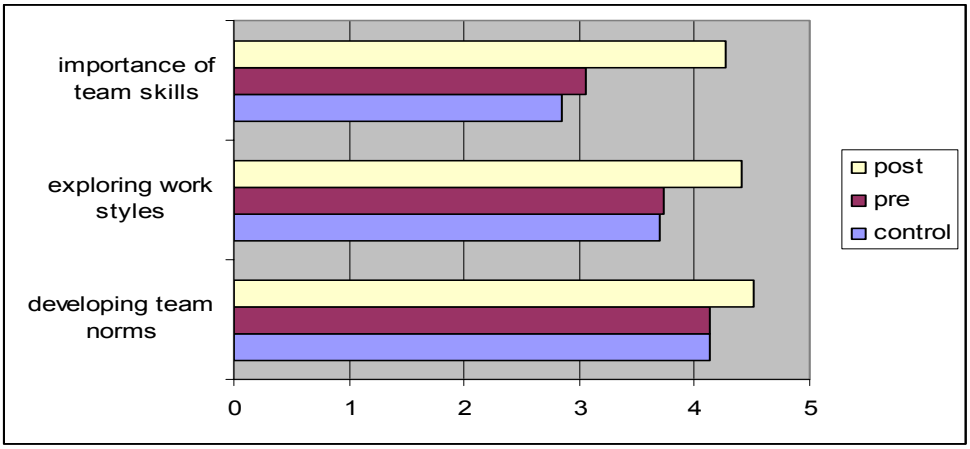

Figure 4. Student evaluations of their confidence to perform the teaming module objectives.

Results from the lifelong learning module are shown in Figure 5. The objectives from this module have been placed into three categories. In 'demonstrating the learning process' and 'determining what they needed to learn', the post-module students were slightly more confident than the control group. However, the control group was more confident in its ability to find resources for learning new information. Note that both groups are in the 'Agree' to 'Strongly agree' range when describing their ability to meet these objectives. This figure may be showing that the traditional engineering curriculum is already fulfilling the needs of the students to appreciate and engage in lifelong learning. Ten students completed this module, and twelve were in the control group.

Material from the lifelong learning module has been used for four semesters in Mechanical Engineering Design I, and it was used once in Dynamic Machine Components, both senior level courses in mechanical engineering. It has also been used at least two semesters in Foundations of Engineering I, an introductory multi-disciplinary engineering course.

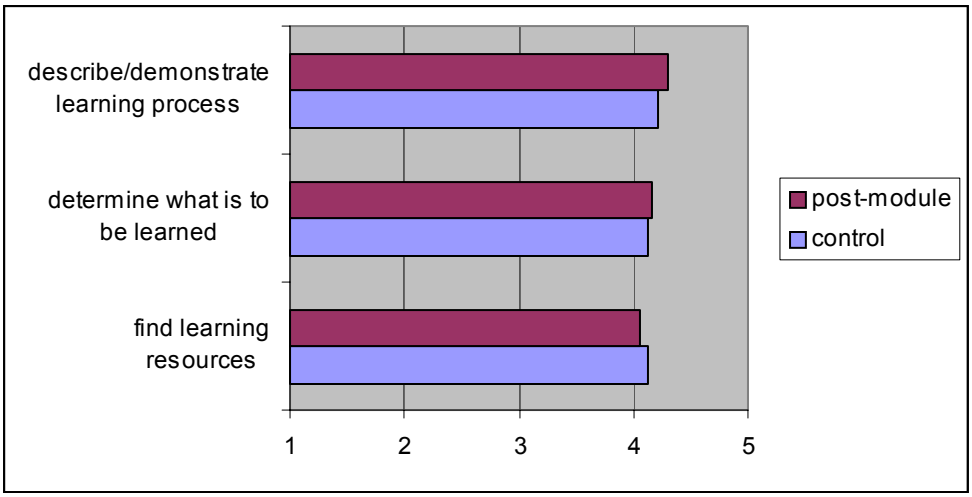

Figure 5. Student evaluations of their confidence to perform the lifelong learning module objectives.

Conclusion

Modules to be used in three class periods in a standard course have been created on the topics of lifelong learning, project management, teaming, and time management. Each module contains a set of PowerPoint slides, an instructor's guide, suggested homework assignments, and additional materials for a faculty member who would be interested in using the modules. A preliminary draft of each of the modules except for time management is available for use by other faculty. The modules can be accessed at

http://www.ece.ua.edu/faculty/rpimmel/public_htlm/ec2000-modules.

The authors are very interested in receiving feedback from anyone who uses the modules, and our contact information is available at the end of the paper.

Each of the modules has been beta-tested with a randomly selected group of engineering students in various majors. Results of this usage show that the students had a positive reaction to the modules and they had confidence in their ability to meet each of the modules' learning objectives.

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