

The Effect of EC2000 on Curricula Related to Professional-Practice Skills Outcomes: A Case Study

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Abstract – ABET Engineering Criteria 2000 (EC2000) guidelines have increased our focus on so-called ‘soft skills’ (teamwork, communication, lifelong learning, global awareness, societal impact of engineering practice, and ethical/professional behaviors). The problem has two components. First, students must have an opportunity to develop proficiency in soft skills curriculum objectives. Second, teachers must document the students' achievement level in these soft skills. Data collected before and after a successful accreditation visit indicate that faculty have included more soft skills related activities in their courses. During a one year period prior to the accreditation visit, faculty buy-in to the assessment process increased. More importantly, survey results showed seniors' confidence level in ethics, contemporary issues, and lifelong learning improved. Finally, faculty are showing a growing acceptance of most of these skills as an integral part of the new engineering curriculum. The use of the term engineering-related professional-practice skills to replace ‘soft skills’ is suggested.

Keywords: Faculty surveys, outcomes assessment, EC2000, soft skills, engineering-related professional-practice skills

INTRODUCTION

Throughout the years, faculty at the Mercer University School of Engineering (MUSE) have been involved in numerous assessment activities related to the accomplishment of student outcomes. As a result of EC2000, some of our focus has concentrated on outcomes that have been labeled as soft skills. For many observers, the soft skills outcomes include teamwork, communication, global awareness, ethics, societal impacts of engineering practice, and lifelong learning. These student outcomes have not been traditionally associated with an engineering curriculum, but are gaining recognition as essential components of a modern engineering curriculum [Evans, 3; Peterson, 5]. An additional topic (project management) was selected for study because it is an engineering-related professional practice skill desired by employers [Aldridge, 1; Society of Manufacturing Engineers Education Foundation, 6].

This paper reviews efforts made by Mercer University faculty to address this problem and includes data collected before and after a successful accreditation visit. In the fall of 1999, the author began a research project with the goal of increasing the accomplishment of students' soft skills outcomes. The problem situation as it existed had two major aspects: proficiency and documentation. First, students needed to have an opportunity to develop proficiency in soft skills curriculum objectives. Second, faculty needed to document the students' skill levels. It has been observed that determining a method to adequately measure these soft outcomes is a challenge for engineering educators [Besterfield-Sacre, 2]. We present a method for comparing faculty efforts and student outcomes with respect to engineering-related professional-practice skills.

METHOD

For the purposes of this study, the following topics were designated as engineering-related soft skills: teamwork, communication, knowledge of contemporary issues, ethical and professional behavior, lifelong learning, and project management. Initial data gathering by the author included a review of all course notebooks with respect to EC2000 a-k outcomes, as well as interviews with department chairs and select non-administrative faculty. The baseline data

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was determined from the responses to a paper-based survey that was adapted from materials developed by a National Science Foundation (NSF) Coalition [Gateway Coalition, 4]. The initial research instrument consisted of a four page survey that was placed in each faculty member's mailbox in February 2000. To enhance anonymity, the cover letter instructed the respondents to detach page one (the only page that included the faculty member's name) from the rest of the survey and submit the completed survey to a departmental secretary. The secretary placed page one of the survey in one envelope and pages two to four in a different envelope. In that manner the author was able to ascertain who had completed the survey but could not associate specific responses with a particular person.

The first page of the survey included a place for respondents to write their name, courses taught, and assessment activities for the past year. On page two of the survey, faculty members were asked to rate to what extent their courses provided students with the opportunity to learn and practice specific skills. Page three included questions about the faculty's use of assessment to give feedback to students; it also included questions about faculty's perceptions about the administration's support for assessment procedures. Questions on pages two and three of the survey were based on a five-point Likert scale. The final page of the survey included open-ended questions about the assessment process and the survey instrument. This paper is focused on quantitative data (from page two of the survey) as well as qualitative data (from page four of the survey).

RESULTS

Quantitative Results

The survey was administered to the faculty four times over a period of five years; the most recent survey was administered during the spring 2004 semester. Since the EC2000 criteria and assessment procedures of concern to this research project apply only to the undergraduate curriculum, faculty who were administrators or did not teach undergraduate classes during the implementation period were omitted from the participant base. The response rate varied from a low of 19/30 to a high of 24/30. Partial results from the first survey administration are summarized in Table 1.

TABLE I
FACULTY SURVEY SPRING 2000 - CURRICULAR RESPONSES

Outcome	Rating				
	Not at All	To a Limited Extent	To a Moderate Extent	To a Great Extent	To a Very Great Extent
Analytical Skills	0	0	3	9	7
Communication Skills	1	2	7	3	6
Creative Problem-solving	0	4	4	7	4
Ethical/Professional Behavior	4	4	7	1	3
Global Awareness	7	4	3	3	1
Lifelong Learning	2	6	4	5	1
Project Management	3	4	5	4	3
Research and Experimentation	3	2	6	5	3
Teamwork	0	2	7	4	6

In an effort to quantify the results, the weighted score for each category was calculated. The qualitative descriptors were assigned quantitative values ranging from 5 for “To a Very Great Extent” to 1 for “Not at All” and a weighted score was obtained. By comparing the weighted scores, the researcher was able to rank the perceived importance/incidence of the topics in our curriculum. Relative ranks for the nine categories compared over the entire study period are shown in Figure 1.

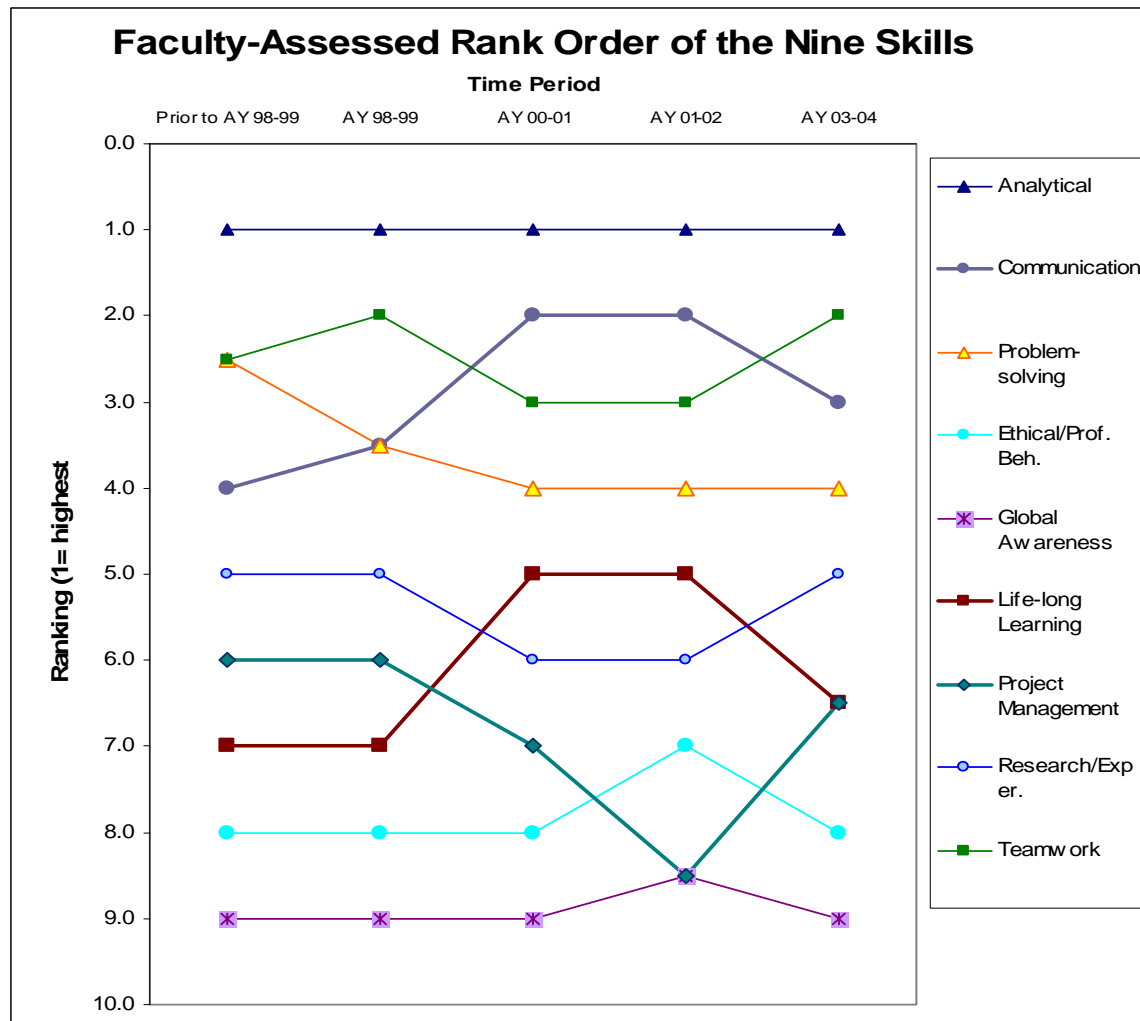


FIGURE 1
LONGITUDINAL RANK ORDER FOR THE NINE SKILLS

Due to the weighted scores in the February 2000 survey, the author characterized Teamwork, Communication, and Project Management as high-incidence professional practice skills. Global Awareness, Ethical and Professional Behavior, and Lifelong Learning were characterized as low-incidence professional practice skills. The remaining three skills (Analytical, Problem Solving, and Research/Experimentation) were labeled technical skills because they are traditionally associated with the modern engineering curriculum. The researcher developed a Strong Opportunity construct by calculating the percentage of faculty who indicated 5 for “To a Very Great Extent” or 4 for “To a Great Extent” for each of the nine outcomes included in the survey. The three figures below compare how the Strong Opportunity results changed during each observation period.

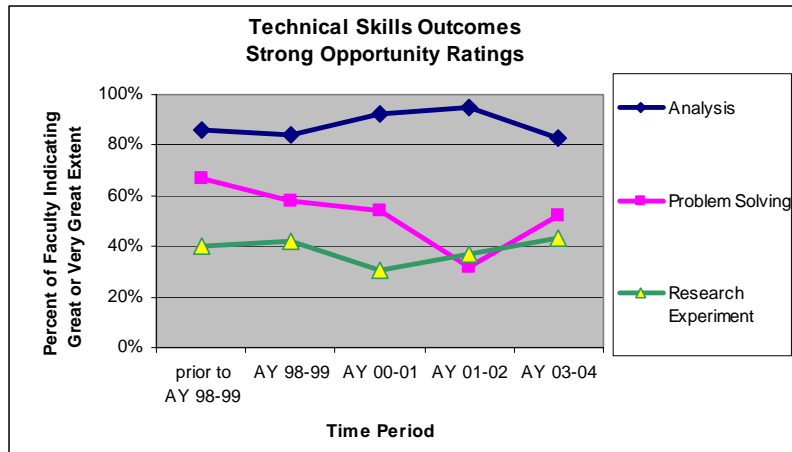


FIGURE 2
STRONG OPPORTUNITY RATINGS FOR TECHNICAL SKILLS

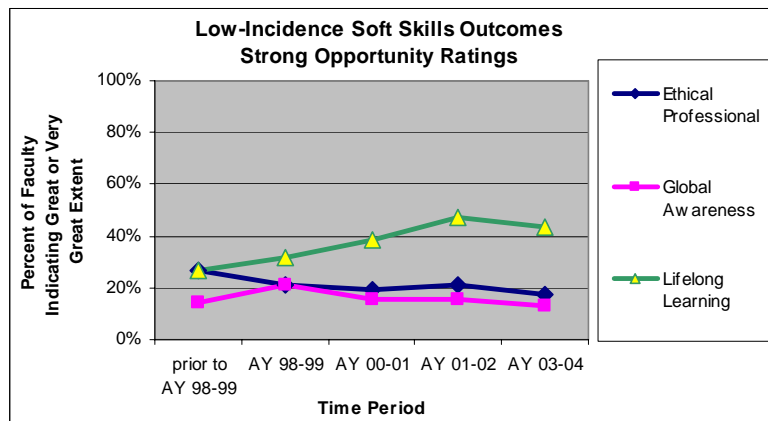


FIGURE 3
STRONG OPPORTUNITY RATINGS FOR LOW INCIDENCE SOFT SKILLS

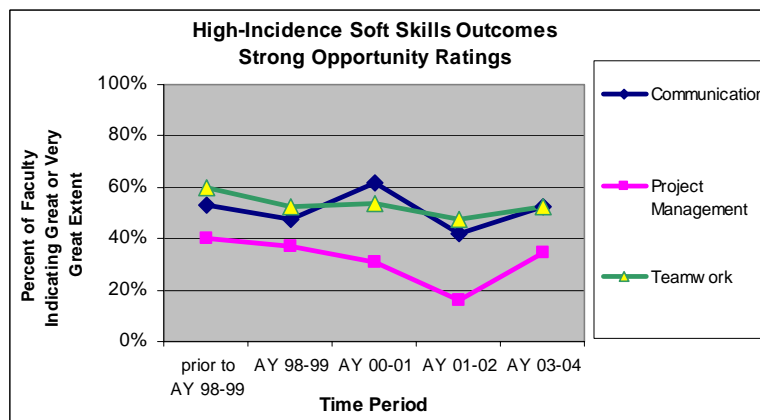


FIGURE 4
STRONG OPPORTUNITY RATINGS FOR HIGH INCIDENCE SOFT SKILLS

Results of the Senior Survey administered by the dean's office give general support for the findings above. For completeness, all eleven of the surveyed outcomes are included in the table below.

TABLE II
STUDENT SURVEY 1998 – SELF ASSESSMENT OF LEARNING OUTCOMES

Outcome	Weighted Average*
a. an ability to apply knowledge of mathematics, science, and engineering	3.8
b. an ability to design and conduct experiments, as well as to analyze and interpret data	3.6
c. an ability to design a system, component, or process to meet desired needs	3.8
d. an ability to function on multi-disciplinary teams	4.3
e. an ability to identify, formulate, and solve engineering problems	3.7
f. an understanding of professional and ethical responsibility	3.3
g. an ability to communicate effectively	4.0
h. the broad education necessary to understand the impact of engineering solutions in a global and societal context	3.3
i. a recognition of the need for, and an ability to engage in lifelong learning	3.7
j. a knowledge of contemporary issues	2.8
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	3.4

* 1 = low/poor 5 = high/outstanding

Students' lowest self-ratings were for ABET Criterion 3 outcomes related to global awareness, ethics, and contemporary issues. These findings are consistent with the results of the faculty survey. The biggest discrepancy appears to be in outcome i (lifelong learning). Students rated their competency in lifelong learning higher than outcome b (design and conduct experiments), outcome k (engineering tools), outcome f (ethics), outcome h (global awareness), and outcome j (contemporary issues). However faculty asserted that their emphasis on lifelong learning was much lower. It may be that students' responses reflected abilities and attitudes developed out of the classroom as well as in the classroom.

Qualitative Results

Faculty comments from page four of the survey reflect a variety of attitudes toward outcomes assessment and the assessment process. The following is a sampling of quotes from faculty.

- Though we have far to go, we have set a plan that will help us achieve excellence.
- All faculty are involved, only a very few give mere token efforts.
- Faculty are too overburdened to be creative and try innovative techniques. We are spending a ton of effort on documentation of assessment rather than assessment.
- We are expending less time actually assessing and significantly more time documenting assessment.
- Assessment appears to be only a SACS/ABET exercise, not a real self-examination.
- I can only comment by saying that we appear to be making great effort. I know we have written and rewritten multiple outcomes and completed multiple assessments in my department.

- I believe there is a formal assessment method which we describe to ABET & SACS, and we do perform this assessment. I also believe there is an informal process where we continuously strive to improve our courses & student learning primarily motivated by our own pride and sense of self accomplishment. I rely mostly on this second form of assessment and do the first because I am obligated to.
- I am not equipped to teach ethics.
- I came to this school to teach mechanical engineering, not ethics or global awareness.
- If I add ethics and global awareness to my courses, what do I take out?

Thus the faculty have mixed feelings about the effectiveness of the overall assessment program. Because the topics are included in EC2000, there is an increased awareness of the need to emphasize the importance of global issues and ethical/professional behavior in the engineering curriculum. The faculty survey results show that most faculty are reluctant to include these topics to a great extent in the courses they teach. Others just aren't convinced they should be teaching some of these soft skills. The student survey results, however, show that students give themselves a relatively strong competency rating in several of the soft skills outcomes (teamwork, communications, problem solving, and lifelong learning). They give themselves a lower competency rating in ethics. The area that is low in both opportunity and perceived competence is global awareness and contemporary issues.

Data collected by the author before and after a successful accreditation visit indicate that the faculty have included more soft skills related activities in their courses. During a one year period prior to the accreditation visit, faculty buy-in to the assessment process increased; four faculty members wrote professional-practice or assessment-related papers for presentation at engineering education conferences. The senior student survey that was first administered in 1998 has been administered every year since then. There are indications of an increase in student awareness of the school's assessment efforts. Students' confidence level in ethics, contemporary issues, and lifelong learning are improving. Finally, faculty are showing a growing acceptance of most of these skills as an integral part of the new engineering curriculum.

CONCLUSION

The results of the series of research surveys indicate that School of Engineering faculty have consistently offered a curriculum that emphasizes analytical skills, communication skills, and teamwork. Although they are an integral part of the curriculum, skills related to problem solving, project management, research/experimentation, and lifelong learning are emphasized to a lesser extent. In spite of increased awareness of the need to emphasize the importance of global issues and ethical/professional behavior in the engineering curriculum, most faculty have been reluctant to include these topics to a great extent in the courses they teach. The good news is that students gave themselves a relatively strong competency rating in several of the soft skills outcomes (teamwork, communications, problem solving, lifelong learning). The major area that remained low in both opportunity and perceived competence is global awareness. Due to the consistency of this observation over a five year period, we conclude that faculty and students at the School of Engineering do not currently accept the validity of global awareness as a significant learning outcome for an undergraduate degree in engineering.

Finally, it should be noted that the use of the term soft skills is not meant to be pejorative. Rather, it is the term most commonly used when discussing a specific subset of the EC2000 outcomes. This author suggests that the term 'engineering-related professional-practice skills' be used in place of 'soft skills'.

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