Session 2255

The Use of Employer Surveys to Evaluate Professional-Practice Related Skills in an Industrial Experience Program

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Abstract

Students' non-course activities such as co-ops and internships offer a very good opportunity for students to develop engineering-related professional practice skills (sometimes known as 'soft skills') that are included in the EC 2000 criteria. Employee evaluations have long been an integral part of the Mercer University School of Engineering (MUSE) Industrial Experience Program. Here at Mercer, we have decided to use employer evaluations to investigate all eleven EC2000 a-k outcomes, as they relate to the MUSE 8 Outcomes, to gain an outsider's perspective on our curriculum. The director of the Industrial Experience Program and a member of the Assessment Committee obtained Institutional Review Board approval to conduct a survey to document the effect of co-op experiences on EC2000 outcomes. To facilitate this research, the industrial experience director revised the Employer's Evaluation form to include direct references to the MUSE 8. This revised form was first distributed to employers at the beginning of the Summer 2001 term. Forty-eight students participated in the program during the Summer 2001 term of which thirty-nine employee evaluations were returned to the Industrial Experience Program Office. Data has since been collected for Fall 2001, Spring 2002 and Summer 2002. Seventeen students participated during Fall 2001, twelve during Spring 2002 and thirty-three during Summer 2002. Of these, sixteen, eleven and thirty-one surveys, respectively, were returned. This paper describes preliminary data from the employer survey as it relates to MUSE 8 outcomes.

I. Introduction

Cooperative (co-op) education has long been recognized as a win-win situation for both employers and students. Employers benefit by getting high-quality temporary employees who are often given special short-term projects[14]. Furthermore, employees of cooperative education students use the co-op experience as an opportunity to recruit well-qualified graduates[14]. In a survey of 68 supervisors, managers, and human resource staff from a total of 55 engineering firms, Duggan[9] found that recruiting quality employees is the major reason for using coop students. Another benefit discovered by Hurd and Hendy[13] is improved retention. Their research review indicated that employees who had previous coop experience with the company were retained at a higher rate than those who had no previous experience. A recent survey of corporate cooperative education directors[12] indicated that new hires who had previous co-op experience exhibited greater maturity and problem solving ability than those who had no co-op experience.

From the students' point of view, co-op offers students the ability to get hands-on experience and earn a decent wage[14]. Furthermore, the co-operative experience gives students a chance to develop the professional-practice skills that are not often evidenced in new hires[11,15]. This is especially important as most employers have a “perception that many graduates lack essential knowledge and experience of the modern workplace”[16].

Although it is generally accepted that co-op provides students with valuable practical experience, there is a lack of specific literature documenting the benefits of co-op/intern programs, especially with respect to fundamental engineering principles[4]. Researchers at other engineering schools have offered anecdotal evidence that university-sponsored work experiences provide a rich environment in which students can develop skills related to learning outcomes such as teamwork and communication, but few have provided quantitative data. Wankat, Oreovicz and Delgass[19] report that a 1994 alumni survey indicated that practical work experience, along with lab and design courses taken at the school, were very important sources for learning certain "soft skills". The survey instrument listed written and oral communication, ethics, teamwork, leadership, and meeting skills; however, other EC2000 a-k outcomes such as global and contemporary issues were not included in the survey. The Wankat, Oreovicz and Delgass[19] results as well as those of Canale, Cates, and Duwart[8] indicate that students' non-course activities such as co-ops and internships offer a very good opportunity for students to develop their soft skills.

The Mercer University School of Engineering (MUSE) supports industrial experience as an approach to learning. We know that practical experience adds relevance to the student’s education and will fortify their learning process. To help facilitate this process, learning objectives were developed for the Industrial Experience Program: to improve student learning inside and outside the classroom, to prepare students for the journey of lifelong learning, to increase the number of students with practical engineering experience prior to graduation, to strengthen relationships between Mercer University and employers who hire Mercer University students and graduates, and to provide enthusiastic and high-quality graduates for our employers[2]. Further, the MUSE demonstrates this support of the industrial experience option to learning with the collaboration between Career Services and the MUSE. Through this collaboration, students who qualify (GPA of 2.5 or better) and participate are provided individual career development support through various workshops specifically targeted to freshman students and one-on-one sessions for upper level students by the Career Services staff. This unique pairing of Career Services with the academic mission of the MUSE Industrial Experience Program leverages the expertise in both departments[2].

II. ABET EC2000 a-k Criteria and MUSE 8 Outcomes

According to the new ABET Criteria guidelines[1], universities must show they are assessing their curriculum using a variety of methods in an effort to achieve specific learning outcomes. This curriculum improvement process may be seen as part of an overall quality improvement effort[5,17] that will benefit all of the stakeholders, including students, parents, employers, faculty, and administrators. According to Dunn[10], a triangular relationship exists between academics, students and employers, which forms a type of partnership. When one of the partners is affected, all partners are affected in some way. Hence, when changing curriculum to meet EC2000 a-k criteria, employers are affected.

To assist with assessment, MUSE developed a relationship table linking MUSE outcomes, which were developed to meet the needs of our school, to specific EC2000 a-k criteria (Table 1). The first four MUSE 8 outcomes are technical in nature; the other outcomes are more non-technical (with respect to the engineering curriculum). The employee evaluations are an important part of the Mercer University School of Engineering Industrial Experience Program and an excellent method to gain an outsider's perspective on our curriculum as they related to all eleven EC2000 a-k criteria. Therefore, the evaluations were revised to obtain employer feedback related to the EC2000 criteria by the director of Industrial Experience by using the MUSE 8 outcomes. Data for Summer 2001[3], Fall 2001, Spring 2002 and Summer 2002 semesters were collected.

Table 1: MUSE/ABET Relationships

MUSE 8	**ABET 11 (a-k)**
1. Apply mathematics and science principles to the solution of engineering problems.	a. ability to apply knowledge of mathematics, science and engineering
2. Apply appropriate breadth and depth of skills in identification and analysis of engineering problems.	c) ability to design a system, component, or process to meet desired needs e) ability to identify, formulate, and solve engineering problems k) ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
3. Apply appropriate breadth and depth of skills in engineering design and analysis of engineering problems.	c) ability to design a system, component, or process to meet desired needs k) ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
4. Design and conduct experiments and analyze data.	b) ability to design and conduct experiments as well as to analyze and interpret data k) ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
5. Function effectively on interdisciplinary teams.	d) ability to function on multi-disciplinary teams
6. Communicate effectively in a variety of modes, i.e. written, oral, and visual	g) ability to communicate effectively
7. Relate the practice of engineering to global contemporary issues, to professional ethics, and to the need for life-long learning	f) understanding of professional and ethical responsibility h) broad education necessary to understand the impact of engineering solutions in a global and societal context i) understanding of the need for and ability to engage in lifelong learning j) knowledge of contemporary issues
8. Provide leadership to and contribute to sustaining and improving the community	h) broad education necessary to understand the impact of engineering solutions in a global and societal context j) knowledge of contemporary issues

III. The Survey Instrument and Results

The Employer's Evaluation form was reviewed and approved by Mercer's Institutional Review Board in spring 2001. The survey includes twenty-five questions related to students' work performance. Nineteen of the twenty-five questions use a Likert-type scale with the following values: Excellent 5; Very Good 4; Average 3; Below Average 2; and Poor 1. The remaining survey questions allow non-Likert responses; the questions deal with students' strengths and weaknesses and future employment status. Copies of the employer survey may be obtained by contacting one of the authors.

The data in Table 2 form the benchmark data for our study and include rank-ordered evaluation data by outcome. As seen in Table 2, Outcomes 1, 5, and 6 received the highest rankings in the summer 2001. It is perhaps not surprising that communication and teamwork are so highly rated by employers. Anecdotal evidence from past conversations with employers has indicated that our students perform well in these areas. In light of previous survey results, it is somewhat surprising that the employers give such a high rating to our students' ability to apply math and science. As reported by Burtner[6] our freshman have exhibited low self-confidence in their math and science ability; freshman students enrolled in the Mercer University School of Engineering during AY 99-00 who took the Pittsburgh Freshman Engineering Attitudes Survey© rated themselves 3.1 (on a 1-5 scale) for the math and science outcome. On the other hand, employers of students who had just completed their freshman year gave the work experience students a rating of 4.4 (also on a 1-5 scale). Outcomes 2, 3, and 4 received slightly lower scores. However, the data show employers are generally satisfied with students' ability to solve problems and analyze data. Outcomes 7 and 8 received the lowest average scores. These results are not unexpected, as anecdotal evidence indicates that employers often do not evaluate engineering students on these attributes.

Table 2: Baseline Data Rank-ordered by Outcome - Summer 2001 (U01)

Outcome	Mean Score* Summer 2001
5	4.42
6	4.39
1	4.31
2	4.22
4	4.19
3	4.17
7	4.09
8	4.05
Overall	4.23

*Scale: Poor-1 Fair-2 Good-3 Very Good-4 Excellent-5

Regardless of relative rank, it is important to note that employers rated each outcome greater than 4.0, on average. This finding is consistent with research conducted by Todd, Barron and Pangborn[18]. These authors reported on a survey of co-op participants and their employers which was part of a comprehensive assessment program. Their preliminary results indicated that supervisor's average ratings of co-op participants ranged from a low of approximately 4.0 for outcome h (global/societal issues) to a high of approximately 4.5 for outcomes d (teamwork) and k (tools and techniques).

The two highest rated outcomes were teamwork and communication. These non-technical outcomes have been associated with the undergraduate engineering curriculum at Mercer University since its inception. For our preliminary analysis, one-way ANOVAs comparing ratings for technical and non-technical outcomes were performed. For more detailed information, see Burtner and Barnett[7].

Table 3 includes the baseline data for each outcome in addition to the Fall 2001, Spring 2002, and Summer 2002. As indicated by the data, outcome 5, teamwork, ranked highest of the outcomes. However for subsequent terms, outcome 7, globalization, ethics and life-long learning, were consistently highest. There is not enough data at this time to indicate a trend. The second highest outcomes are 6, 5 and 6, 2, and 5 for Summer 2001, Fall 2001, Spring 2002, and Summer 2002, respectively.

Table 3: Employer Evaluation by Outcome - Summer 2001 (U01), Fall 2001 (F01), Spring 2002 (S02), and Summer 2002 (U02)

Outcome	***Mean Score* U01***	***Mean Score* F01***	***Mean Score* S02***	***Mean Score* U02***
1	4.31	4.19	4.09	4.43
2	4.22	4.19	4.27	4.30
3	4.17	4.06	4.09	4.36
4	4.19	4.19	4.00	4.36
5	4.42	4.25	4.09	4.50
6	4.39	4.25	4.18	4.47
7	4.09	4.31	4.36	4.66
8	4.05	4.13	3.91	4.32
Overall	**4.23**	**4.20**	**4.13**	**4.42**

*Scale: Poor-1 Fair-2 Good-3 Very Good-4 Excellent-5

Figures 1, 2, 3 and 4 are comparisons of ratings by work experience level (co-op year) for Summer 2001, Fall 2001, Spring 2002, and Summer 2002, respectively. By looking at the employer evaluation based on the number of work rotations the work experience students have completed, we may infer the potential benefit of additional co-op rotations.

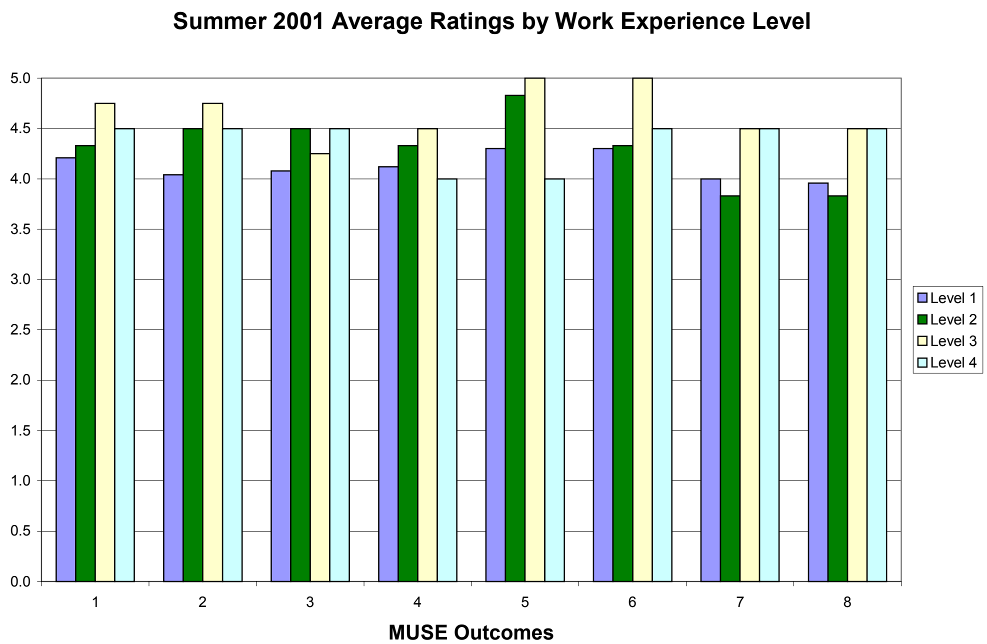

Figure 1: Comparison of average ratings by work experience level - Summer 2001.

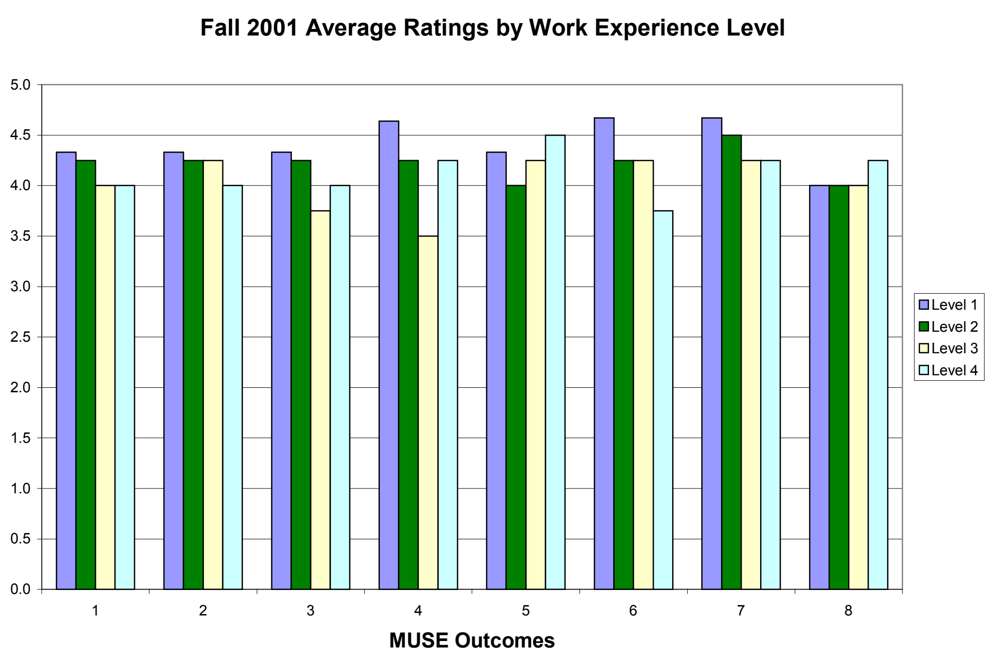

Figure 2: Comparison of average ratings by work experience level - Fall 2001.

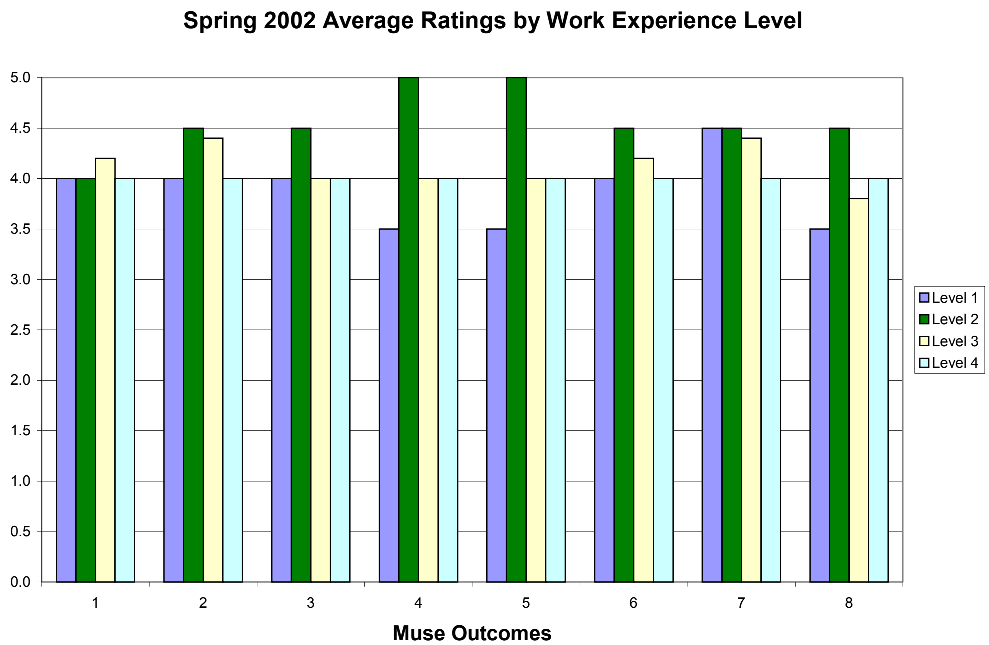

Figure 3: Comparison of average ratings by work experience level - Spring 2002.

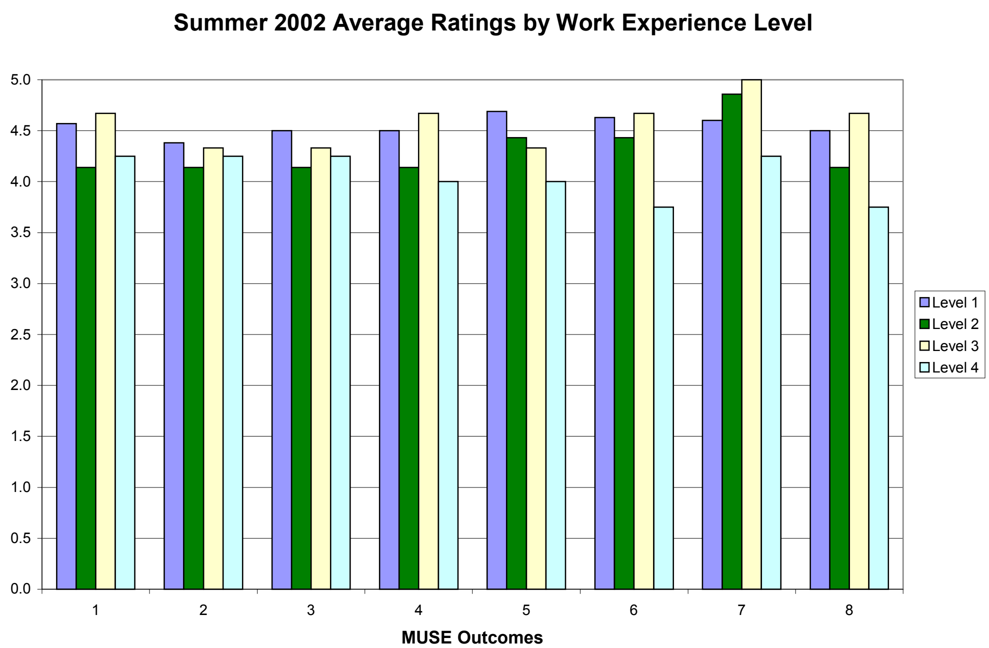

Figure 4: Comparison of average ratings by work experience level - Summer 2002.

For summer 2001, 27 of the surveys returned were for students enrolled in the program for the first time; the numbers for the second, third and fourth rotations were six, four, and two, respectively. Figure 1 indicates that satisfaction with student performance showed a positive correlation with the number of rotations completed. Students participating in the third and fourth co-op rotations received higher scores, on average, than the newer co-op students. On the other hand Figures 2, 3, and 4 do not exhibit a similar correlation. We will need to investigate this phenomenon further before drawing any conclusions as to the relationship between cumulative co-op experience and workplace expertise as judged by the students' supervisors.

While not the primary focus of this paper, the employer survey data also included qualitative responses from employers in a variety of industries. Typical industries that placed our students included aerospace, heating and air conditioning, hospital, paper mill, power companies, telephone companies, various government contractors, and a biomedical pharmaceutical company. Comments from employer evaluations on the students' strengths and weaknesses were also obtained in addition to data for the EC2000 a-k criteria. A synopsis of the employer comments for strengths were: 1)good communication skills, strong work ethic, well roundedness, teamwork, analytical skills, quality of work and initiative. Some comments related to weaknesses were: 1) needs to continue improving general engineering skills, and 2) could be more assertive in verbal communication, project planning, organizational planning, and self-confidence. The combination of qualitative and quantitative feedback offers a richer picture of the students' abilities.

IV. Conclusion

Data from our surveys have been presented to the entire faculty as part of our new assessment program, instigated, in part, by recent changes in engineering accreditation guidelines. The data are especially important as they provide input from an external source that can be used to help complete the feedback loop as we continually assess the engineering curriculum.

We would like to acknowledge the thoughtful comments of the reviewers of this paper as it was suggested that we might also want to evaluate similar data for non-co-op students. At this time, the scope of our study does not include IRB approval for research on non-co-op students. We agree this is a valuable avenue of research for the future.

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