Mapping Professional Performance Metrics into ABET Outcomes Assessment Process

Dr. Arif Sirinterlikci, Robert Morris University

Arif Sirinterlikci is a University Professor of Industrial and Manufacturing Engineering and the Department Head of Engineering at Robert Morris University. He holds BS and MS degrees, both in Mechanical Engineering from Istanbul Technical University in Turkey and his Ph.D. is in Industrial and Systems Engineering from the Ohio State University. He has been actively involved in ASEE and SME organizations and conducted research in Rapid Prototyping and Reverse Engineering, Biomedical Device Design and Manufacturing, Automation and Robotics, and CAE in Manufacturing Processes fields.

Mapping Professional Performance Metrics into ABET Outcomes Assessment Process

Abstract

In this manufacturing engineering program, the internship course is mandatory. The benefit of such course is that the permanent placement rates of this program are higher when compared to similar institutions. Many of the students are staying in their internship companies as engineers after graduation. On the contrary, it is becoming harder to place all of the students into industrial internships due to increasing enrollments in both the domestic and international students. Thus, the internship coordinator and faculty members have modified the format of the experience, adding in-house research projects sponsored by the faculty members along with external research experiences including National Science Foundation (NSF) Research Experiences for Undergraduates (REU) or similar programs. In addition to REUs, some students are also finding employment directly at the partnering colleges.

For the assessment process, the program has utilized student and employer surveys in gaining feedback for continuous improvement. Student surveys are based on the perception of students on attaining the ABET student outcomes (a-k) while supervisor surveys are performance metrics and competency based. This paper will map ABET student outcomes and supervisor survey metrics. The correlation between the outcomes and expectations of employers will be determined and gaged based on the data collected over a span of few years.

Introduction

This Engineering Department offers three different internships through ENGR 4900 (3 credits), ENGR 4901 (1 credit), and ENGR 4902 (2 credits) Engineering Practice courses. A student has to take either ENGR 4900 or a combination of ENGR 4901 and 4902. This is not a very common occurrence, usually internship is an optional element of the curriculum^{1,2,3}. Student's choice is usually determined by the flat tuition threshold of 18 credits per semester. For example, if the student has 1 credit space in their schedule or registered for 17 credits, he or she will take ENGR 4901 at that time and needs to complement it with ENGR 4902 at a later time.

Enrollment into the course is handled by the Engineering Department along with the Career Services. Each student needs to complete a package that includes the AIP (Academic Internship Program) Student Form, Employer Form, and Mutual Letter of Agreement that draws the expectations for the experience including the 150 minimum hours of engineering work. This work can be of design, analysis type or manufacturing, service/maintenance, and even technical sales - to emulate engineering job functions in a real-world environment. Once the student is registered, he or she receives a syllabus and summary of requirements including the final report (can be substituted by a professional portfolio including reports and drawings that were

submitted to the company - 25% of the final grade), final Power Point Presentation (PPT to be made to the peers from the same section of ENGR 490x - 10% of the final grade), journal and log (25% of the final grade). Supervisor feedback (35% of the final grade) is critical. Each student is required to have a supervisor, direct or indirect supervisor, who is aware of student's performance. Supervisors are determined by the companies at which students are employed. For the internal research projects, supervisors are determined by the students as they choose their project and the owner of it. The supervisor is approached (most likely through phone contact and e-mail) for both qualitative and quantitative analysis. As a part of the qualitative analysis - the internship supervisor has to fill in the form given in Figure 1. Supervisor is also asked to give a letter grade for quantitative analysis. Feedback from both sections determine student's final grade from the company. If there is a discrepancy between the qualitative and quantitative sections, the instructor may contact the supervisor again and may adjust the student's final grade based on the information received and quality of the student's report, journal, and PPT. Students also need to turn in a student survey given in Figure 2 (5% of the final grade) rating their own experience. This form is based on tying their experience to ABET student outcomes.

To maintain consistency in evaluating student performance, all grades are assigned by the Internship Coordinator for ENGR 4900, 4901, and 4902. When this paper was being prepared the coordinator was in his 7th year. Thus, there has also been consistency of grading during a long time span.

Results

Since the interning student numbers are increasing with the booming enrollment, the data relating to their experience becomes more critical. Student survey and supervisor evaluation results along with final grades have been summarized and analyzed in Faculty Course Assessment Reports (FCARs). The main objective of this effort is to capture the big picture as well as the minor details including student issues of adaptation to the work environment and professionalism, promptness, communication, and evidence of lack in preparation at the school. The FCAR documents were used in the previous ABET accreditation cycle and will be used again in the next accreditation cycle. Student performances included in the FCAR reports can be seen in Figure 3 for 58 students who took the ENGR 4900 course within a two year span. Results indicate excellent performances by the student body. These grades also include internship supervisors' input as discussed below.

Almost all of the students are satisfied with their internship experience as the student survey results indicate. Employer satisfaction is also another proof that the program has been successful. Only 1-2 % percentage of students has received negative reviews within the last few years out of about 100 students who have done at least one form of engineering internship.

Engineering - Internship-Supervisor Evaluation For each of the following performance characteristics please place an “x” in the line that best reflects your experience with this student. Thank you so very much!		
Attitude/Application to Learning		
4	Outstanding and extremely enthusiastic	
3	Interested and industrious	
2	Average	
1	Indifferent	
Ability to Learn		
4	Learns very quickly	
3	Above average in learning	
2	Average	
1	Slow to learn	
Dependability		
4	Completely dependable	x
3	Above average in dependability	
2	Usually dependable	
1	Below average in dependability	
Writing Ability		
4	Consistently clear, organized, uses standard English	
3	Reasonably clear, organized, usually uses standard English	
2	Has some gaps in writing ability	
1	Has difficulty writing	
Quality of Work Contributions		
4	Excellent	
3	Very good	
2	Average	
1	Below average	
Relations With Others		
4	Gets along with others exceptionally well	
3	Works well with others	
2	Gets along satisfactorily	
1	Some difficulty working with others	
Judgment/Decision Making		
4	Exceptionally mature/makes good decisions	
3	Above average in maturity/decision making	
2	Usually makes good decisions	
1	Often demonstrates poor judgment	
Communications Ability		
4	Consistently articulate, coherent, confident	
3	Reasonably articulate, coherent, confident	
2	Has some gaps in speaking ability	
1	Has difficulty speaking	
Engineering Preparedness		
5	Would hire this student right now if we had the opportunity	
4	Would consider placing in an entry level engineering position	
3	Has the engineering skill and knowledge consistent with class	
2	Will take considerably more education before I would employ	
1	Unprepared to function as an engineer at my facility	

Figure 1. Internship Supervisor Survey⁴

My Engineering major is: (place an “x” under yours)	Biomedical	Industrial	Manufacturing	Mechanical	Software

In my internship:	NA	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I applied knowledge of mathematics, science and engineering.						
I designed and conducted experiments, as well as analyzed and interpreted data.						
I designed a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.						
I functioned on multi-disciplinary teams.						
I identified, formulated, and solved engineering problems.						
I fully understood professional and ethical responsibilities.						
I communicated effectively.						
I used the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.						
I recognized the need for life-long learning and I can engage in it.						
I have been aware of contemporary issues.						
I used the techniques, skills, and modern engineering tools necessary for engineering practice.						

Figure 2. Internship Student Survey

Figure 3 Grade distributions for 58 students completing their internship course

The author would present supervisor feedback collected by the evaluation form for 22 students who recently completed their engineering practice class.

Figure 4 Attitude/Application to Learning

Figure 5 Ability to Learn

Figure 6 Dependable

Figure 7 Writing ability

Figure 8 Quality of Work Contributions

Figure 9 Relations with Others

Figure 10 Judgment/Decision Making

Figure 11 Communication ability

Only on very rare occasions, students were ranked average in the multiple factors of evaluation including attitude/application to learning, ability to learn, dependability, writing ability, quality of work contributions, relations with others, judgment/decision making, and communication ability. The survey of the employers showed that 68% of the students were found to be employable for experienced level positions upon graduation while 27% were deemed to be eligible for entry level positions, making 95% of the students pass the engineering preparedness test of the employers. According to the Internship employers only 5% of the students in concern needed additional knowledge and skill preparation for employment according to the employers presumably obtainable by graduation as prepared in Figure 12.

Figure 12 Engineering Preparedness Results Obtained from Internship Employers

Some students in this internship program find employment at large international companies such as GE, Philips and Bayer, while others employed by smaller manufacturers such as Schroeder Industries, Atrium Innovations. A third group are employed in research groups at this institution and other in research programs like CMU, U. of Pittsburgh. Student performance is based on

multiple factors as described earlier and the internship advisor uses a standard supervisor evaluation form for the three groups mentioned above for obtaining qualitative data along with the grade feedback he receives. This is to maintain better consistency. In case of discrepancies existing between the quality of student work, student feedback, and supervisor feedback (as also mentioned earlier) an adjustment may have to be made in the student's grade by the advisor or a second call is placed to discover the root cause of the difference.

Outcomes Assessment

This Engineering Department takes its outcomes assessment process seriously. Each full-time faculty member is obligated to conduct course assessment by preparing an FCAR for each course they are teaching with the exceptions of courses having fewer enrollments than 6 students in each of the BS programs or not being taught. In the case of having less than 6 students from both majors, faculty members still can do a short report with a reflection component. The engineering faculty members under the leadership of a senior member produced a new FCAR template in Spring 2014, and the department also trained its adjunct faculty in the following summer using this new FCAR template. In its course level assessment practices, the department follows the closing the loop principle. In programmatic level assessment practices, the members review issues in student performance documented by FCARs in special department meetings (most recently in Fall 2015) as well as study the currency and appropriateness of each applied outcome in our courses (most recently in Summer 2014). Meeting minutes, relevant communications, and resulting documents are used for documentation and reporting purposes.

Internship reports serve in addition to the student and alumni surveys to strengthen outcomes assessment processes. They help the department draw a better big picture with levels of student and alumni confidence and competence considering that the department gets strong and positive responses from all of these groups. Alumni job placement rates, work-place and graduate school success are also indicators that agree with our survey results along with number of provisional patents earned and regional, national, and international competition wins. In all, this information is supportive when used along with the outcomes assessment process for continuous improvement. Small number of the students is also taking FE exams, the department intend to use that certification, as well as the CMfgT exam for outcomes assessment in the near future. Even though, the department use this in continuous improvement due to its statistical insignificance, the administration still traces the student and alumni results regularly.

In terms of the Engineering Practice courses, the following segments of the supervisor survey given in Figure 1 can be correlated with the following ABET student outcomes as presented in Table 1.

Table 1. Correlation of Internship Supervisor Survey Component to ABET Student Outcomes

Internship Supervisor Survey Component	Relevant ABET Student Outcome⁵
Writing Ability	g
Communications Ability	g
Relations with Others	d
Engineering Preparedness	a, b, c, e, k
Quality of Work Contributions	a, b, c, e, k
Attitude/Application to Learning	i
Ability to Learn	i
Dependability	f
Judgement/Decision Making	b

Conclusions

In the case of professional experiences, there is a need for tools other than ABET student outcomes-based assessment. In this study, the author has proven that these tools based professional performance metrics can be valuable means in assessing student performance, learning, and preparedness. On the contrary, these tools can still be tied to the general ABET student outcomes as prescribed in Table 1. Thus, the results of employer feedback can be correlated to the student outcomes in analysis, even though the match may not be one-on-one. The relationship between student outcomes and professional performance metrics can be modified to reflect one-on-one matches. In addition, program specific outcomes can also be related to professional performance metrics as well. Another approach will be utilizing both tools in parallel in determining effectiveness of the professional experience program in concern. When used in conjunction, both tools will have greater impact in the continuous improvement efforts.

References

- [1] Sirinterlikci, A., & Kerzmann, T. L. (2013, June), Contributions of a Mandatory Internship Course to an Engineering Curriculum Paper presented at 2013 ASEE Annual Conference, Atlanta, Georgia.
- [2] Ntafos, S., & Hasenhuttl, M. (2015, June), Internships, Other Employment, and Academics Paper presented at 2015 ASEE Annual Conference and Exposition, Seattle, Washington.
- [3] Miller, M. H. (1998, June), Industry Internships as a Tool for Curriculum Development Paper presented at 1998 Annual Conference, Seattle, Washington.
- [4] Unpublished ABET Self-Study Report, 2015.
- [5] <http://www.abet.org/wp-content/uploads/2015/05/E001-15-16-EAC-Criteria-03-10-15.pdf>