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Employers, a vital partner for program assessment

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Employers, a vital partner for program assessment

Abstract

This is an evidence-based paper discussing the use of student employers and supervisors as part of an engineering program's assessment plan. In 2016, our institution, York College of Pennsylvania, started a new civil engineering program, with the goal of becoming ABET-accredited. This new program joined three other engineering programs already established at the school. As part of the program design, students were required to complete three mandatory full-time co-op experiences, each lasting 12-15 weeks, interspersed with the traditional eight semesters of classroom and lab instruction. In developing this program the authors wanted to include a standardized evaluation tool for the co-op students' performance that was easy for employers to use and was focused on developing the student by an honest and frank employer assessment. Faculty also realized that by looking at the then-new ABET student outcomes (SOs 1-7) they might be able to develop a simple evaluation tool for employers to share both critical developmental feedback with the students as well as provide another direct measure of student attainment of some of the ABET student outcomes. In this paper, the authors will briefly discuss the co-op program and how it fits into the curriculum and review the literature on the benefits and challenges of work experience as well as developing work assessment measures. The paper will then explain the development of the evaluation survey tool, how the questions were selected, and their connection to ABET SO's 1-7. The authors will share how results are used in terms of ABET SO attainment from the employers' perspectives and how they are used to support their system of continuous improvement, ABET Criterion 4. The paper will also talk about other ways that this assessment data can be used to provide a representative overall program assessment, monitor the effects of program changes, highlight trends and provide direct third-party program assessment. At the authors' institution, the majority of students enter the engineering workforce immediately after graduation, as opposed to starting graduate programs or entering into other fields. Involving employers who have experience with the students in the workplace in the program's assessment can provide an impartial, unbiased assessment that may be more indicative of student preparedness to enter the workforce as a practicing engineer than grades and GPAs. Finally, the paper will offer recommendations that any program could use if they have students who participate in co-op, internships, or other work experiences, whether as a requirement or an elective.

Introduction

In 2016, York College of Pennsylvania started a new civil engineering program, with the goal of becoming ABET-accredited by the Engineering Accreditation Commission (EAC). This new program joined three other established ABET-EAC accredited engineering programs-mechanical, computer, and electrical engineering. As part of the program design, students were

required to complete three mandatory full-time co-op experiences, each lasting 12-15 weeks, interspersed with the traditional eight semesters of classroom and lab instruction. In developing the co-op program, the authors wanted to include a standardized evaluation tool for the co-op students' performance that was easy for employers to use and was focused on developing the student by providing an honest assessment from their employers. Faculty also realized that by looking at the then-new ABET student outcomes (Criterion 3, see Appendix A) there might be an opportunity to develop a simple evaluation tool for employers to both share critical developmental feedback with the students as well as provide a direct measure of student attainment of some of the ABET student outcomes [1]. The existing engineering programs had used employers' student assessments as part of their outcome assessment [2] as well, although using the previous ABET Criterion 3 outcomes. The tool they developed included 40 Likert questions in the evaluation of the co-op student including the importance relative to the task assigned, preparedness when they started the experience, and ability developed during the co-op for 13 different criteria as well as overall performance. There was a yes-or-no question about recommending the students for a return co-op assignment and one open-ended question to offer suggestions to enhance the student's performance and/or experience. Comments about this survey often included terms such as "ugly" and "cumbersome". While it attempted to cover all areas of student outcomes, some were not often relevant to the student's experience or supervisors were uncomfortable or felt unable to provide an evaluation, i.e. "knowledge of contemporary issues" or "the broad education necessary to understand the impact of engineering solutions in a global and societal context". While employers were encouraged to discuss the assessment with students, there was no mechanism to provide them with a copy of the completed survey.

In this paper, we will briefly describe the co-op program and how it fits into the curriculum and review the literature on the benefits and challenges of work experience as well as the development of student work assessments. We will then explain the development of the assessment survey tool, how the questions were selected, and their connection to ABET Criterion 3, student outcomes (SO) 1-7. The authors will share examples of the results they have seen in terms of ABET SO attainment from the employers' perspective and how they are used to support their system of continuous improvement, ABET Criterion 4. The authors will also show other ways that this assessment can be used to provide a representative overall program assessment, monitor trends, or possibly demonstrate the effects of program-level changes as seen in students' performance in the workplace. We will show that involving employers who have experience with the students in the workplace in the program's assessment can provide an impartial, unbiased assessment that may be more indicative of students' and the program's ability to prepare graduates to enter the engineering workforce. Finally, the paper will review the benefits of involving employers in the process of continuous improvement and offer recommendations that any program can use if it has students who participate in co-op, internships, or work experiences, whether as a requirement or as an elective.

Value of co-op experience

The value of a co-op or internship experience as part of a college education is well known and recognized as having value on many levels. It has been noted that it benefits students, employers, colleges, and universities. For students, the benefits are often listed as improving their motivation for learning by seeing a real-world connection to their studies as well as increased maturity [3, 4], and general satisfaction with their co-op experiences and their belief that the co-op experience was positive, in terms of preparation for their career [5]. For employers, internships are cited as a cost-effective way to attract, recruit, vet, and hire full-time permanent employees [5]. Colleges and universities often benefit from industry recognition, industry-academia knowledge exchange, and often academic brand enhancement [4]. Others have noted that the "idea that an engineer should be able to take on a professional role immediately on leaving college without some prior guided experience of working in industry is shown to be nonsense" [6]. Perhaps the most concrete positive outcome of internships for both students and employers is the full-time employment offers.

Literature review of the assessment of student work experience

Student performance in the classroom may differ greatly from performance in an academic or classroom setting [7]. It is not uncommon for faculty to see students who have an average academic classroom performance rise to the occasion and become workplace superstars. Assessing a student's, or any employee's, performance of real-world engineering work is not as straightforward a process as evaluating performance on a math problem, or even a design calculation. The environments of the workplace and the classroom are vastly different. The workplace is often chaotic, uncontrolled, and varied. Even the most active of classroom settings are by comparison usually more controlled. Often what is called for are competency-based assessments (CBAs) or Workplace-Based Assessments (WBAs), which entail performance-based assessments rather than knowledge-based assessments that are the norm in engineering education [7, 8]. A literature review returned few relevant articles about the development of student performance-based assessment tools for the workplace, with much of it focused on the health care and medical professions. However, from what was found, some researchers have postulated that CBAs should theoretically incorporate several characteristics, such as focusing on performance in authentic situations, using multiple assessors, and integrating learning with assessment activities. Some of the specific characteristics that should be part of the assessment design include: providing actual activities from professional practice, involving practitioners in the development of assessments, using observations of performance, addressing higher-order processes, integrating with instruction, individualized assessment, and criterion-based scoring [8]. In discussing the WBAs of medical doctors, it has been suggested that there are four principles to consider: the expertise of the observer/assessor, the contributions of multiple

observers, the training of the observers, and the relationship of observer and the doctor [9]. Other programs documenting assessment include evaluations of undergraduates in equine-related internships, and students in engineering and built environment disciplines. The assessments were provided by employers and focused on Likert ratings of students' professionalism such as being prepared for the work required and quality of work as well as providing an opportunity to respond to open-ended questions [10, 11]. Other research found the assessment can use a standardized format but should allow for some level of personalization [12]. However, it is important to note that there has not been significant research or empirical evidence concerning the quality of assessments that incorporate these theoretical characteristics [13].

Supervisors are ideally situated to provide student assessment in the workplace and have on-site access to the students during their periods of work, whether on co-op or internship. In addition to access, they have the experience, knowledge, and expertise in their field. Often they have experience with providing employee assessment and are intimately familiar with requirements demanded of employees in their particular work situation and their value in the process has been noted by many [10, 14, 15, 16]. It is also noted that the supervisor has an interest in assessment not only from the perspective of monitoring the students and improving their capabilities, but also of raising the quality of those entering the profession [17]. One criticism of using supervisors for assessment is that there are long-held and consistent concerns about leniency bias of supervisors, i.e. their tendency to mark students highly [15, 18, 19]. Even with this tendency, it has been argued that supervisors and their input are integral to the process [20]. The positive value of a third-party assessment, outside of academia, for student development, has also been recognized [14] and any experienced teacher can attest that students more readily accept and seemingly value comments and advice from a third party over their faculty. On a more holistic level, the use of industry in the creation of assessment tools has been advocated for and it is suggested will likely result in a tool that is more aligned with what can easily be assessed as well as what should be assessed in the workplace [21].

Development of our co-op program

The first engineering major at York College of Pennsylvania was started in 1995 with key input from local industry, and strong support for three mandatory co-ops. Industry partners participated initially by hiring co-op students from the fledgling program, and assisting in the initial ABET accreditation process for the mechanical engineering major. As the program grew, electrical and computer engineering majors were added in 2006, and civil engineering was added in 2016. There are now approximately 400 engineering majors across all disciplines, and all are required to complete three mandatory co-ops for graduation (see Table 1 for co-op rotational cycle for engineering majors). As the table shows, the engineering program operates on a full academic schedule year-round, allowing students to gain three semesters of work experience and eight academic semesters within 48 months, a full four years.

Table 1: Co-op Schedule

	Fall	Spring	Summer
First-year	Academic Term	Academic Term	Break
Sophomore	Academic Term	Academic term	Co-op I
Junior	Academic Term	Co-op II	Academic Term
Senior	Co-op III	Academic Term	Academic Term

Students are not assigned or provided co-op positions, but have to seek out, apply to, and secure a position themselves. The program has a full-time co-op advisor who works with the students and teaches a 1-credit required career management course to help prepare the students for acquiring and succeeding during their co-op experience. The program does provide job postings and contact information for employers, but students are also free to find their own positions. Positions that are with first-time co-op employers are reviewed by the faculty and co-op advisor for appropriateness (generally working under the supervision of an engineer and engaged in engineering tasks, rather than just laborer positions). The selection and acceptance of a co-op position are based on an agreement between the employer, who is paying the student, and the individual student. Each co-op experience is a 2-credit course and each co-op student is assigned an engineering faculty advisor who is expected to make a site visit halfway through the co-op to meet with the student and the on-site supervisor. This meeting provides a verbal assessment of the student's performance, highlights any issues that might have arisen, and creates a connection and link to the supervisor. Faculty often discuss the employer's evaluation and other student co-op requirements, mainly creating a poster as a self-reflection exercise and updating their resume. The most meaningful assessment comes from the online evaluation completed by the employer at the end of the co-op.

Development of assessment tool

When designing our assessment tool, we had a two-fold objective—student development and program assessment. First and foremost, our goal was to provide formative developmental feedback to the students to help them improve their ability to succeed in a professional setting and better prepare them to enter the profession upon graduation. It has been shown that meaningful feedback can provide students with an understanding of how they can improve as well as close any gap between their current level of performance and abilities and what will be expected in professional practice [10, 22]. The assessment tool was consciously designed to be formative as regards to an individual student's assessment. As it was not summative, we hoped to avoid the leniency bias noted in supervisor assessments of students [16, 19, 20]. To stress the developmental nature of this tool, students are given a pass or fail grade on their co-op

experience, not a grade that impacts their GPA. A “Pass” grade is achieved by completing the co-op experience, a student survey on their experience sent to them at the end of the co-op period, and a reflective exercise (creating a co-op poster). A “Fail” grade is only given if a student's co-op is ended for cause or if they fail to complete the reflective exercise. To date, we have had one student let go for cause. They received a “Fail” for their grade and will have to pass an additional co-op experience to graduate. In addition, faculty stress to supervisors and employers during their co-op visit that “short of firing a student for cause”, their feedback does not affect the student’s grade, P/F. This separation of feedback from grades has been noted as important to the quality of supervisor feedback [22]. Of course, having supervisors provide feedback and assessment just makes sense as they can “not only guide students in integrating knowledge, values, and skills, but provide students with professional supervision that helps them learn how to use feedback to improve their practice skills” [18]. While the assessment is done at the end of the co-op, the objective for the students is to monitor their progress towards being ready to enter the profession, help identify their strengths and weaknesses, and is done in a low stakes way, i.e. there is no point value or traditional grade associated with the assessment. For these reasons and from the student perspective we view this as a formative assessment.

An important secondary goal was to receive a program-level assessment of how we were meeting ABET student outcomes. ABET requires programs to assess student outcomes from Criterion 3, see Appendix A. “Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through the program” [1]. Engineering supervisors are again in a position to see the application of learning through the students' abilities to handle the demands of the workplace and view students as potential future employees. Using supervisors also provides a third-party and reasonably unbiased assessment of the program. An advantage of being a brand new program is that none of our program graduates are in supervisory positions at this point, nor do we have employers with long-standing ties to our program. In the future, this is something we will have to monitor to determine if it is impacting or biasing the assessments. One challenge is that each employer, workplace, and position can vary greatly over job skills and knowledge required and used. Although all positions are approved as noted above, faculty do check for the appropriateness of work being done by students during their visit with both the student and the supervisor. To date, we have not had any issues in this area.

Using the ideas and ideal characteristics suggested from our review of the literature, we developed an assessment tool to meet both of our goals. We focused on using the ABET student outcomes that we felt were most applicable and most reasonable for supervisors to assess. It should be noted that the ABET student outcomes recognize the importance of technical skills and “soft” or professional skills and require both. This is in line with what employers are saying they want from future employees as well – technical skills, of course, but also professional skills [14, 23]. Examples of desired professional skills include leadership, an ability to effectively work in

a team, communication skills (both verbal and written), strong work ethic, flexibility/ adaptability, and ability to work with others [24, 25]. Conforming to theory and practice, our assessment tool focused on professional competence and essentially asked the employers and supervisors to assess the performance of what students actually did in their particular work experience to provide a measurement of how the program was meeting some of its desired outcomes, which naturally did involve a level of generalization [26]. This third-party assessment can facilitate assessing multiple capabilities, provide industry feedback, and draw on samples of actual practice [27], all elements important to program assessment. In addition to conforming to characteristics on student assessment outlined in the literature review, it was also important to make a tool that was easy for employers to use.

Looking at ABET student outcomes 1-7 (See Appendix A), we felt employers or supervisors were in the best position to assess outcomes 1 (solve complex engineering problems), 3 (communicate), 5 (function on a team), 6 (experiment, interpret data, draw conclusions), and 7 (acquire and apply new knowledge). While not all elements of any given outcome might apply to every working situation, these provided a broad enough perspective that we thought they could be adequately assessed. We provided a Likert scale for supervisors to assess the student's ability and how prepared the students were to meet the demands in each area (5 – Extremely well prepared, 4 – Well prepared, 3 – Acceptable level, 2 – Poorly prepared, 1 – Very poorly prepared). This is essentially asking how well our program is doing at meeting the student outcomes as seen by employers. A second question is aimed to assess the change in a student's overall ability throughout the co-op in a given area (5 – Much better, 4 – Somewhat better, 3 – Stayed the same, 2 – Somewhat worse, 1 – Much worse). Supervisors were also given an open-ended question in each area as well to comment or provide recommendations on things for the student to work on to improve or to sustain in this area in the future. This last question was included mainly for the individual student's development, although we do look over responses for commonalities that might need to be addressed by the program. We also ask for an overall assessment of the student's performance on a Likert scale (5- Exceptional, 4 - Exceeds expectations, 3 - Meets expectations, 2 - Improvement needed, 1 - Unsatisfactory). There are also open-ended questions about the student's overall strengths and areas for improvement, see Appendix C for the employer evaluation (our assessment tool). Supervisors receive the online survey tool via an email invitation during the last three weeks of the co-op experience, and if not completed receive reminders toward the final week of the co-op. Supervisors are encouraged to have an individual meeting with the student before the end of the co-op period. The assessment tool allows for a PDF printout to be discussed with and provided to the student. The program receives the data from the online survey. At the end of the survey, supervisors are given an option to request a meeting with a faculty member to discuss any issues that may have arisen, either with the student or the program. The rate of return on these evaluations averages 92%.

This assessment tool was developed with the help of our industry advisory board. In May of 2019, our board reviewed the assessment questions, offered suggestions, and confirmed the appropriateness of the questions and tool itself from the employer's perspective. Additionally, with the first iterations of using this tool, faculty reviewed the employer evaluation with supervisors to get their feedback on the tool as well. We hoped to minimize any supervisor leniency bias by stressing these are used as developmental assessments for the student and that we use the results only on a collective basis for program-level assessment [14]. This setup allows us to use multiple assessors to provide data. Each supervisor provides an assessment; generally, each student has a different supervisor assess them for each of their three unique co-op experiences, and we have 15-30 different supervisors providing assessments in any given co-op period. This collective use for program assessment is, in a sense, a summative application of the formative tool. In these ways our tool attempts to adhere to the best practices of combining multiple assessments from various supervisors, providing a standardized form that can also allow for individualized assessment, and developing the assessment tool in consultation with industry [8, 9, 12, 16]. Others have noted that what faculty might perceive as elevated supervisor ratings, as compared to the student's academic average, might be explained by the fact that students often excel in the real-world application of skills, even if they might not excel in an academic setting [28]. It seems likely that supervisors' "assessments could be the true reflection of student performance, particularly as supervisors may be better placed to gauge workplace performance given their exposure to entry-level staff in the professional environment and proximity to the student" [16].

Use of assessment data

In terms of assessment and contributing to a plan for continuous improvement as required by ABET Criterion 4, we get direct measures from the co-op employer evaluations for five student outcomes, as mentioned above. This is only one part of our assessment of those outcomes, but we feel it is an important one. We can look at how well the students do in each of the measurements, take an average and look to see if the score exceeds a program-determined acceptable level (3 being the "acceptable level" in our case). We can also look to ensure that we have an acceptable number of students who score 3 or above; we set that goal at 70% or more of the students achieving that level or above. This is the same basic standard we use for all our ABET assessments. As an example, for a direct measurement tied to a graded assignment, we look for an average score over 70%, our self-determined acceptable level, and we look to ensure 70% of the students achieved 70% or above. This ensures that, for example, a large number of students receiving 5 (or a very high score on a graded assignment) do not mask an equally large number of students receiving 1 or 2 (or scores below 70% on graded assignments). Figure 1 shows this for student outcome 1, problem-solving, over the course of all co-ops. While we do use this same standard for all co-ops, (I, II, and III), it is incumbent on our co-op advisor and faculty to evaluate the positions and determine they are at an appropriate level for the student.

Faculty visits and close working relationships with employers have helped ensure this happens and has been successful. Employers also have this desire as they often view co-op students as future employees, want to get as much out of them as possible, and provide a challenge so other students will want to work with them in the future. We do have a couple of industry partners we only use for first co-ops as it has been determined that they cannot provide the further development students need or desire. In Figure 1 we see the average assessment score from the supervisors of all the students who participated in a co-op during that period. As a small program, student cohort groups overwhelmingly completing the same co-op (I, II, or III) during a given co-op period (summer, fall, or spring). This was universally true in our first two years. We do now, on occasion, have a student who for any of a variety of reasons misses a normally scheduled co-op opportunity (medical, personal, academic, or athletic reasons) and then will be on a different co-op rotation than the majority, i.e. most students are completing their second co-op in the spring, but one student may be completing her first. However, the number of students this applies to is very low. In this example, the data does show that the students met the level of achievement goal (3 or greater) and all scored 3 or better in this measure. At this point, no assessments have not indicated any of the areas with an average below the 3 level and all with well over 70% scoring 3 or above. However, we continually monitor this data for all criteria, and if we see it lowers or is not meeting acceptable levels, the faculty can create and implement a remedial action and assess the results to look for improvements—this is the essence of an ABET Criteria 4 plan, continuous improvement. We can also look at the data to see if changes made in the curriculum, in relation to these assessments or others, are showing effects, positive or negative, or none at all.

This is a very easy and straightforward piece of assessment data, but is only the start to what we can do. Our survey assessment tool provides us with lots of important information, some of which we share here. We find this to be a treasure trove of useful assessment data, especially as it comes from people outside the institution and those in the profession our students plan to enter upon graduation.

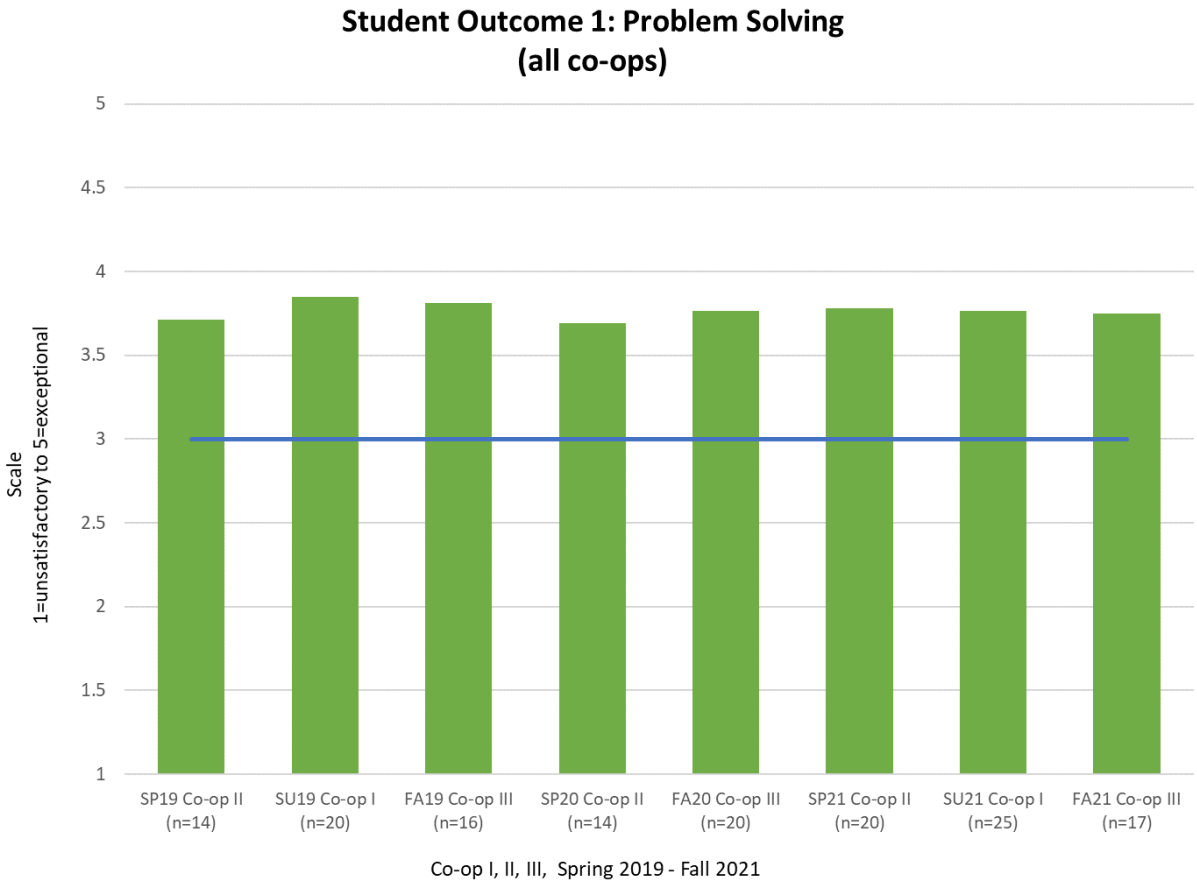

Figure 1: Performance on ABET SO1 (Solve problems)

An example of another measure we can look at is our students' ability to learn and improve while on the job. In Figure 2, we highlight the averages of all students in a given graduating class on each of their three co-ops in the area of, "identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics on the co-op", i.e., is the program preparing students to an expected level to perform real-world engineering work, in respect to solving problems, again using a Likert scale with scores of 5 (extremely well prepared) to 1 (Very poorly prepared) as detailed above. We then compared, again by co-op, the supervisor's assessment of the change in the student's ability to solve engineering problems after the co-op (again with a Likert scale of 5 - Much better to 1 - Much worse, as detailed above). In the case of this outcome, for example, we see that students were, on average, better than acceptably prepared, and they still on average showed improvement in their ability in this area during the co-op. This of course can be reviewed for each of the five student outcomes we requested to be assessed. Figure 3 shows the same data but combined for all co-ops, rather than just for one particular cohort, as in Figure 2, or for each term as in Figure 1.

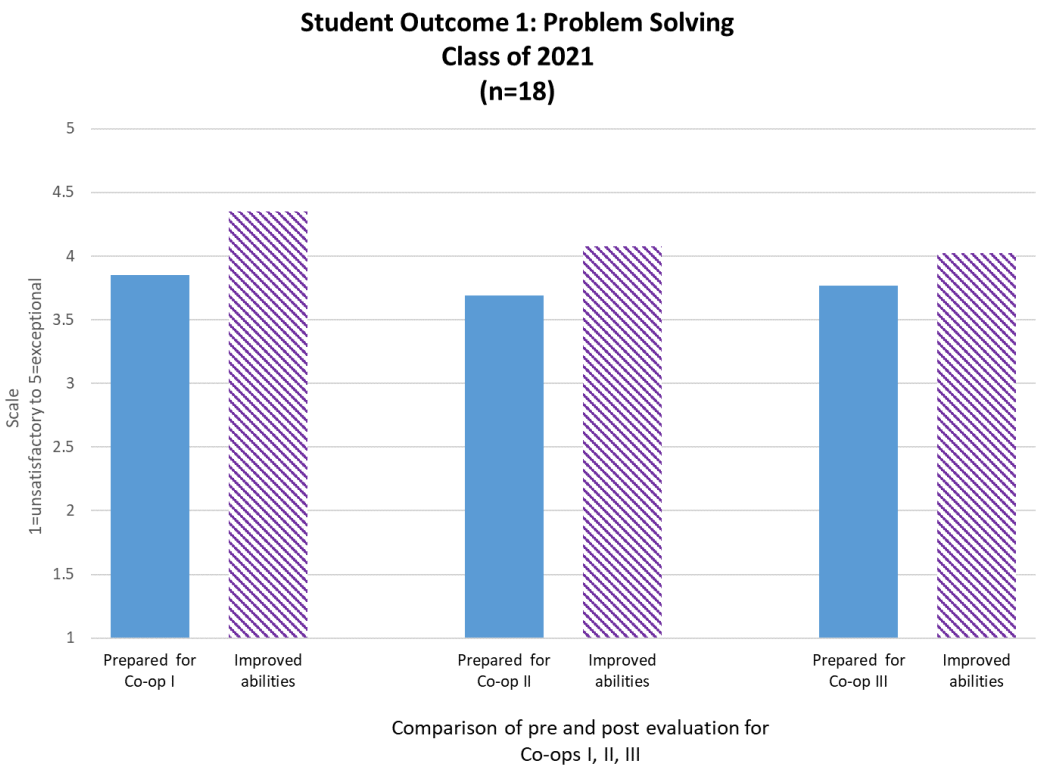

Figure 2: Comparison of preparedness for co-op and improvement at the end of co-op (Problem Solving--SO 1) for the graduation class of 2021

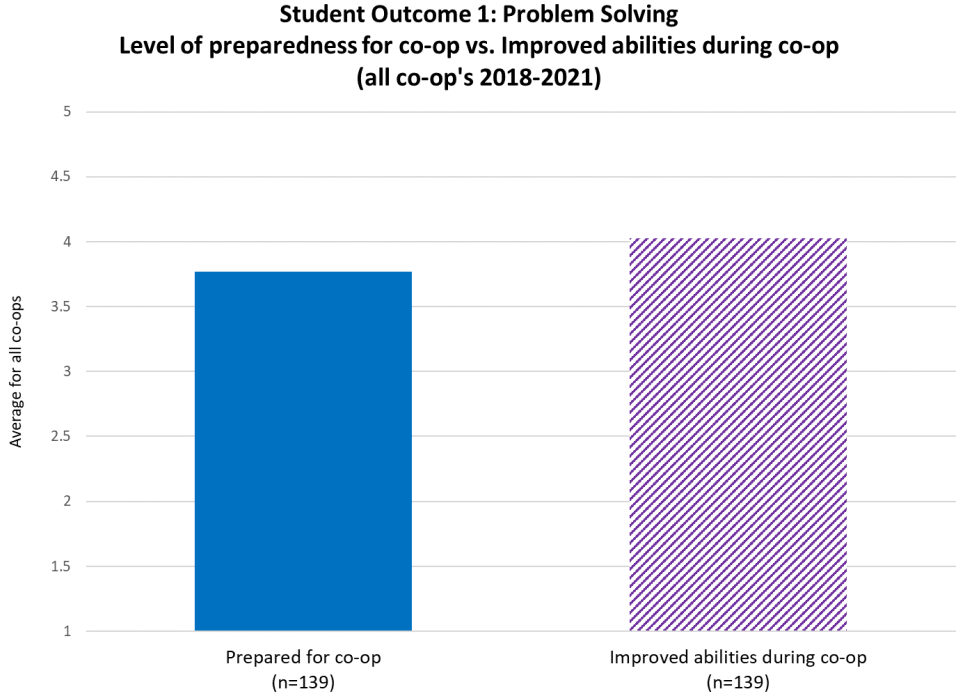

Figure 3: Comparison of preparedness for co-op and change in ability during co-op (Problem Solving--SO 1), averaged for all co-ops

Another way we can look at the assessment data is by comparing different graduating classes or cohorts and asking if they are doing an acceptable job on co-op see Figure 4 (below) we look at how the students have progressed from co-op I (typically summer after their 2nd year) through Co-op III (typically fall of their senior year), based on overall co-op performance. While an increase in performance would be expected, we do not necessarily see that. However, it should be noted that all averages are above 3.5 (between 'meets expectations' and 'exceeds expectations'). Such a trend over a prolonged period, or a downward trend, could point to a need to do a more in-depth exploration of the causes of this unexpected situation. In this case, possible explanations could be related to the fact that Co-op II for the class of 2021 was cut short due to COVID-19 and many of the Co-op III experiences for that class were done remotely. The Class of 2022 only had two co-op experiences as their first co-op did not occur until the traditional period for a second co-op, again due to COVID-19. In this case, all summer 2020 co-ops were canceled by the college and the requirement for one co-op was waived. Given that the scores are all in the acceptable or better levels, the fluctuations might just be explained by different evaluators, different positions, differing expectations, etc. Over time this is another measurement that can be explored to see if troubling or unexpected trends are occurring. This data could then help us to make program and curricular adjustments and again use our employers' assessment to see if changes made have the desired results. Of course, this type of assessment could be made for any of the five student outcomes employers assessed as well.

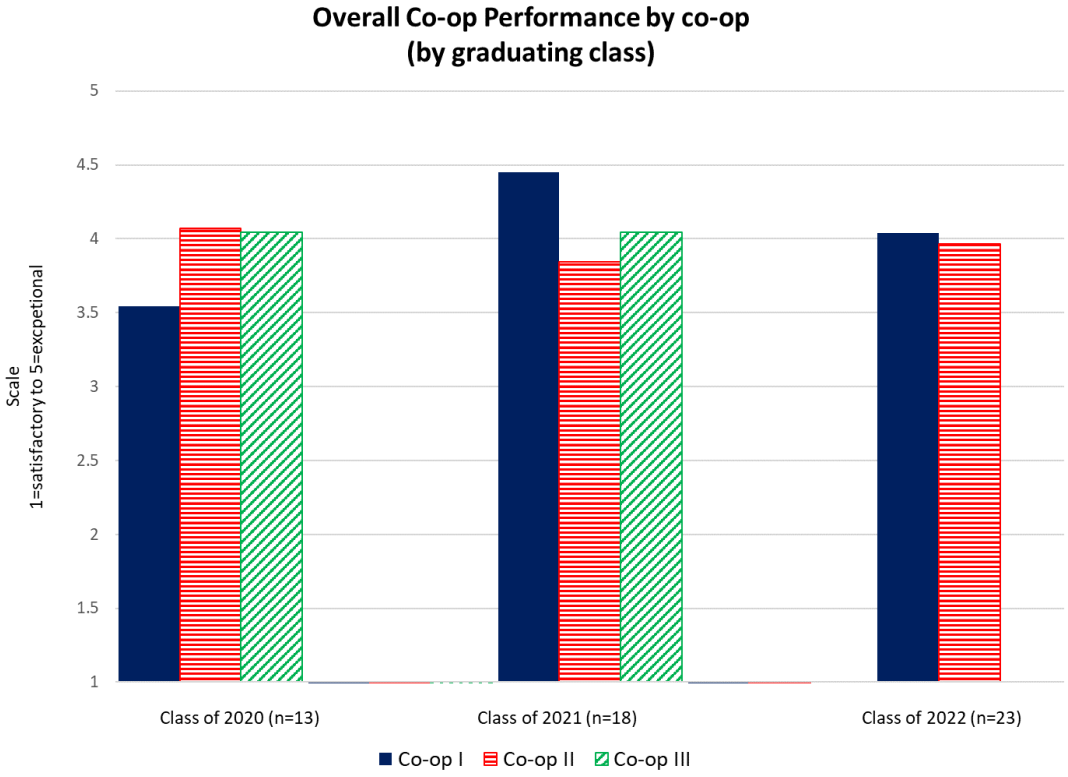

Figure 4: Overall co-op performance by class

One of the interesting ways to use the data is to see if classroom achievement is correlated to performance in the workplace. As mentioned, employers or supervisors provide an overall assessment of the student's performance rated on a Likert scale of 1-5 (5- Exceptional, to 1 - Unsatisfactory, see above for details). We looked at the students from our first two graduating classes (n=31) and averaged their overall performance ratings through all their co-ops. We were then able to compare this to their GPAs (0-4 scale for our college), see

As this figure indicates, success in the classroom does not always correlate with success in the workplace, as suggested by Heywood [6]. At our school, the majority of engineering students enter the engineering workforce immediately after graduation, as opposed to starting graduate programs or entering into other fields. Involving employers who have experience with the students in the workplace may be more indicative of student preparedness to enter the workforce as a practicing engineer than grades and GPAs. All students attained success in their co-op experiences, defined as "meets expectations" (noted by the green line at 3.0 evaluation average) or better as averaged on their overall performance rating on all their co-ops. It is also worth noting that no student in these first two cohorts received an unsatisfactory or poor overall rating on any co-op, and similarly GPAs were all above 2.5. Although this is a fairly small sample size, this chart seems to suggest that the program is succeeding in preparing students for professional practice and graduating students who are prepared to meet the demands of the engineering workplace, even those who may not have been academic standouts.

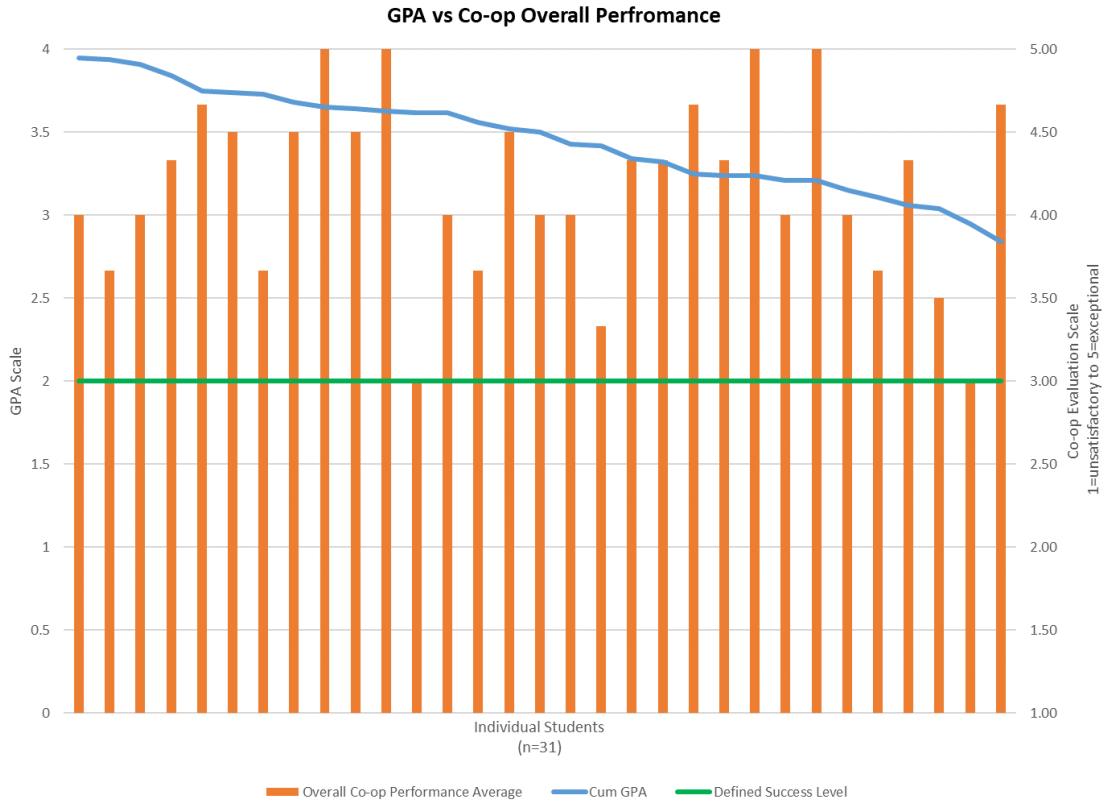

Figure 5: GPA vs. Overall co-op performance average by student

Future work

As we have more students participate in co-op and we gather more assessments in the program we plan to use this data as part of our measure of the effectiveness of changes made to the curriculum and the program. As a new program, many of the initial changes and modifications were made before the students went out on co-op, but for future changes, we will be able to see if there is an impact. We also anticipate that at some point these assessments could become a driver or serve as a bellwether for needed changes. As we have more data and more students go through the program, there is an opportunity to explore and look for the reasons or deeper meanings associated with the result. One of these areas could be looking at, for example, those that had a middle-level GPA but very high co-op assessments or looking for patterns of student performance and the relation between groupings of students with GPA and co-op performance. Other areas for future work include tracking trends in students between each co-op experience and conducting more analysis of the connection between how well employers feel students are prepared for the co-op and how much they see them change.

Summary

At our institution, cooperative work experience provides meaningful, constructive experience to civil engineering students as they build confidence and skills outside the classroom. We have found that employers are a vital partner not just as supporters of and champions for our program, and employers of our graduates, but also as outside assessors of our program outcomes. Enlisting the help of employers and supervisors to evaluate co-op student experiences has proven beneficial in several ways. First, it provides our students with a real-world assessment from an industry professional. For our program, assessment questions linked directly to ABET outcomes provide meaningful assessment data as part of our continuous improvement program (ABET Criterion 4) that was part of a successful first-time ABET accreditation of the new civil engineering program. Also, employer feedback can help inform decisions about curriculum, course sequence, and future changes. Our industry partners have proven to be willing and eager participants in enrollment events, the classroom, and student professional association presentations, as well as willingly providing an industry perspective on their needs and education requirements of future employees. Involving them in assessment seems to be a natural step and has involved many more in our program and certainly strengthened our connection with industry. We have found that even in the early years of our program's development, these assessments have provided us with a lot of useful information to help guide the program or confirm our direction. We have found that many of our industry partnerships are often started or developed through employers and supervisors. In addition, the assessment data is regularly shared with the Civil Engineering Industry Advisory Board, which eagerly reviews it. As a new program, we have only collected limited data to this point, but with all our students participating in three co-op experiences, we expect to be able to monitor trends and look for things that can point to potential issues or show the effects - positive, negative, or neutral - of changes we make. We believe that involving employers can provide valuable information for programs that do not have mandatory co-op or internship programs as well. A student work survey assessment tool is easy to develop. Many students already participate in internships or summer employment opportunities with engineering companies. If these experiences can be identified, we believe most employers, as well as students, would be willing to do a student evaluation that can then be

used as part of a program's assessment plan. In our case, this was an important direct measure that was used to achieve a successful first ABET accreditation.

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APPENDIX A -ABET Engineering Accreditation Commission Criterion 3. Student Outcomes [1]

The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

APPENDIX B

Co-op Companies, 2018-2021

American Contracting & Environmental Services, Inc.

C2C Design Group *

Century Engineering, Inc.

The Chazen Companies, a LaBella Company *

CLSI *

Conewago Enterprises Inc. *

C. S. Davidson, Inc. *

Development Design Concepts

Dynamic Earth, LLC

ECS Mid-Atlantic, LLC *

ERC of PA *

EXP US Services, Inc.

Freshpet Kitchens *

Gannett Fleming*

Geo-Technology Associates, Inc *

Grunley Construction Company, Inc.

HNTB Corporation

Harford County- Department of Public Works

Herbert, Rowland & Grubic, Inc. *

Hillis-Carnes Engineering

James R. Holley & Associates, Inc.

IWM International, LLC

Johnson, Mirmiran & Thompson, Inc. *

Keystruct Construction, Inc.

Kinsley Construction Inc. *

Langan Engineering and Environ

Maritime Applied Physics Corp. *

Maryland Department of Transportation

Maryland Highway Department

McCarthy Engineering

AW Mercer

McCrone

Michels Corporation

Modjeski and Masters, Inc.

Mott MacDonald

MRG Labs

The Mula' Group *

Naval Surface Warfare Center Philadelphia Division *

NTM Engineering, Inc.

Omni

Pennoni

Priority Construction

RGS Associates

Site Design Concepts, Inc.

Snyder, Secary & Assoc., LLC *

Structural Preservation Systems, LLC

Suburban Consulting Engineers

Terraform Engineering

Toole Design Group

Towne Square Engineering

Triad Engineering, Inc.

UGI Utilities, Inc.

Urban Engineers, Inc.

Utility Services Group, Inc.

Wallace Montgomery & Associates

Frederick Ward Associates

Warehaus AE *

The Whiting-Turner Contracting Company, Inc. *

Wickersham Construction & Engineering, Inc.

WSP

York College of Pennsylvania (Facilities)

The York Water Company *

* Companies that hired multiple co-op students

APPENDIX C- Employer Survey [Administered through Qualtrics]

Thank you for employing one of our co-op students, your support helps make our program a success and provides a great benefit to our students.

Please take a few minutes and complete this assessment of your co-op student's performance this term. After completing the evaluation, you will be able to download a copy of your evaluation in PDF form. We ask that you schedule a meeting with your co-op student to go over your assessment of their performance as you would with any other employee. For co-op students it is critical that they receive feedback as this is a development portion of their education and as their employer, you are in a unique position to assess the student.

We also use your feedback, in aggregate with that of other employers, to help us assess and continually improve our program.

Thanks again for your continued support, time and assistance!

Background Information
Student's last name: Student's first name:

Your name (first and last): Your email: Your position/title:

Employer/Company/Firm name:

Employer/Company/Firm address (street, city, state, zip)

Please list the dates of the student's co-op:

Briefly describe what the student worked on during the co-op. You may list tasks or projects worked on, or responsibilities they handled.

Outcomes Assessment

We would like to ask you about the student's performance in five important areas and then get your overall impression of the student's performance during the co-op. In each area we'd like an overall rating of how prepared the student was to meet your requirements, their level of competence at the end of the co-op and any comments in that area for the student.

1. Communications

a. Rate how prepared was the student to communicate (written and oral) in appropriate ways (formal, informal, technical) to a variety of audiences as required in their position?
5 – Extremely well prepared 4 – Well prepared 3 – Acceptable level 2 – Poorly prepared
1 – Very poorly prepared

b. At the completion of the co-op how well do you rate the student's over all ability to communicate to a variety of audiences?
5 – Much better 4- Somewhat better 3 – Stayed the same 2 – Somewhat worse 1 – Much worse

c. Comments or recommendations on things for the student to work on to improve or to sustain in this area in the future.

2. Teamwork

a. How prepared was the student to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives?
5 – Extremely well prepared 4 – Well prepared 3 – Acceptable level 2 – Poorly prepared
1 – Very poorly prepared

b. At the completion of the co-op how well do you rate the student's ability to function effectively on a team?
5 – Much better 4- Somewhat better 3 – Stayed the same 2 – Somewhat worse 1 – Much worse

c. Comments or recommendations on things for the student to work on to improve or to sustain in this area in the future.

3. Problem solving

a. How prepared was the student to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics on the co-op?
5 – Extremely well prepared 4 – Well prepared 3 – Acceptable level 2 – Poorly prepared
1 – Very poorly prepared

b. At the completion of the co-op how well do you rate the student's ability to solve engineering problems?

5 – Much better 4- Somewhat better 3 – Stayed the same 2 – Somewhat worse 1 – Much worse

c. Comments or recommendations on things for the student to work on to improve or to sustain in this area in the future.

4. Using engineering analysis and judgement

a. How prepared was the student to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions?
5 – Extremely well prepared 4 – Well prepared 3 – Acceptable level 2 – Poorly prepared 1 – Very poorly prepared

b. At the completion of the co-op how well do you rate the student's ability to analyze problems and use engineering judgment to draw appropriate conclusions.
5 – Much better 4- Somewhat better 3 – Stayed the same 2 – Somewhat worse 1 – Much worse

c. Comments or recommendations on things for the student to work on to improve or to sustain in this area in the future.

5. Learn new knowledge and skills

a. How prepared was the student to acquire and apply new knowledge as needed, using appropriate learning strategies?
5 - 5 – Extremely well prepared 4 – Well prepared 3 – Acceptable level 2 – Poorly prepared 1 – Very poorly prepared

b. At the completion of the co-op how well do you rate the student's ability to acquire and apply new knowledge as needed.
5 – Much better 4- Somewhat better 3 – Stayed the same 2 – Somewhat worse 1 – Much worse

c. Comments or recommendations on things for the student to work on to improve or to sustain in this area in the future.

Overall assessment

Did the co-op student behave ethically and professionally during the co-op?

[If no was indicated] please provide details of this behavior.

[If no was indicated] Would you like us to contact you about this student's behavior?

Overall what are the student's strengths, considering knowledge, skills, and professional behavior and attitude expected of an employee at your company.

What are areas for improvement?

Overall how would you rate the student's performance?

5- Exceptional 4 - Exceeds expectations
3 - Meets expectations 2 - Improvement needed
1 - Unsatisfactory

Would you like us to contact you concerning the student and their performance?

Comments for the student

Finally, would you like one of us in the Civil Engineering program to contact you about any aspect of the program or the co-op?

[If yes selected] To help us make sure the right person contacts you, what areas or issues would you like to discuss with us?