

Cooperative Educational Program Outcomes and its Correlation with Students' Academic Performance-A Case Study

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Abstract

The cooperative education program outcome in one of the Massachusetts Maritime Academy's (MMA) undergraduate majors, Facility Engineering (FENG), has been investigated. The ultimate outcome of the co-op term can be a determining factor in how well prepared the students would be in their future engineering careers. At the end of each co-op, the employers are required to participate in a brief survey and evaluate the student's performance in several criteria. The correlation between the employer's feedback and students' GPA is investigated. Also, students' performance in their three co-ops is analyzed to determine correlation between students' years of study with his/her co-op experience. The results showed that the highest GPAs do not necessarily correlate to exceptional work performance during a co-op and conversely a low GPA does not correlate with poor co-op work performance.

Introduction

Since 1906 when Herman Schneider founded an innovative approach called cooperative education (co-op), many researchers studied different parameters involving the outcomes and benefits of co-op programs. Generally, the co-op programs are designed to provide the students with practical "hands-on" experience, practical managerial experience, and interpersonal practices of a public or private sector facilities operation or engineering firm and its surrounding community.

Blair et al. [1] statistically investigated the effect of co-op education on GPA, length of time in school, and starting salary. They showed that engineering students who completed the co-op education program earned higher GPAs, earned more in terms of starting salaries, but took approximately two semesters longer to complete their undergraduate program. Ramirez et al. [2] used a regression model within a database of engineering students across six institutions. They showed that co-op students are more likely to graduate in engineering with higher GPAs than their nonparticipant counterparts, although they will take longer to graduate. Using a similar database, Main et Al. [3] identified the factors that influence student access to cooperative education programs. Richard et al. [4] investigated the effect of capstone co-op education on future career and students' secondary technical educational scores. Additionally, she studied the effect of co-op educational program on student GPA, Individualized Education Plan (IEP) status, and length of time on co-op or quality of student training plan. It was determined that students with the co-op experiences, have a significantly higher score on both the written and practical portions of their exams. Friel [5] employed a statistical analysis approach to examine the employer's perspective regarding benefits and problems experienced during co-op and identified their statistical significance.

The co-op outcomes can be varied by different factors such as the number of co-ops, student's majors, and the school's mission. In Massachusetts Higher Education, Massachusetts Maritime Academy, MMA, is designated a special mission college. MMA has only seven academic majors each with a particular

professional maritime or industry focus. As part of educational training, students are required a minimum of six months, three (8-10 weeks) cooperative education periods.

This work aims to answer the following questions:

- 1- Is there any meaningful correlation between student's co-op employer evaluation and students' GPA?
- 2- How does students' performance change over the course of the three co-op experiences?

Methodology

Three data points are correlated for each student. The first is the final GPA that the student obtained at the completion of the major. This is a measure of the academic success of the student while at the Academy. The second set of data is the corresponding students' 3 co-op grades as evaluated by the employer. The employer's evaluation is based on the data collected using surveys designed by MMA's career services portal during 2010-2015. The survey encompasses a wide range of topics based in four key areas; work performance, technical ability, intellectual acuity, and communications skills. The entire competencies tree is shown in Figure 1.

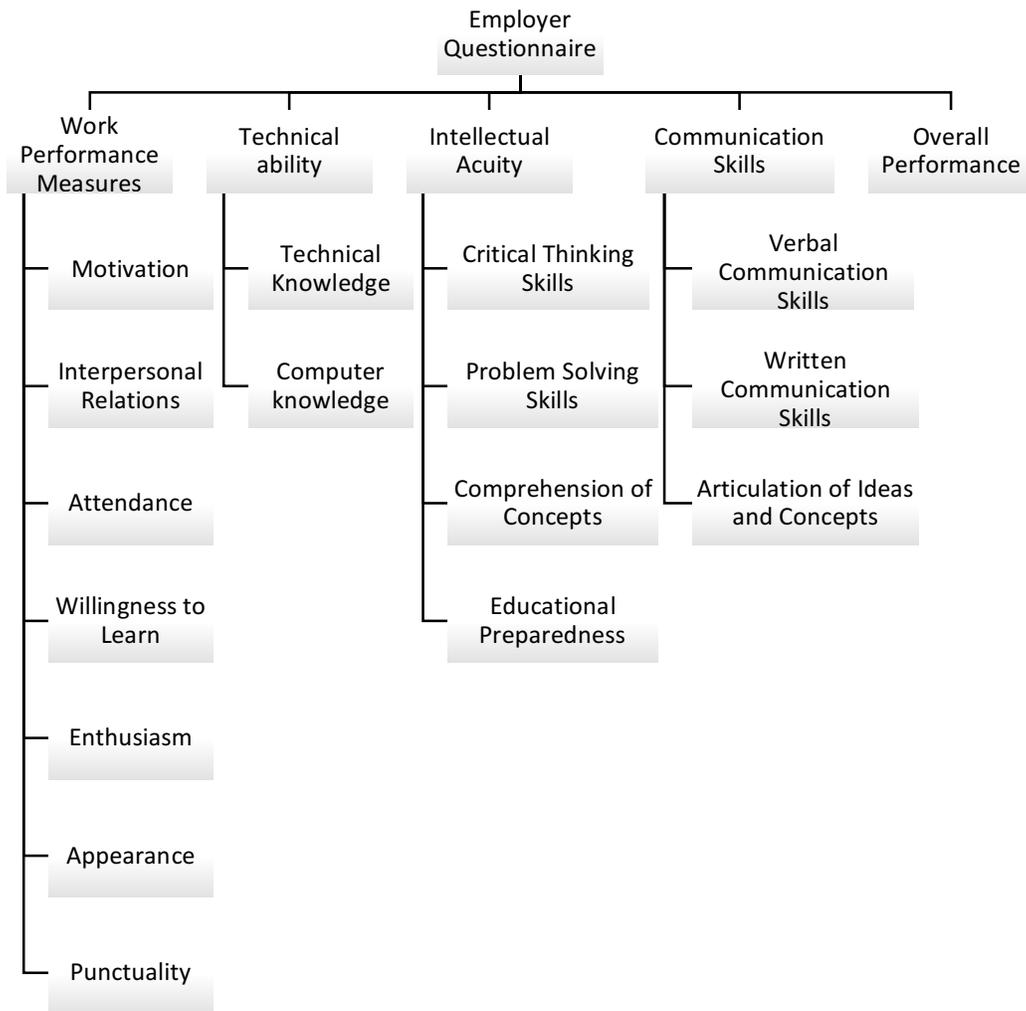


Figure 1. Employer Evaluation Breakdown

There are employer evaluation data available for 243 students in the Facilities Engineering Major. This population was further reduced to 128 students, after removing all students who have yet to graduate or who have missing data. Some initial analyses show that the difference between the two populations is within 5.3% of each other, it was felt that having complete co-op and GPA data from only graduated students was the best way to ensure that the baselines for all the data are consistent.

This population has been broken into 4 groups based on final GPA. These groups are defined as follow; Group 1 is defined as students with a GPA below 2.5 (31 students), Group 2 are students with a GPA between 2.5 and 3.0 (44 students), Group 3 are students with a GPA between 3.0 and 3.5 (38 students) and Group 4 is students with a GPA above 3.5 (15 students). The population of students of Group 4 is smaller than the other 3 groups, but these high academic achieving students are naturally going to be a smaller percentage of the student in the major.

The average co-op grade for each group was computed for each of the three co-ops. A linear regression analysis of the data was done to compare the rate of grade increase or decrease between the co-ops, and to measure the student's growth over the 3 co-op semesters as a metric to compare the student groups.

The frequency of “excellent” and “good” employer evaluation results were also calculated across the 4 student groups over the 3 co-ops. These scores accounted for 97-100% of all the results across these 4 student groups, so there was no need to look at the frequency of any of the employer evaluations below good.

Results

The first data point investigated was the academic grade earned by the student in each co-op (Figure 2). At the completion of a co-op, the student writes an engineering report which is graded by a faculty member based on a specific rubric. Nineteen percent of the academic grade is based on the employer evaluation. The remainder of the grade is the faculty member’s assessment of the student’s report. Since the faculty member was not involved in the co-op and had no direct knowledge of the student’s work except for that which was presented in the report, the academic grades for co-ops are best used as a measure of the student’s growth in the written communication skills and assessed by student’s grade.

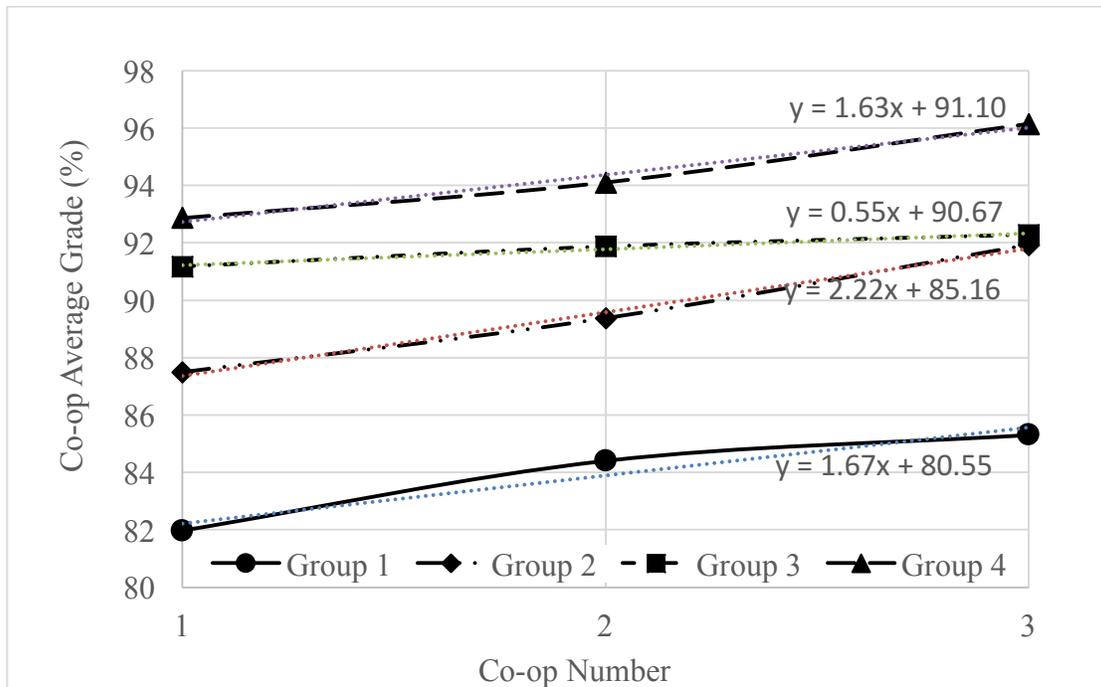


Figure 2. Average Co-op Grade versus Co-op Number

Figure 2 shows a measurable increase in learning; specifically it shows an improvement in the student’s written communication and articulation of ideas and concepts from the first to the third co-op. Throughout the period of study, the grades reported for students were in direct relation to their grouping; namely Group 4 had the highest grades and Group 1 had the lowest grades.

Using the linear regression analysis the improvement over the course of three co-ops was compared. Interestingly, the results showed the greatest rate of improvement (slope of 2.2) was in Group 2 followed by Group 1 (slope of 1.67) and Group 4 (slope of 1.63). The lowest improvement was related to Group 3 (slope of 0.55). The students in Group 2 may be tentative during their first co-op since they are unsure of the requirements; however, they have enormous capacity to learn which is evident by their rate of improvement. The students in Group 1 have academically the lowest grades and therefore they have a great incentive to do well on their co-op experience which carries 6 credits toward their GPA. The Group 4 students are notably high achievers and continue working toward excellence. Their rate of increase in academic grade performance is due mainly to the fact that they start at a higher grade level and do not have as much room to grow. Lastly, the Group 3 students, who show very little rate of improvement, demonstrate they may be satisfied with their initial co-op grade.

To investigate any correlation between a student’s GPA and the Employer Evaluation submitted at the end of each co-op a series of tables and graphs were created. Table 1 shows the percentage of students who received an “excellent” employer evaluation in each of the three co-ops as a function of their GPA.

Table 1 - Percentage of Students Receiving an Excellent Evaluation

Excellent Evaluation					
Group	GPA	1st Co-op	2nd Co-op	3rd Co-op	Average
1	<2.5	70.9%	59.3%	60.9%	63.7%
2	2.5-3.0	59.4%	47.7%	63.6%	56.9%
3	3.0-3.5	65.8%	71.1%	63.2%	66.7%
4	3.5-4.0	46.7%	73.3%	60.0%	60.0%

The data from Table 1 are graphically represented in Figure 3. In Figure 3, “excellent” employee evaluation vs student GPA, it is interesting to note that the students with the lowest GPA (Group 1) had the greatest percentage of “excellent” reviews in the first co-op; whereas the students with the highest GPA (Group 4) had the lowest percentage.

The first co-op is often completed by “shadowing” and assisting an engineering technician since the students’ engineering training prior to the first co-op is limited and the jobs assigned are often not extremely technical. The students’ lack of technical expertise provides less opportunity for the employer to judge critical thinking and problem solving skills but does provide the opportunity to measure the individual student’s interpersonal relations, motivation, willingness to learn, and enthusiasm. The students in Group 1 are often very willing to learn the practical skills and demonstrate great enthusiasm, which lead to a high percentage of “excellent” employer evaluations resulting higher evaluations.

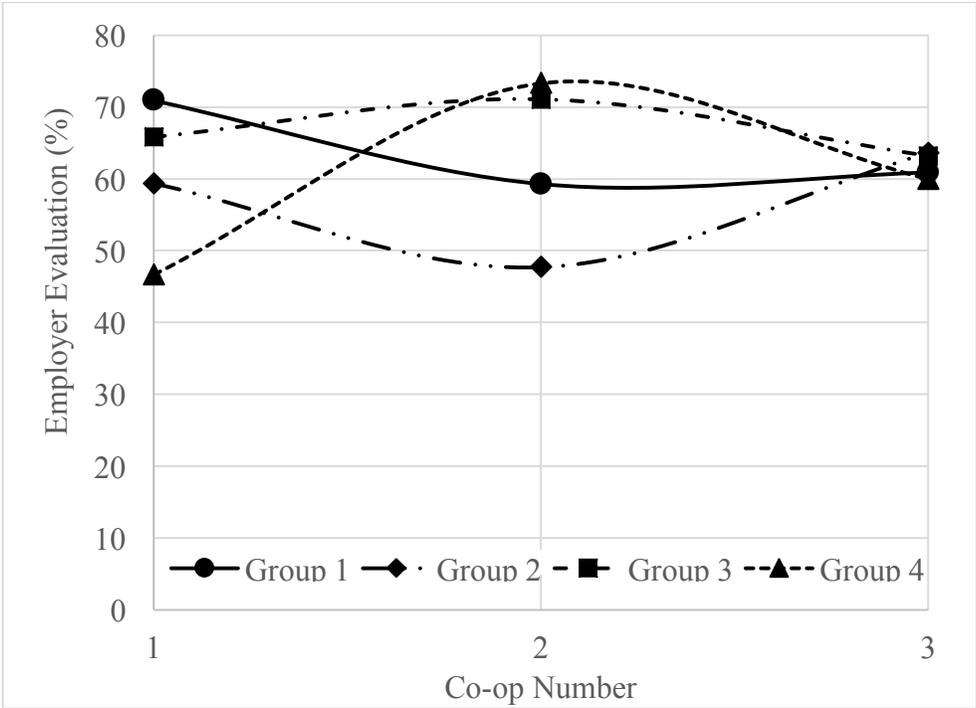


Figure 3. Percentage of “Excellent” Employee Evaluation versus Co-op Number

Students with the highest GPA (Group 4) have the lowest percentage of “excellent” employer evaluations in the first co-op. These students are also highly motivated to learn but may not show as much enthusiasm as the students in Group 1. The students in Group 4 understand the math and engineering theory but may feel challenged or not feel as comfortable with the physical application and “hands on” nature of the co-op experience.

The students in Group 3 have a higher percentage of “excellent” evaluations than those in Group 2 for the first co-op; however, by the third co-op, when technical knowledge, computer knowledge, critical thinking, problem solving skills, and comprehension of concepts are evaluated, there are approximately an equal number of “excellent” evaluations in each of the student grade Groups.

The percentage of students who received a “good” employer evaluation in each of the three co-ops as a function of their GPA is presented in Table 2 and graphically represented in Figure 4.

Table 2 - Percentage of Students Receiving and Good Evaluation

Good Evaluation					
Group	GPA	1st Co-op	2nd Co-op	3rd Co-op	Average
1	<2.49	23.6%	37.0%	37.0%	32.5%
2	2.50-2.99	16.0%	47.7%	34.1%	32.6%
3	3.00-3.49	31.6%	26.3%	34.2%	30.7%
4	3.50-4.00	53.3%	26.7%	40.0%	40.0%

Figure 4, which compares “Good” Employee Evaluation versus Co-op Number as a function of GPA, shows a different trend. Here, the students in Group 4 have the highest percentage of “good” evaluations followed by the students in Group 3. The students in Group 2 have the lowest percentage of “good” evaluations. By the third co-op, a relatively equal percentage of students in each category receive a “good” evaluation.

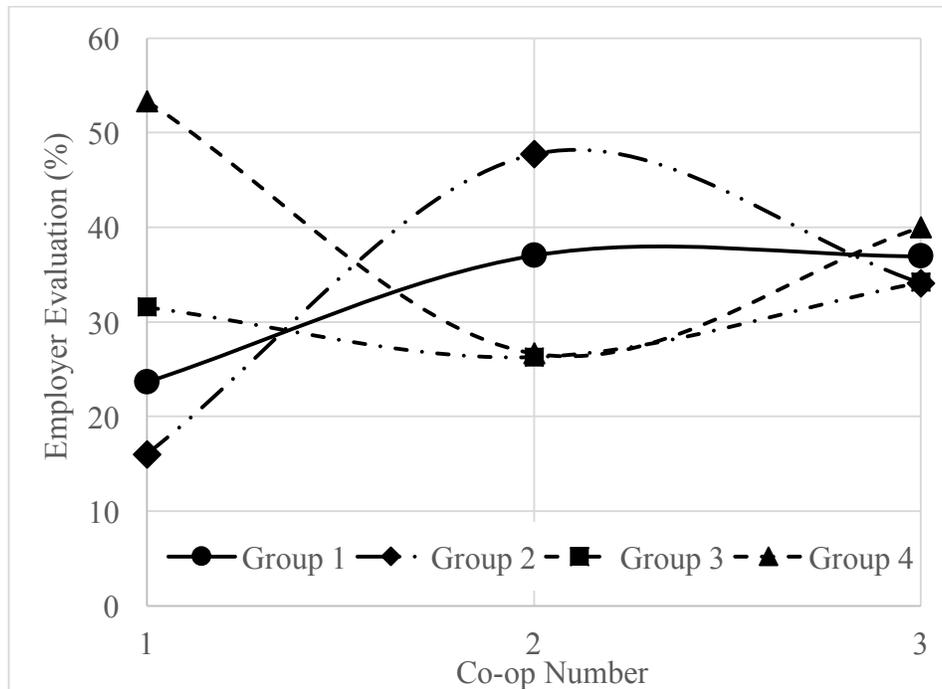


Figure 4. “Good” Employee Evaluation versus Co-op Number

Similar to Figure 3, the employer’s evaluation in the first co-op is based more on interpersonal relations, willingness to learn, and enthusiasm rather than critical thinking, technical ability or problem solving skills. The students in Group 4 are competent in “hands on” work but less comfortable with interpersonal relations. This may be related to their self-motivation and independent thinking skills and therefore they may not possess the same social skills or interpersonal relations as Group 1; as they have yet to experience a “need” to develop these skills. Once they have experience in the co-op environment, they understand the need for these skills and work to improve them. The more reserved tendencies of Group 4 students lead to “good” rather than “excellent” evaluations in the first co-op; yet, their technical proficiency and academic acuity are evident, which can be well documented by their grades.

One hundred percent (100%) of the students in Group 4 received an “excellent” or “good” evaluation in each of the three co-ops. Ninety-seven percent (97.0%) of the students in Group 3 received an “excellent” or “good” employer evaluation in each of the three co-ops. Only 75.0% of students in Group 2 received “excellent” or “good” evaluations in co-op 1 but over 97.0% received an “excellent” or “good” evaluation in the successive two co-ops. In Group 1, 93.4% of the students received an “excellent” or “good” evaluation in their first co-op. This number steadily increased to over 97.8% in co-op 3.

The improvement between co-op 1 and co-op 3 can be linked to their timing within the academic curriculum and the maturity of the student. Co-op 1 occurs during the summer between the student’s sophomore and junior year (or after their 4th semester) and stresses introductory engineering concepts. At this point in their curriculum, the student has completed a limited number of engineering courses, including statics/mechanics, auxiliary machinery I and II, machine tool technology, and commercial boilers. Co-op 2 occurs between the student’s junior and senior year (or after their 6th semester) and puts more emphasis on technical knowledge as the student has completed additional courses and associated

labs including strength of materials, electronics, electrical machines, thermodynamics, refrigeration, and municipal wastewater.

Massachusetts Maritime Academy Career Services Department conducts a Career Fair in the fall semester every year. During the Career Fair, the seniors have an opportunity to express interest in and even interview with a number of companies from both the private and the public sector. These students are then able to take that confidence with them into their final co-op which occurs during the break between the student's fall and winter term (or after their 7th semester). At this point, the student has matured and is almost ready to enter the workforce. The additional courses completed include: operational controls, fluid mechanics, and electrical power distribution.

Surprisingly, the percentage of "excellent" and "good" co-op evaluations seemed to converge for all 4 groups. The excellent evaluations for the first and second co-ops had a much greater range than the third one. This is the same behavior seen with the "good" evaluations where the spread of the first two co-ops is much greater than the final co-op.

Conclusion

Considering the co-ops as small scale real life engineering career experiences, it can be inferred that relying solely on GPA (or theoretical knowledge) as a hiring criteria may be biased for the purpose of engineering career (Based on employer's preferences reflected in the evaluation).

It has been found that the highest GPAs do not necessarily correlate to exceptional work performance during a co-op. Also a low GPA does not correlate with poor work performance. Regarding co-op grade improvement over three co-ops, Group 2 showed the greatest rate of improvement followed by Group 1 and Group 4. The lowest improvement was related to Group 3.

Acknowledgement

The authors would like to thank the Massachusetts Maritime Academy's Vice President of Academic Affairs, Director of Institutional Effectiveness and the Department of Career and Professional Services for their support of this research.

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