Cooperative Education in an Industrial Engineering Program

Nadjib Brahimi*, Fikri Dweiri, Imad Al-Syouf, Sharafuddin A. Khan

Department of Industrial Engineering and Management
University of Sharjah, United Arab Emirates

Abstract

The purpose of this paper is to describe the experience and lessons learned from implementing the cooperative education option in the department of Industrial Engineering and Management at the University of Sharjah, UAE. The objectives are to analyze the impact of the cooperative training on the performance of the students and study the role of the co-op training in enhancing the achievement of student learning outcomes. The study confirms earlier results from prior studies which show, for example, that students who choose the co-op option have higher cumulative grade point average and show better achievement of program outcomes.

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1. Introduction

Cooperative education combines classroom instructions with work experience in corporations. Its main objective is to provide an environment for applied problem solving to allow students apply their classroom knowledge. It seems that the first cooperative education program was founded in 1906 by Herman Schneider, Dean of the College of Engineering at the University of Cincinnati [1]. Since then, many institutions have adopted the cooperative option in engineering education. Nowadays, to ensure quality in cooperative engineering programs, the Accreditation Board for Engineering and Technology (ABET) has developed standards in this regard.

Burnet and Greisch [1] list the introduction of cooperative education programs as one the most outstanding engineering education and engineering technology achievements of the 20th century. Cooperative education presents benefits for the students, for the corporations receiving students as trainees, and for the educational

* Corresponding author. Tel: +97165053979; Fax +97165053963
Email Address: nbrahimi@sharjah.ac.ae;
program. It was shown in many studies that students who choose a cooperative education have higher Grade Point Average (GPA) [2], higher starting salaries (See, for example, Rodgers and Weston, 1987)[3]. Schuurman et al. [4] also showed that students who choose cooperative education are more likely to be hired prior to their graduation. This likelihood increases from 51% for students which one work experience to 59% for those who had two work experiences. It increases up to 78% with students who had 4 or 5 work experiences. A study made by Friel [5] showed that the benefits of cooperative education for the employers include prerecruiting, technical support, and low cost engineering help, among others. Cooperative education can also help meeting educational objectives. Parsons et al. [6] tried to show the role of student professional experience in meeting those ABET criteria which are more related to non-technical engineering skills.

Schuurman et al. [4] showed that the cooperative education experience equally affects different majors, including industrial engineering. Their study included also the effect of cooperative education on student gender and concluded that male and female students are equally affected. Though some previous studies (Gardner et al. 1992, for example) [2] speculated that female engineers might have benefited more from work experiences than males to counter the problem of not taking females seriously.

Despite all the benefits of cooperative education, some corporations face problems with the trainees as shown in the study by Friel [5]. Some of these major problems include cultural and technology barriers.

The process of developing a cooperative program differs from one institution to another. It depends on many factors such as the general educational policy of the country, cultural issues, and the economic environment. Linn et al. [7] provided some general tools and guidelines to help in the development of a successful cooperative program.

Due to the success of the cooperative education experience of the Industrial Engineering and Management (IEM) program at the University of Sharjah, the authors of the paper would like to share their experience. Therefore, the purpose of this paper is to describe the experience and lessons learned from implementing the cooperative training at the Industrial Engineering and Management program at the University of Sharjah. The objectives are to analyze the impact of the co-op training on the performance of the students and to study the role of the co-op training in enhancing meeting ABET criteria.

The IEM program started at the University of Sharjah in 2007 in the Fall semester with less than twenty students mostly transferring from other majors. The program proposes two options: an option with co-op experience of one semester and a second option with senior design projects (SDP). The co-op course is given seven credit hours and students choosing this option are exempted from senior design projects (four credit hours) and one elective course (three credit hours). In both options, the students are supposed to take a summer training of about eight weeks in their third year. In 2007, industrial engineering major was very new in the United Arab Emirates in particular and in the Gulf region in general. It was also very rare to find programs with co-op option. The introduction of such a course in this context was very challenging from a cultural and academic point of view. Since the students do not have the habit to work before graduating. Even the summer training was introduced few years after the establishment of the College of Engineering with no credit hours and it was not given a lot of importance in many cases by students and faculty.

The remainder of the paper is organized as follows. Section II presents the methodology used in this study. Section III gives an overview of the co-op at the IEM department. Section IV discusses the main results obtained from implementing the co-op training at the IEM department. Finally, the conclusions are presented in Section V.

2. Methodology

A literature review was conducted on previous studies about cooperative education and related topics such as training, accreditation, and student learning outcomes. Data related to both students who selected the co-op option and the senior design project option at the IEM department were collected from the department records
and analyzed. Several descriptive statistical tools were used to present the data; based on which an analysis was carried out.

3. **Overview of co-op in IEM department**

The "Cooperative Training Program" is a joint effort between the Department of Industrial Engineering and Management and the public and private sectors in the area of specialization to allow students to practice the skills and knowledge they have learned. Cooperative (co-op) training gives the students the opportunity to explore their future career and helps them in establishing an important connection between theory and application, academic environment and real-world practice. The students improve their communication, ability to work on teams, critical thinking, and decision making skills. Moreover, they learn about the ethics and disciplines at the work place.

The objectives of the Co-op course are stated as:

- Introduce students to the industrial environment and give them a glimpse on what their expecting career looks like.
- Develop the student ability to formulate and solve real life Industrial Engineering Problems.
- Enhance student skills as teamwork, organization skills, ethics, and critical analysis.
- Build up the relation between the department and the various industrial fields as well as knowing the needs and expectations of these fields for graduating students.
- Improve job opportunities for students after graduation.

The co-op training course represents a great method for students to achieve the program outcomes due to its many objectives and course outcomes. The course outcomes and their relation to IEM program outcome (based on ABET student outcomes a-k) are listed below. For each outcome, the related a-k outcomes are shown between parentheses.

- Ability to apply learned academic knowledge and skills in the work environment (a, k).
- Ability to identify and formulate engineering problems (e).
- Ability to function on a multi-disciplinary team (d).
- Ability to communicate orally and in writing (g).
- Ability to successfully complete industrial tasks and contribute to the company (k).
- Ability to gain and develop employability skills (f, h, k).
- Ability to embrace new learning opportunities and challenges (i).
- Ability to use critical/creative thinking in decision making and problem solving (a, e).
- Ability to develop personal management skills related to time, organization, and stress (a, k).
- Ability to analyze engineering problems and suggest solutions (a, c).
- Ability to develop criteria to evaluate suggested solutions, and select the preferred one (h, k).

Below is the list of IEM program outcomes (based on ABET criteria a-k):

Upon successful completion of the Bachelor of Science program in IEM, graduates will have:

- An ability to apply knowledge of mathematics, science, and engineering.
- An ability to design and conduct experiments, as well as to analyze and interpret data.
- An ability to design and improve integrated systems of people, materials, information, facilities, and technology.
- An ability to function as a member of a multi-disciplinary team.
- An ability to identify, formulate, and solve Industrial Engineering & Management problems.
- An understanding to professional and ethical responsibility of engineering needs.
- An ability to communicate effectively.
Co-op training course is divided into three main elements, starting with the student, department and finally the organization where the students are performing their training. Each one of these elements carries specific roles and responsibilities making them unique in relation to other elements which help in getting the most outcomes out of the co-op program, see Figure 1.

2. Results and Discussion

The collected data about the senior and graduated students from the IEM program are analyzed and presented in this section. There were 292 students enrolled Industrial Engineering and Management program during the
2011/2012 academic year. There are 108 (8% male and 29% female) local and 184 (43% male and 20% female) non-local students. They are distributed almost equally between genders (52% male and 48% female) students.

Until May 2012, there were 62 students who finished either the senior design project (SDP) or the co-op in industry option. A total of 38 (61.3%) students chose the SDP option while only 24 (39.7%) students chose the co-op option.

The gender distribution of either choice of the SDP or co-op option is presented in the next figure. Figure 2 shows that 7 male (11.3%) and 17 female (27.4%) students choose the co-op option while 22 male (35.5%) and 16 female (25.8%) students choose the SDP option.

To show the academic achievements of students who choose either the co-op or the SDP option, the students’ cumulative grade point average (CGPA) out of 4.0 are analyzed and the result is shown in the next figure. Figure 3 shows the senior design project and co-op option students’ cumulative grade point average out of 4.0 (CGPA). The figure is clearly shows that the average CGPA for male students (3.16) who took the co-op students is higher than the rest of the students.

To find who is interested most in the co-op option or the SDP option, we analyzed the gender and nationality of the students choosing the co-op option and who choose the SDP option. Figure 4 shows the nationality and gender distribution of the co-op and SDP students. The percentages of local female, local male, non-local female, and non-local male students who chose the co-op option are 58%, 8%, 21%, and 13%; respectively are shown in the figure. It is clear that most of the students who choose the co-op option (58%) are local female students. For the SDP option, the percentages of local female, local male, non-local female, and non-local male students who choose the SDP option are 32%, 5%, 11%, and 53%; respectively are shown in the figure. It is clear that most of the students who choose the SDP option (53%) are non-local male students.
Fig. 3: CGPA of SDP & Co-op Students

Fig. 4: Nationality & Gender Distribution of Co-op and SDP students Students
To analyze which gender scores higher in the co-op option, the average score in the course of the co-op is presented in Figure 5. The figure shows that the female students’ average GPA (3.5) in the co-op option is higher than the male students GPA (3.42). Please notice from Figure 5 that the CGPA of male students is (3.16) which is higher than the female students’ CGPA (2.87). The same analysis is performed on the students choosing the SDP option. The result is also shown in Figure 5. The figure shows that both female and male students scored the same average GPA (3.27 and 3.28 for male and female students; respectively). Figure 6 also shows that the average GPA in the co-op course is higher than the average GPA the SDP courses regardless of their gender. In our opinion, this is partially due to fact that an industry supervisor participates in the evaluation of the student performance during the co-op experience as well as the students gained experience in communication skills.
Finally, we are interested in how well the co-op and the SDP experience helps the students in achieving the program a-k ABET students learning outcomes. Figure 6 shows the co-op and SDP options achievements of a-k ABET students learning outcomes. The figure clearly shows that the co-op option achievements are higher than the senior design project option. This is due to the extra benefits of interacting with the real industrial practice for full semester.

3. Conclusions

From the start of the IEM program, it was planned to enhance the experience for the students by giving them the option to take part in the co-op in industry. We encourage students to take the opportunity of experience of the co-op option, not only due to the fact it adds direct value to their resume but also because it helps them in achieving the internationally set standards of the ABET a-k student learning outcomes. From our short experience in the co-op education, we recommend that all engineering students take part in the co-op in industry option to enhance their communication and team work skills to easily relate the theoretical knowledge with practical applications.

The results in this study confirm some of the findings in previous studies related to cooperative education, in particular the fact that the students who choose cooperative education option have higher CGPA and show a better achievement of learning outcomes. The study also shows that the impact on male and female students is almost the same.

References