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Implementing Co-operative Education in an Industrial Engineering Program in the United Arab Emirates: Experience and Lessons Learned*

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This research presents the co-operative (co-op) education experience in an Industrial Engineering and Management program in the University of Sharjah, United Arab Emirates (UAE) and its role in achieving the students' learning outcomes. Previous researchers found that students who choose a co-operative education achieve higher Grade Point Average (GPA) and emphasized the role of a student's professional experience in meeting the non-technical engineering skills criteria of the Accreditation Board for Engineering and Technology (ABET). In this research, an effort is made to show the degree of achievement of both technical and non-technical skills expected from the program's graduates. The graduates' data are analyzed using descriptive statistics. We show the differences between the genders' choice of co-op or Senior Design Project (SDP) option as well as their Cumulative Grade Point Average (CGPA) and the achievement of ABET criteria. The results show that more than 50% of the students choose the co-op over the SDP option and this number has been increasing over the last few years. Knowing that UAE society is composed mostly of expatriates of many different nationalities, we have analyzed the choice of students based on their nationalities and found that the co-op is the favorite choice for Emirati students with an over whelming female majority (92%), while Expatriate students favored the SDP option. Our results confirm other findings in the literature in terms of CGPA and achievement of learning outcomes. For example, the CGPA was higher for students who choose the co-op (2.95 out of 4) than for the SDP students (2.70 out of 4). The students' achievement of the ABET criteria was almost 9% higher for co-op students compared with that for SDP students. Based on these results, we are recommending the implementation of co-operative education in other engineering programs in the University of Sharjah.

Keywords: co-operative education; industrial engineering; student learning outcomes

1. Introduction

Co-operative education combines classroom instructions with work experience in a corporation. Its main objective is to provide an environment for applied problem solving to allow students to apply their classroom knowledge. It seems that the first co-operative 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 co-operative option in engineering education. Nowadays, to ensure quality in co-operative engineering programs, the Accreditation Board for Engineering and Technology (ABET) has developed standards in this regard.

Burnet and Greisch [1] list the introduction of co-operative education programs as one of the most outstanding engineering education and engineering technology achievements of the 20th century. Co-operative education has benefits for the students, for the corporations receiving students as trainees, and for the educational program. It was shown in many studies that students who choose a co-operative education have higher Grade Point Average (GPA) [2] and higher starting salaries ([2–7]). Magee [8] defined a set of attributes against which he assessed 'new engineers' and found that co-op graduates grade substantially higher on many of these attributes. Schuurman *et al.* [9] also showed that students who choose co-operative education are more likely to be hired prior to their graduation. This likelihood increases from 51% for students with one work experience to 59% for those who had two work experiences. It increases up to 78% for students who had 4 or 5 work experiences. A study made by [10] showed that the benefits of co-operative education for the employers include pre-recruiting, technical support, and low cost engineering help, among others. Co-operative education can also help meeting educational objectives. Parsons *et al.* [11] tried to show the role of student professional experience in helping them to meet those ABET criteria that are more related to non-technical engineering skills.

Schuurman *et al.* [9] showed that the co-operative education experience equally affects different majors, including Industrial Engineering. Their study also included the effect of co-operative education on student gender and concluded that male and female students are equally affected. Though, some previous studies (e.g. [2]) speculated that female

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engineers might have benefited more from work experience than males, to counter the problem of females not being taken seriously.

Besides all the benefits of co-operative education, some corporations face problems with the trainees as shown in the study by [10]. The first major problem seems to be the cultural barriers related to language or to the corporation culture. Another major problem is related to technology barriers. This is related to students who were not effective because they did not have enough education or were not capable of keeping up with the technology of the company. In the Arab countries, co-operative education exists in just a few universities and research in this area is very limited if not nil. To the best of our knowledge, there are no publications about co-operative education in Arab countries that can be found in specialized international journals. Based on the classification proposed by [12] and extended in [13], most faculty members in engineering education in Arab countries can be considered to belong at most to Level 2 (Scholarly Teacher). This is due to the lack of freedom, incentives, and resources that should be given to these faculty members to do any experimentation or research work in education.

The process of developing a co-operative program and the best model to use differ from one institution to another. They depend on many factors, such as the general educational policy of the country, cultural issues and the economic environment. Some general guidelines for the process of implementing co-operative programs can be found in [14] or in [15]. Before starting the implementation of a co-operative program, it is important to understand its benefits, philosophy and impact on the employers, students and the academic institution. The implementation process should also include the choice of the structure of the program, its sequencing with the academic 'in class' work, and the preparation and development of the resources [14]. In terms of structure, the program can be optional, mandatory or selective. The latter case is similar to the optional structure; however, the students are allowed to choose the co-operative option if they meet some criteria such as a minimum CGPA. Several models of academic and work sequencing exist. Two common models are the alternating co-op and the parallel co-op. In alternating co-ops, students usually attend school for one semester and work for the second semester of the year. In the parallel model, students work for half a day and go to school for the other half. The alternating model might be better in the long term for students as this is the preferred model for employers who view co-op students as potential future workers [16].

The success of many co-operative education programs in the world has lead to the development of a whole area of scientific research on this subject. There have been a considerable number of publications in scientific journals and conferences [17,18] on co-operative education. The types of publications range from theoretical (e.g. [19]) to case studies and experiences (e.g. [20, 21]). Recent literature reviews of co-operative education include Zegwaard and Coll [22] and Sovilla and Varty [23].

The authors of the current paper started this project after the success of their cooperative education program in the Industrial Engineering and Management (IEM) department of the University of Sharjah (United Arab Emirates).The purpose of this paper is to describe the experience and lessons learned from implementing co-operative training in a specific Industrial Engineering program in a Middle East University. The objectives are: (i) to analyze the popularity of the co-op training among different categories of students, (ii) to understand its impact on the performance of the students and (iii) to study the role of the co-op training in helping the students to meet ABET criteria. In this paper, we will confirm previous results about the positive impact of co-operative education on newly graduated engineers and the alignment of this education model with the United Arab Emirates' labor nationalization program (called Emiratisation) [24].

The IEM program started in 2007 with fewer than 20 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 students basically follow the same study plan until they finish their summer training after their sixth semester (see Fig. 1). After the summer training, students choosing the Senior Design Project (SDP) option take senior design projects (four credit hours) and one extra elective course (three credit hours). Students choosing the co-op option will instead take the co-op training course, which is given seven credit hours. In both options, the students are supposed to take a summer training of about eight weeks in their third year. When the IEM program started, it was a very new subject in the United Arab Emirates and in the region in general. It was also very rare to find programs with a 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 don't have the habit of working before graduating. The summer training was introduced a 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 members. Notice that the issue of giving little importance to co-operative education by students and faculty was raised by [25]. On the other

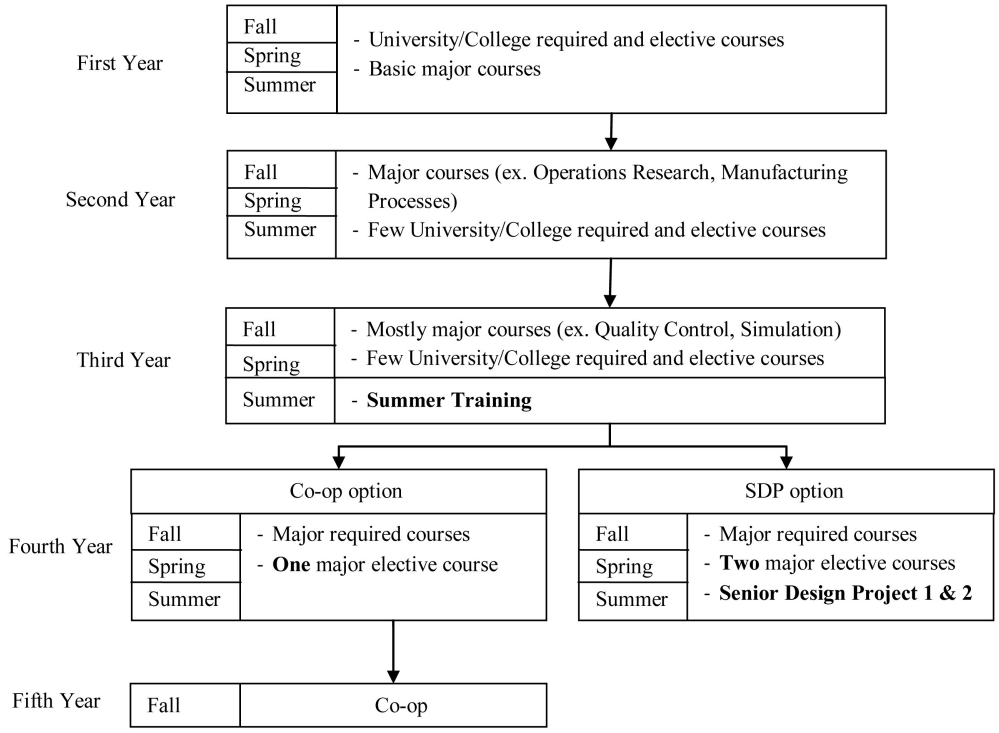

Fig. 1. General structure of the study plan of the Industrial Engineering and Management program showing the Co-operative (Co-op) and Senior Design Project (SDP) options.

hand, they show that alumni and employers consider that co-op experience and summer trainings are very important for the success of recently graduated engineers. The initial expectations of the IEM department from the students were closer to those of summer training over a longer period. Several changes were made to the course to improve its outcomes and meet the expectations of the employers and the academic program.

The remainder of the paper is organized as follows. Section 2 presents the methodology used in this study and the limitations. Section 3 gives an overview of the co-op at the IEM department. Section 4 discusses the main results obtained from implementing the co-op training at the IEM department. Finally, the conclusions are presented in Section 5.

2. Methodology

A literature review was conducted using accessible scientific databases on previous studies about cooperative education and related topics such as training, accreditation, student learning outcomes, industrial engineering and UAE. Historical data from the IEM department related to the student groups who selected the co-op option and to those who selected the Senior Design Project option were collected and analyzed. The analyzed data covered all the IEM graduates from the first batch who graduated in Spring 2009/2010 up to and including those who graduated in Fall 2012/2013. Several descriptive statistical tools were used to present the data, based on which an analysis was carried out.

The scope of this study is to investigate and reflect on the experience and lessons learned from implementing the co-operative training at a specific Industrial Engineering program in one of the UAE universities. The findings of this case study cannot necessarily be generalized to other programs and universities in other Middle East countries, since the process of developing a co-operative program differs from one institution to another, and it depends on many factors such as the general educational policy of the country, cultural issues and the economic environment.

3. Overview of internship at the IEM

IEM students may have the opportunity to participate in two internship programs: summer practical training for all students and co-op training in industry for students who choose to take the co-op option.

3.1 Summer practical training

Summer practical training is an integral part of all study programs in the College of Engineering. The

training period is 240 hours to be covered in six to eight weeks, and junior standing is required for enrollment. It is imperative that the student does the training outside the classroom, where he/she is exposed to a practical working environment wherein the knowledge and skills that he/she has acquired in the classroom may be put into practice. Normally, practical training is offered during the summer period. In some cases, however, the internship could be completed during the regular semesters. The University of Sharjah has established a Career Advising and Student Training Office (CASTO) as an integral part of the educational process. It provides comprehensive career services and assistance to students and secures training opportunities through three programs:

1. Local (in UAE): Governmental organizations and private companies.
2. Regional (Arab World): Through Arab Council for Training of Students of Arab Universities (ACTSAU).
3. International (World Wide): Through the International Association for the Exchange of Students for Technical Experience (IAESTE).

The training program at the University of Sharjah is a well-built program that is designed in a way that will challenge the trainees and enhance their skills to become professional employees, ready to assume their responsibilities after graduation.

3.2 Co-op training in industry

IEM students have an option to take co-op training in industry. The co-op training is a joint effort between the Department of Industrial Engineering and Management and the public and private sectors in an area of specialization that allows students to practice the skills and knowledge that they have learned. Co-op training gives the students the opportunity to explore their future career and helps them to establish an important connection between theory and application, academic environment and real-world practice. The students improve their skills such as the ability to work in teams, critical thinking, and decision making skills. Moreover, they learn about the ethics and disciplines in the work place. In the co-op training students will spend one semester in a carefully selected organization where they receive practical training and engage in meaningful engineering projects, applying their knowledge to solving real-world problems. The co-op students are encouraged to pursue their co-op training in the same organization that was used for the summer training, if possible. Co-op students are required to submit a final report that consists of two main parts: one is on the student's general activities and the skills acquired and developed during co-op, and the other part is on a capstone design project that includes the major design and implementation phases. The student is also expected to give a public presentation on the project and the activities he/she participated in during their co-op practice. Both co-op and summer training are unpaid, though a few organizations give some incentives to the trainees. It is important to mention that unpaid training may raise different legal issues, which have not been considered yet in the University of Sharjah. This issue was the subject of some research in the United States, a review of which is presented by Svacina [26].

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

1. To introduce students to the industrial environment and give them a glimpse on what their expecting career looks like.
2. To develop the student ability to formulate and solve real life industrial engineering problems.
3. To enhance student skills such as teamwork, organization skills, ethics and critical analysis.
4. To build up the relationship between the department and the various industrial fields as well as knowing the needs and expectations of these fields for graduating students.
5. To 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

Table 1. Mapping of the co-op course outcomes to the ABET students' outcomes

	Course outcomes	Link to student's outcome
1	Ability to apply learned academic knowledge and skills in the work environment.	*a, k*
2	Ability to identify and formulate engineering problems.	*e*
3	Ability to function on a multi-disciplinary team.	*d*
4	Ability to communicate orally and in writing.	*g*
5	Ability to successfully complete industrial tasks and contribute to the company.	*k*
6	Ability to gain and develop employability skills.	*f, h, k*
7	Ability to embrace new learning opportunities and challenges.	*i*
8	Ability to use critical/creative thinking in decision making and problem solving.	*a, e*
9	Ability to develop personal management skills related to time, organization, and stress.	*a, k*
10	Ability to analyse engineering problems and suggest solutions.	*a, c*
11	Ability to develop criteria to evaluate suggested solutions, and select the preferred one.	*h, k*

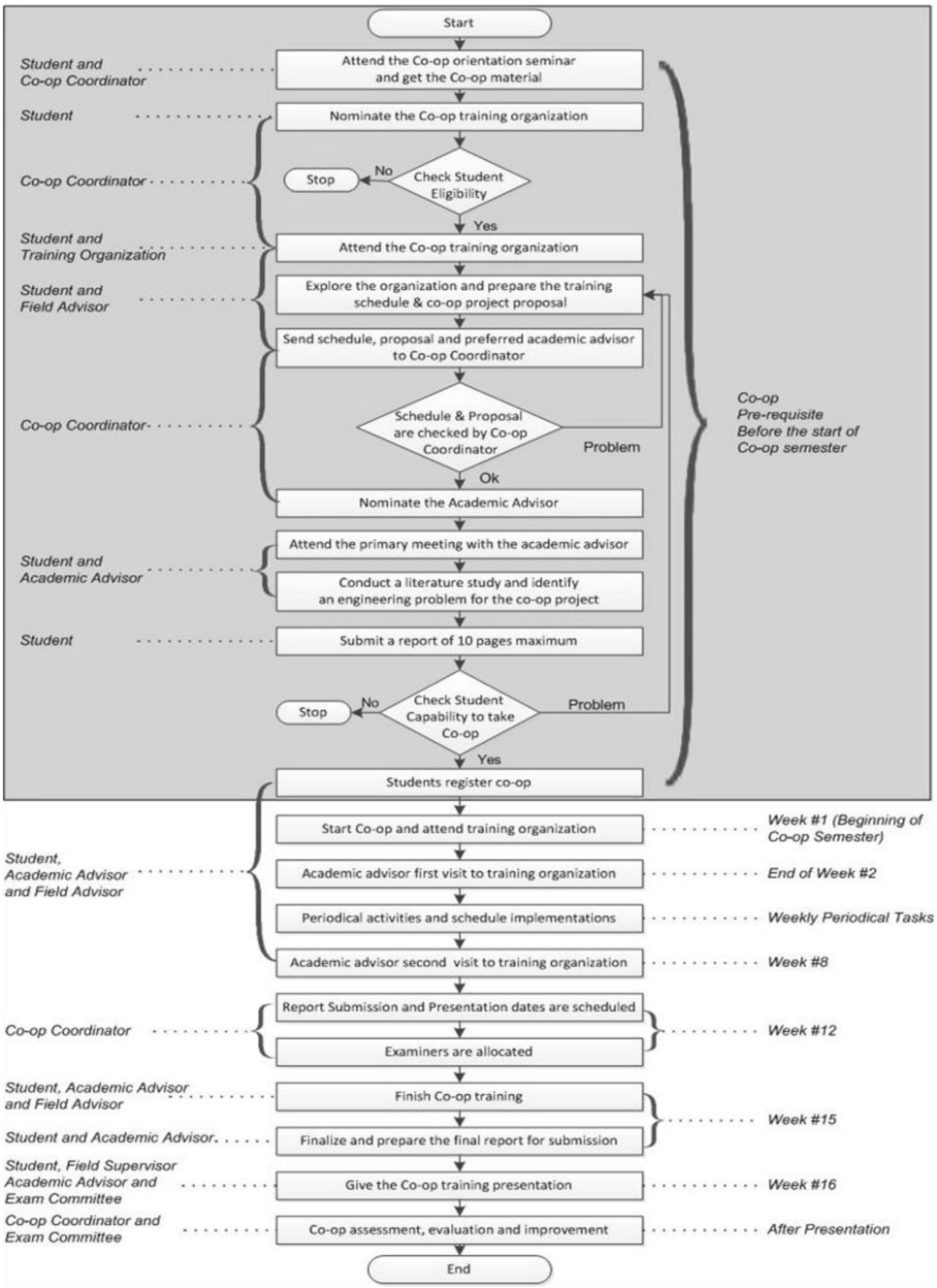

Fig. 2. Flowchart of the co-op training course at IEM.

outcome (based on ABET student outcomes *a–k*) are illustrated in Table 1. A list of program outcomes is presented in the Appendix at the end of the paper.

The co-op training course is divided into three main elements, starting with the student, department and finally the organization where the students are doing their training. Each one of these elements carries specific roles and responsibilities, making them unique in relation to other elements, which helps to get the most outcomes out of the co-op program, see Fig. 2.

4. Results and discussion

The data collected about the senior and graduated students from the IEM program are analyzed and presented in this section. The demographic distribution of the enrolled students in the Industrial Engineering and Management program is presented first in Fig. 3. There were 323 students enrolled during the 2012/2013 academic year of whom 41% were Emiratis (11% male and 30% female) and 59% were Expatriate students (40% male and 19% female). The enrollment was distributed almost

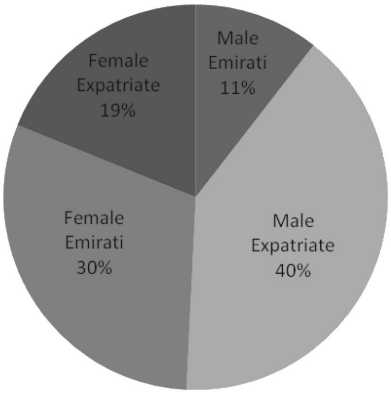

Fig. 3. Distribution of enrolled Students in IEM department, based on nationality and gender.

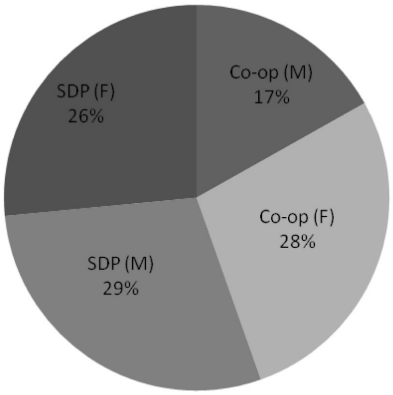

Fig. 4. Gender distribution of students over Senior Design Project (SDP) and Co-op options (F: Female, M: Male).

equally between genders (51% male and 49% female) students.

These percentages are very different from the distribution of the population in the United Arab Emirates. The population in the UAE has a very particular structure as the nationals (Emiratis) constitute only 13% of the total population [27]. The difference is because most of the Expatriates in the UAE are laborers who cannot bring their children to study in the UAE.

Until December 2012, there were 83 students who finished either the Senior Design Project (SDP) or the co-op in industry option. The percentage of students who took the SDP option was 55% (46 students) against 45% (37 students) for the co-op option. Given that the students choosing the co-op option need at least nine semesters to graduate, having 45% of students choosing this option can be considered as a great success. Notice that this percentage has been increasing over the last few years. For example, it was only 40% in the spring semester of the 2011/2012 academic year [28]. This increase can be attributed to two main factors. The first factor is the active participation of the program alumni students in promoting the IEM program and hence encouraging students to apply for training in their companies. The second factor might be that the students notice the high impact on hiring opportunities for past students who have chosen the co-op option.

The gender distribution of either choice of the SDP or co-op option is presented in Fig. 4. There were 14 male students (17%) and 23 female students (28%) who chose the co-op option, while 24 male students (29%) and 22 female students (27%) chose the SDP option.

Though Schuurman *et al.* [9] showed that male and female students benefit equally from the co-operative education experience, we believe that it will be interesting to conduct their study on the United Arab Emirates society to check if this is still valid. We refer here to those studies that speculated that female engineers might have benefited more from work experiences than males to counter the problem of females not being taken seriously (e.g. [2]).

To show the academic achievements of students who choose either the co-op or the SDP option, the students' Cumulative Grade Point Average out of 4.0 (CGPA) was analyzed and the results are shown on Fig. 5. The figure shows that the average CGPA for students with the co-op option (2.95) is higher

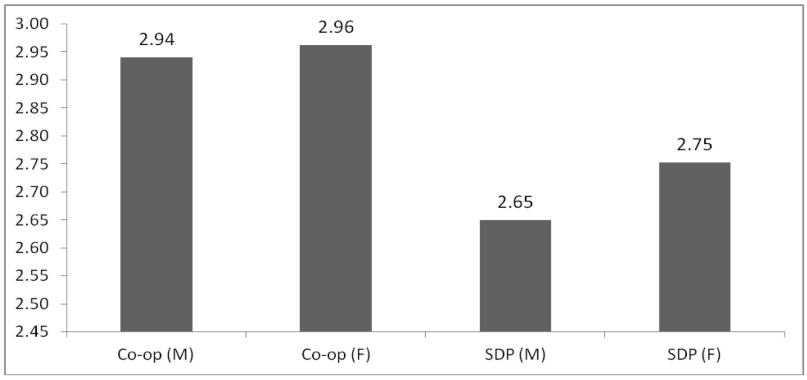

Fig. 5. CGPA of SDP and Co-op students (F: Female, M: Male).

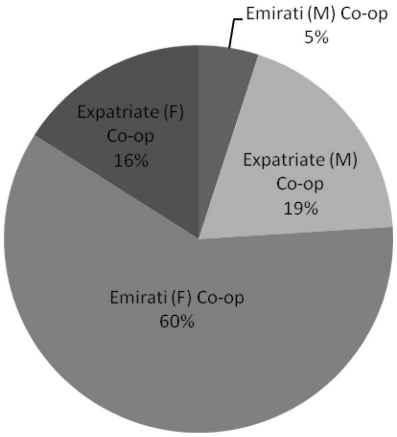

Fig. 6. Nationality and gender distribution of Co-op students (F: Female, M: Male).

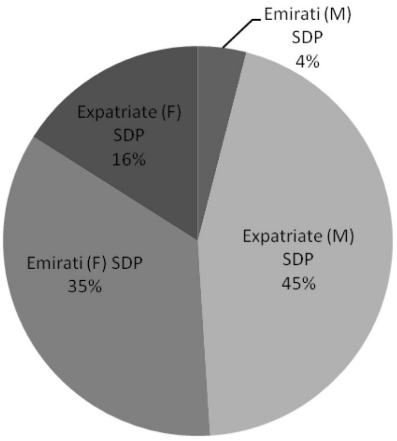

Fig. 7. Nationality and gender distribution of SDP Students (F: Female, M: Male).

than the CGPA of SDP students (2.70). There is almost no difference between the CGPA of male and female students, but female students generally have slightly better scores than male students in most of the courses in the Industrial Engineering and Management program.

The results show that most of the students who choose the co-op option are Emirati students. This is presented on Fig. 6, which shows the nationality and gender distribution of the co-op students. More than half the population of students who took the co-op were Emirati female students (60%), followed by Expatriate male students (19%). This is because of the job opportunities offered to these two categories of student. Female students have less chance than male students of finding a job and most companies in the United Arab Emirates (UAE) prefer to hire Emirati students as part of the implementation of the Emiratisation program of the country, which consists of prioritizing the employment of UAE citizens in the private and public sectors. The percentage of Expatriate female students is low because they are very few in the program in general, as was shown in Fig. 3.

Figure 7 shows the nationality and gender distribution of the SDP students. The percentages of Emirati female, Emirati male, Expatriate female, and Expatriate male students who choose the SDP option are 35%, 4%, 16% and 45%, respectively, ase shown in the figure. It is clear that most of the students who choose the SDP option (45%) are Expatriate male students. This is mostly because this category of students is still facing difficulties in being accepted for co-op in companies. We believe that this situation will improve in the future as the alumni students will make it easier for future students to find a co-op place.

To analyze which gender scores higher in the co-op option, the average score in the course of the co-op is presented in Fig. 8. The figure shows that the female students' average GPA (3.61) in the co-op option is higher than the male students GPA (3.57). Notice that in Fig. 5 the CGPA of male students (2.94) is almost the same as that for female students (2.96). The same analysis is performed on the students choosing the SDP option. The result is shown in Fig. 8. The figure shows that both female

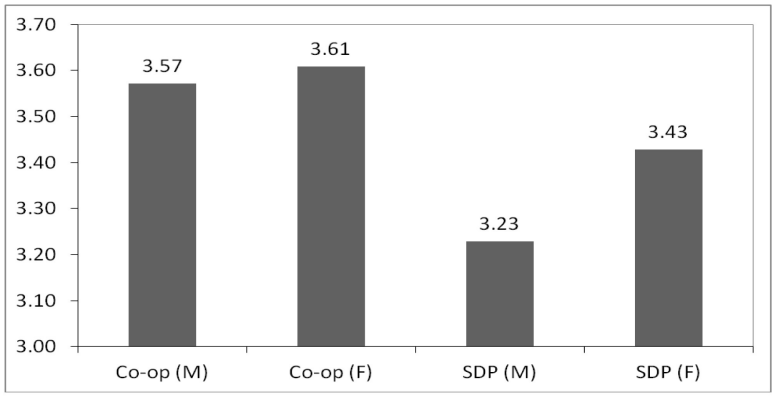

Fig. 8. Average grades for Co-op and SDP (F: Female, M: Male).

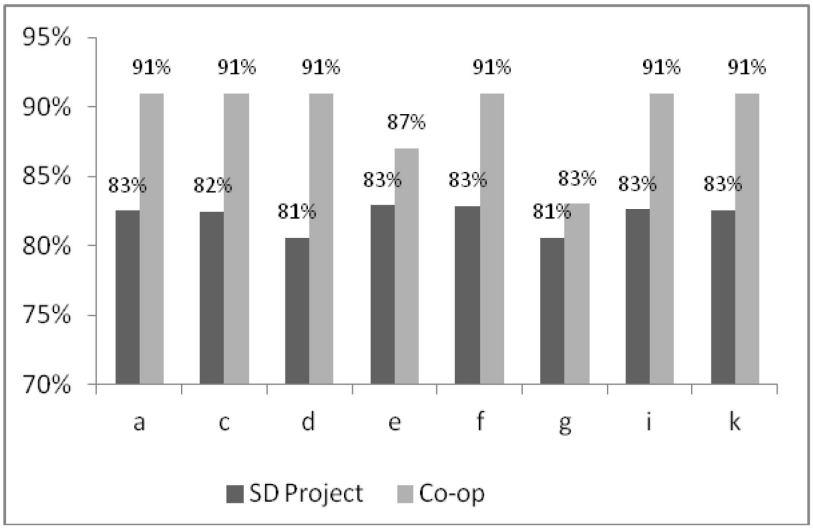

Fig. 9. ABET *a–k* criteria achievement for SDP and Co-op.

and male students scored almost the same average GPA (3.23 and 3.43 for male and female students, respectively). Figure 8 also shows that the average GPA in the co-op course is higher than the average GPA in the SDP courses, regardless of the student's gender. In our opinion, this is partially because an industry supervisor participates in the evaluation of the student performance during the co-op experience, as well as the students gaining experience in communication skills.

Finally, we were interested in how well the co-op and the SDP experience helps the students in achieving the program *a–k* ABET students learning outcomes (see Appendix). Figure 9 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 real industrial practice for one full semester.

5. Conclusion

This paper described the experience and lessons learned from implementing co-operative training at a specific Industrial Engineering and Management program in the United Arab Emirates. The paper presented this experience in a special context in a region where cooperative education is not common.

Despite the cultural constraints faced by the faculty members in implementing the co-operative program when it started in 2007, the popularity of the program's co-op option has been continuously increasing since then. The success of the co-op option is more important with the female Emirati students than with male atudents, and especially Expatriate students. It seems from these results and from our observations that the female students are benefitting more from the co-op than the male students. A more in-depth research is to be carried out in order to confirm this suggestion as it contradicts what has been recently found in the literature. The authors believe that culture plays an important role in this regard. It is also important to do research on the impact of the Emiratisation program on the choices of students.

Higher ABET criteria achievements by co-op students were mostly due to the added non-technical skills acquired by the co-op students. The co-op students also scored higher CGPA than the Senior Design Project students, which confirms the results of previous studies in this area. Based on these results, the authors are recommending other engineering departments in the University of Sharjah to introduce co-operative education in their programs.

The authors are planning to continue collecting data about and from program graduates and their employers in order to do more studies on the impact of co-operative education on them. It will be interesting, for example, to analyze the impact on starting salaries and the likelihood of being hired before graduation.

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Appendix

IEM program outcomes (based on ABET criteria a–k)

Upon successful completion of the Bachelor of Science program in Industrial Engineering (IE), graduates will have:

a. An ability to apply knowledge of mathematics, science and engineering.
b. An ability to design and conduct experiments, as well as to analyze and interpret data.
c. An ability to design and improve integrated systems of people, materials, information, facilities and technology.
d. An ability to function as a member of a multi-disciplinary team.
e. An ability to identify, formulate and solve Industrial Engineering problems.
f. An understanding of the professional and ethical responsibility of engineering needs.
g. An ability to communicate effectively.
h. An understanding of the impact of engineering solutions in a global and societal context.
i. An ability to engage in life-long learning.
j. Knowledge of contemporary issues in Industrial Engineering.
k. An ability to use the techniques, skills and modern tools of Industrial Engineering.

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