

AC 2010-1524: LEARNING OUTCOMES ACHIEVEMENT IN COOPERATIVE EDUCATION: A SURVEY OF ENGINEERING STUDENTS

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Dr. Johrendt obtained her doctorate in Mechanical Engineering in 2005 from the University of Windsor after working for almost ten years as a Product Development Engineer in the automotive industry. Currently an Assistant Professor of Mechanical and Automotive Engineering at the University of Windsor, she previously worked for two years as an Experiential Learning Specialist in the department. She serves as both the Faculty and Departmental Cooperative Education representative. She has co-authored several journal paper publications and conference presentations that have featured experiential learning and engineering education topics as well as her engineering research in vehicle structural durability and the use of neural networks to model non-linear material behaviour.

Schantal Hector, University of Windsor

Ms. Hector is currently pursuing her Bachelor's Degree in International Relations and Economics at the University of Windsor. She is a Research Assistant at the Centre for Career Education and has applied her knowledge and skills as part of the project to develop learning outcomes for the cooperative education program over the past two years. She has been instrumental in the collection and statistical analysis of the learning outcomes data using Excel and SPSS methods and its presentation into a comprehensible graphic format. Other endeavours have included aiding in the development of an online course for co-op students at the University of Windsor and engaging in research that seeks to enhance the employment options for graduates. Her research interest continues to be to help enrich and enhance the co-op experience for other students.

Derek Northwood, University of Windsor

Professor Northwood has over thirty years experience in the field of Engineering Education at the University level. He occupies the posts of Research Leadership Chair and Professor of Engineering Materials. He is President of the World Institute for Engineering and Technology Education - International Academic Advisory Committee (WIETE-IAAC): see www.wiete.com.au for details. He has been instrumental in research aimed at transitioning the University into a learning centered institution as well as research focusing on Materials Sciences/Engineering and Engineering education. He is also an author and co-author of over 270 papers in international refereed journals and over 230 papers in international refereed conference proceedings.

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Ms. Benzinger holds Bachelor of Commerce and Master of Education Degrees. She has implemented student and learning support services for twenty years and has served as the University's Director of the Centre for Career Education for the past eight years. She co-chairs a University-level Cooperative Education Committee aimed at improving and expanding cooperative education at the University. She has initiated a project to identify, support and assess learning outcomes for cooperative education and is part of a group geared at developing a model of assessment for University Career Centres that incorporates learning outcomes.

Geri Salinitri, University of Windsor

Dr. Salinitri has taught several Guidance and Career Education courses involving cooperative education, learning strategies and outcomes and assessment, and has developed the mentor/mentee satisfaction and assessment instruments. For over thirty years, she has been mentoring students and is currently involved in a mentor training program for teachers and student leaders. She is also a member of the Learning-Centred Task Force for the University. She has organized several professional presentations, published work in the area of mentoring,

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Arunita Jaekel, University of Windsor

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Michelle Watters, University of Windsor

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Learning Outcomes Achievement in Cooperative Education: A Survey of Engineering Students

Abstract

In 2007, the University of Windsor established formal learning outcomes for their cooperative education program and implemented new educational strategies to support the achievement of those outcomes. To gauge the effect of the newly implemented activities on the achievement of the learning outcomes, a survey was developed and administered to students and alumni of the unrevised program (control group) and, more recently in 2009, to students participating in the revised program (experimental group). The survey questions were designed to assess respondents' perceptions of the effect that co-op had on: their academic and career-related goals and motivation; identification of personal strengths, weaknesses and preferences; understanding of academic theory and technical knowledge; development of attributes; and the ability to effectively contribute in the workplace through identified soft and transferable industry-related skills.

Students participating in co-op at the University of Windsor may complete regular or extended length work terms. Regular work terms are generally four-months in length, while extended work terms are at least eight months long, although many companies request co-op students for twelve to sixteen month periods. The survey demographics included a question about work term duration, so that the effects of work term length on learning outcomes achievement might also be examined. Although the survey revealed some positive trends related to learning outcomes achievement for control versus experimental groups, they were not at statistically significant levels. However, if the analysis was limited to students who had completed extended work terms, three areas showed changes at statistically significant levels. Decreases in positive response levels were seen for the experimental group with respect to students' abilities to identify personal weaknesses related to their academic options and personal preferences related to workplace options. An increase in positive response level was found with regard to their understanding of theories taught in the classroom.

Introduction

As noted by Haddara and Skanes¹, the first American cooperative education program was in engineering and started in 1906 at the University of Cincinnati with an enrolment of 27 students. It is believed that this program was in part inspired by the sandwich programs which may have existed in the UK since 1840². The first cooperative education program in Canada started in 1957 at what was to be known as the University of Waterloo. It had an enrolment of 75 students and was also in engineering.¹ The programs at Cincinnati and Waterloo expanded very quickly and proved to be very successful. Cooperative engineering programs were implemented at other institutions and cooperative education programs in disciplines other than engineering started to appear. At the beginning of 2010, cooperative education programs exist in 80 post-secondary institutions in Canada with an enrolment of over 80,000 students.³ It is interesting to compare the experience in North America with that in Japan where cooperative education was not introduced until the 1990's and then initially at the graduate, rather than undergraduate, level.⁴

However, there was a rapid expansion of cooperative education and internships and by 2005, a total of 100,000 students participated in internships over a one year survey period.⁴

What defines, or constitutes, cooperative education? According to Hodges and Coolbear⁵, “In a nutshell, co-operative education (co-op) is any structured educational programme which combines classroom learning with productive, relevant work experience. Co-operative education is learning integrated with work.”

A similar, but more extensive, definition of cooperative education can be found in the Asia-Pacific Journal of Cooperative Education (APJCE)⁶:

Cooperative education in the journal is taken to be work-based learning in which the time spent in the workplace forms an integrated part of an academic program of study. Essentially, cooperative education is a partnership between education and work, in which enhancement of student learning is a key outcome. More specifically, cooperative education can be described as a strategy of applied learning which is a structured program, developed and supervised either by an educational institution in collaboration with an employer or industry grouping, or by an employer or industry grouping in collaboration with an educational institution. An essential feature is that relevant, productive work is conducted as an integral part of a student’s regular program, and the final assessment contains a workbased component. Cooperative education programs are commonly highly structured and possess formal (academic and employer) supervision and assessment. The work is productive, in that the student undertakes meaningful work that has economic value or definable benefit to the employer. The work should have clear linkages with, or add to, the knowledge and skill base of the academic program.

The Canadian Association for Co-operative Education (CAFCE) in its definition of cooperative education has similar criteria to APJCE but also defines a minimum period of work experience relative to the time spent in academic study and requires that the student receive remuneration for the work performed³:

"Co operative Education Program" means a program which alternates periods of academic study with periods of work experience in appropriate fields of business, industry, government, social services and the professions in accordance with the following criteria:

- (i) each work situation is developed and/or approved by the co-operative educational institution as a suitable learning situation;
- (ii) the co-operative student is engaged in productive work rather than merely observing;
- (iii) the co-operative student receives remuneration for the work performed;
- (iv) the co-operative student's progress on the job is monitored by the co-operative educational institution;
- (v) the co-operative student's performance on the job is supervised and evaluated by the student's co-operative employer;
- (vi) the time spent in periods of work experience must be at least thirty per cent of the time spent in academic study.

In all these definitions of cooperative education we can see the general theme of “learning integrated with work” and other descriptors including Work-Based Learning (WBL)⁷, Work-Integrated Learning (WIL)^{8,9}, and Industry-Based Learning (IBL)¹⁰ have been used to describe such an education. Cooperative education, together with internships, undergraduate research, design projects, cultural immersion, practicums, and service learning are considered types of experiential learning.¹¹

When looking at experiential learning it should be remembered, as stated by Dewey¹² over 70 years ago, that the fact “that all education comes about through experience does not mean that all experiences are genuinely or equally educative”. As Brockbank and McGill¹³ have pointed out, the primary purpose of higher education is to encourage conditions for learning that are transformative, and the concern in higher education is with learning that includes but goes beyond the instrumental. This is reinforced by Barnett¹⁴, when he argues: “The learning that goes on in higher education justifies the label ‘higher’ precisely because it refers to a state of mind over and above the conventional recipe or factual learning.” Walsh¹⁵ asserts that for full academic recognition to be awarded, “Experience-based workplace learning must therefore demonstrate characteristics of learning that are equivalent to those required for programmes delivered within the university.”

How can such learning characteristics be demonstrated? Professor Karen Roloff, DePaul University Professor of Communication and Director of DePaul’s communication internship program, considers “... the real value is going into an experience with learning outcomes in mind – connecting through reflection and intentionality the world of work and the world of learning”¹⁶. Walsh¹⁵ further argues that since learning which arises through experience has not usually been formally assessed, it is therefore necessary to design appropriate assessment for it to gain academic recognition. Boud and Tennant¹⁷ claim that, in order to effectively support the full academic recognition of experience-based learning in the workplace, academic colleagues need to move “from seeing themselves as persons who induct students into a disciplinary culture to one in which they accept a role as learning consultants, actively engaged in mediating work, context and academic expectation”. Walsh¹⁵ states that “such a change in perception is considerable, and could be difficult to achieve, given that experience-based learning in the workplace has been treated with ambivalence in many universities due to the dominance of the disciplinary perspective”.

What constitutes ‘best practice’ in cooperative work (industry) based learning has been the subject of much investigation, research, and discussion.¹⁸ There are pedagogical issues⁹ and practical issues such as compulsion (mandatory or optional), timing (when and for how long?), and finance (remuneration).¹⁸ A formulaic model (i.e. a definite set of best practices) has been rejected “on the basis that it is reductionist, and probably illusory, for it denies the complex political and the cultural realities that contextualize the education”.¹⁸ We are at a point where we are trying to “identify salient considerations through which best practice can legitimately be conceptualized”.¹⁸

Background to the Present Study

Recently, the Centre for Career Education at the University of Windsor has been working to develop learning outcomes along with supportive activities and assessment tools^{19, 20, 21, 22}. The revised program incorporates elements such as a student cooperative education portfolio²², senior summative assignment, and faculty and employer assessments of student work term presentations and reports. In order to gauge the subjective effectiveness of the revised program with regard to the achievement of the learning outcomes, a survey was administered to students and alumni. The survey was developed to assess student and alumni perceptions of the effect that co-op had on the following: their academic and career-related goals and motivation; identification of personal strengths, weaknesses and preferences; understanding of academic theory and technical knowledge; development of attributes; and the ability to effectively contribute in the workplace through identified complementary industry-related skills.

The outcomes being assessed in the survey fit into the four categories of outcomes defined by Hu et al.²³ for engineering work experience programs, namely: 1. Intellectual Augmentation; 2. Generic Skills and Attributes Development; 3. Career Development; 4. Academic Development. The proximal “benefits” of these outcomes are considered to affect students’ readiness for the labor market or their employability and, in the long term, provide the skills necessary to lead a successful and sustained career in engineering.²³

The survey was administered to both control and experimental groups. The control group was comprised of senior engineering students and alumni having participated in the pre-learning outcome cooperative education program. The experimental group was made up of the group of students participating in the revised program.

The survey consisted of a section of demographic questions and a section related to educational goals, whereby respondents were asked to reflect on their cooperative education experiences and perform a self-assessment. The demographics identified those students and alumni having participated in standard length work terms (less than eight months in duration) and extended length work terms (eight months or more duration).

While the survey results revealed many positive trends for engineering students participating in cooperative education, in general, statistical significance was revealed only when the analysis was limited to those students participating in extended work terms of eight months or more.

Survey Results and Discussion

The control group to whom the survey was initially administered was comprised of computer science and engineering cooperative education students and alumni having participated in the original and unrevised cooperative education program. In total, 674 surveys were sent out in 2008. The overall response rate of the survey was 35%. 83% of the total respondents were engineering students or alumni (39% were students and 44% were alumni). The remainder of the respondents consisted of computer science students and alumni, the responses of whom are not considered in the discussion that follows. Of the control group, 25% of the respondents completed at least one extended work term of eight months or more.

The experimental group to whom the survey was administered in 2009 was comprised of computer science and engineering cooperative education students having participated in the revised cooperative education program. A total of 91 surveys were sent out. The survey had an overall response rate of 34%, similar to that of the control group survey, with 87% of respondents being engineering students. Of the experimental group, 44% of the respondents indicated that they had completed at least one extended work term.

Four survey questions concerning education-related goals were answered using a five-point Likert scale, where 1 = increased greatly, 2 = increased somewhat, 3 = had no effect, 4 = decreased somewhat, and 5 = decreased greatly. The respondents' responses were consolidated to examine the results with respect to the percentage of respondents who answered in a positive fashion (grouping responses of 1: increased greatly and 2: increased somewhat) versus those who reported no effect or a decrease. The percentages of respondents reporting positively were compared for the control and experimental groups for all respondents. It should be noted that statistical significance was not present (using the Pearson Chi-Square test of statistical significance at the critical α -level of 0.05 and one degree of freedom) for the null hypothesis that assumed that there would be no significant differences between the control and experimental groups' responses, so comments are limited to trends shown in the survey results.

Question 1

To what extent did participation in the co-op program affect the following?

- a) Your academic motivation
- b) Your clarity regarding academic goals
- c) Your clarity regarding career goals
- d) Identification of personal strengths related to academic options
- e) Identification of personal weaknesses related to academic options
- f) Identification of personal preferences related to academic options
- g) Identification of personal strengths related to workplace options
- h) Identification of personal weaknesses related to workplace options
- i) Identification of personal preferences related to workplace options
- j) Your understanding of theories taught in the classroom
- k) Your technical knowledge in your field

The responses to this question for the control versus experimental groups are summarized in Figure 1.

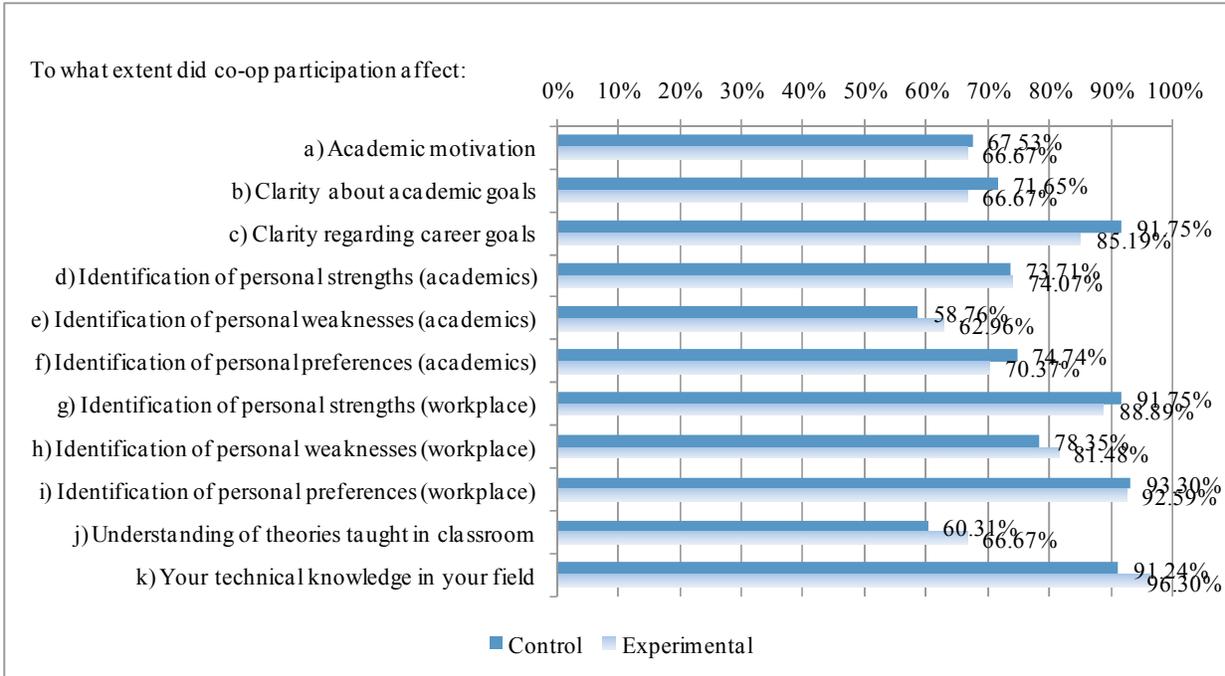


Figure 1: Control versus experimental groups, all work terms.

Note that the survey results show that a greater percentage of experimental group respondents reported a positive response for areas related to identification of personal strengths and weaknesses related to academic options, personal weaknesses related to workplace options, understanding of theories taught in the classroom, and technical knowledge in their field (items d, e, h, j, and k).

Question 2

To what extent did participation in the co-op program help develop the following attributes:

- a) Acquisition of knowledge
- b) Application of knowledge
- c) Integration of knowledge
- d) Research skills
- e) Critical thinking skills
- f) Problem-solving skills
- g) Interpersonal skills
- h) Communication skills
- i) Responsible behaviour to self, others and society
- j) Teamwork, personal and group leadership skills
- k) Creativity and aesthetic appreciation
- l) Ability and desire for continuous learning

The responses to this question for the control versus experimental groups are summarized in Figure 2.

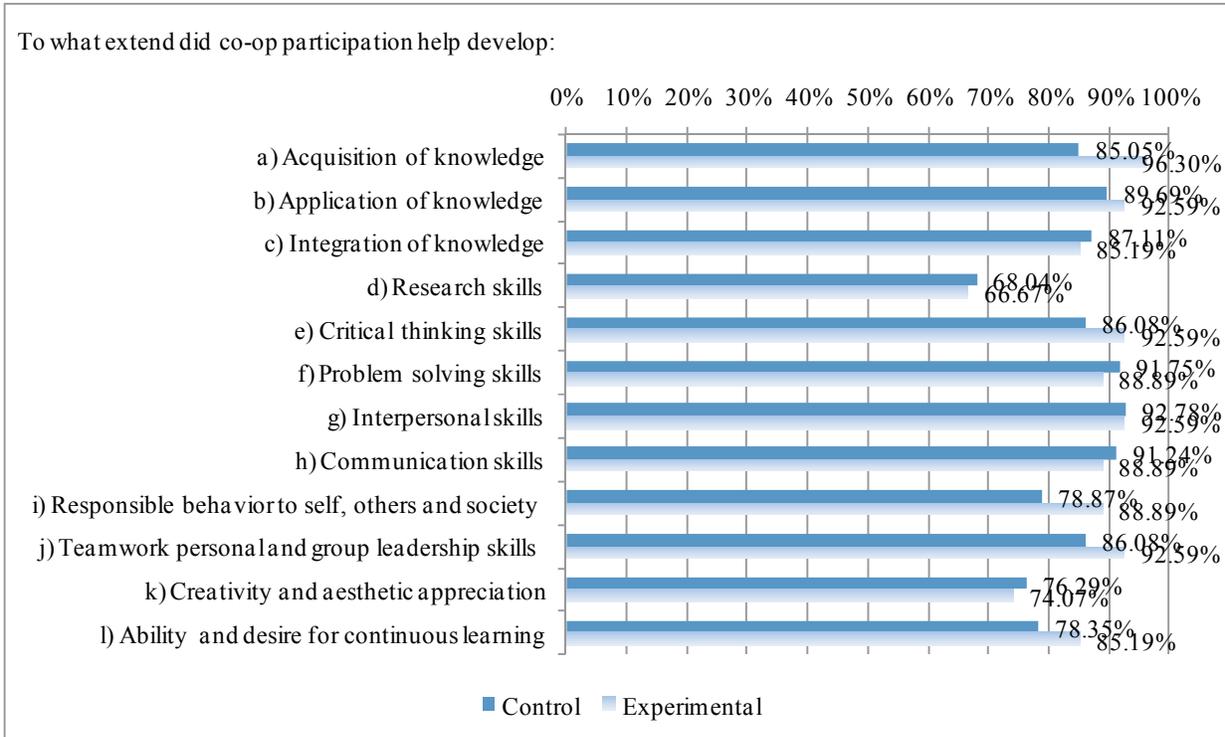


Figure 2: Control versus experimental groups, all work terms.

Note that the areas showing a trend toward increased rate of positive responses for the experimental group versus control group are: the acquisition and application of knowledge; critical thinking skills; responsible behavior to self, others and society; teamwork, personal and group leadership skills; and ability and desire for continuous learning (a, b, e, i, j, and l).

Question 3

To what extent did participation in the co-op program develop in you?

- An understanding of workplace culture
- An understanding of employee health and safety information in the workplace
- A network of contacts within your field
- The ability to make an effective contribution in the workplace

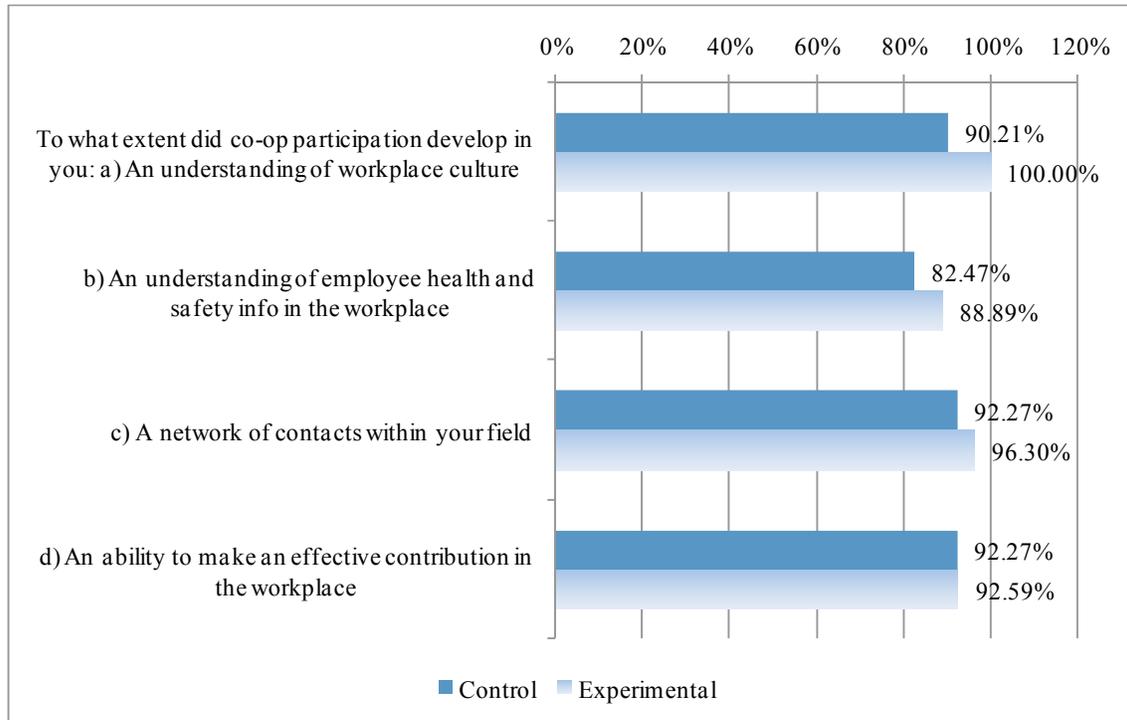


Figure 3: Control versus experimental groups, all work terms.

It is interesting to note that the responses to Question 3 showed an increased percentage of respondents reporting a positive response when comparing experimental to control groups. All (100%) respondents from the experimental group noted an increase in their understanding of workplace culture while participating in the revised program.

Question 4

To what extent did participation in the co-op program affect your employment opportunities by:

- a) Enabling you to identify, assess and develop workplace skills and personal competencies
- b) Teaching you how to write an effective resume and cover letter
- c) Teaching you how to interview effectively
- d) Assisting in the process of career planning
- e) Contributing to your post-graduation employment

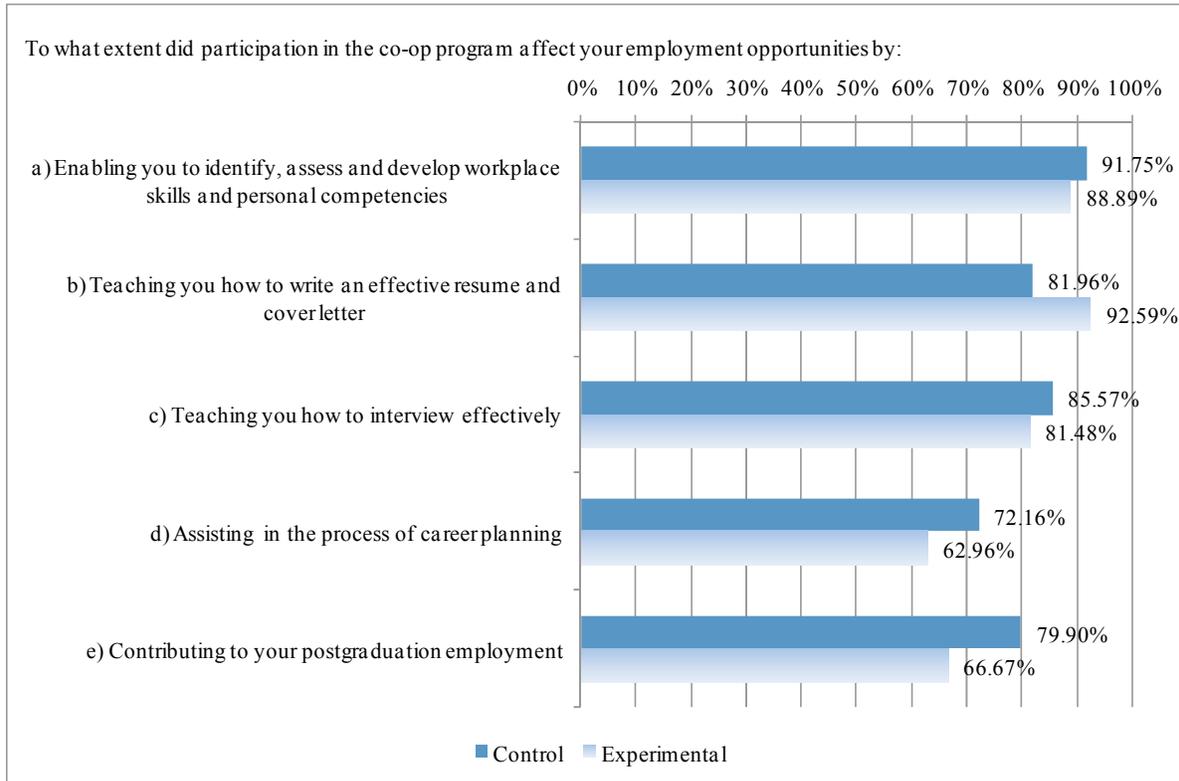


Figure 4: Control versus experimental groups, all work terms.

Note that, with the exception of effective resume and cover letter writing skills, the experimental group showed a lower percentage of respondents indicating a positive response than the control group.

The fact that statistical significance cannot be shown at the critical α -level of 0.05, is indicative that more data is necessary as more students complete the revised program. While some general trends are noted with regard to the proportion of positive responses, it can be said that at this time, marked differences in learning outcomes achievement cannot be shown as a result of the program revision. Additional students in the coming years will be surveyed to support the development and deployment of action items in response to the results.

Survey Results and Discussion: Work Term Length

Interesting results for Question 1 are found when the 5-point Likert scale response data is analyzed only for students participating in extended work terms in the control and experimental groups. Bear in mind that lower numbers (i.e. closer to 1) are deemed as more desirable in this study. The survey results of Question 1 for the control and experimental groups are shown in Figure 5.

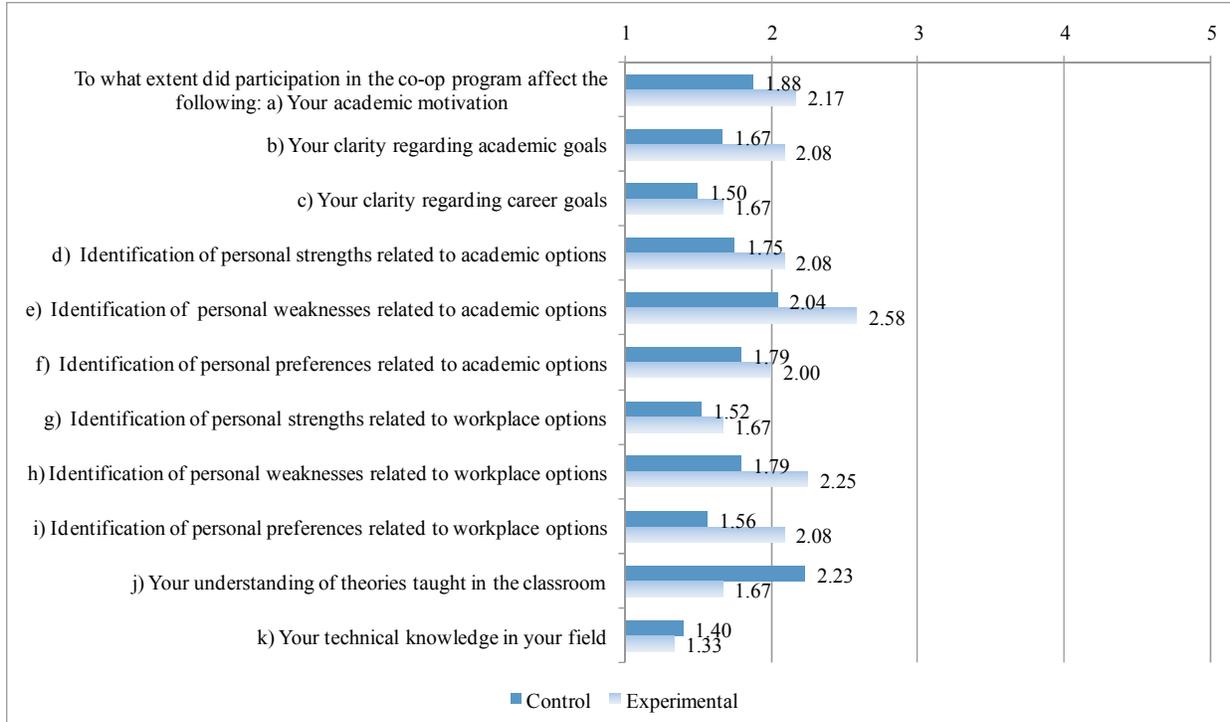


Figure 5: Question 1 responses for control versus experimental groups, extended work term respondents only.

It is important to note that all average response levels indicate positive responses on the Likert scale used for this survey, with values in the 1 – 3 range. Figure 5 shows increases in positive responses (lower average numbers) for the experimental versus the control group only for the last two categories. Statistically significant results at the critical α -level of 0.05 are revealed for items e, i, and j. Thus, for those students experiencing extended work term placements of eight months or more, the revised cooperative education program does not do a better job of assisting them to identify personal weaknesses in their academic development. The survey also shows that the revised program does not facilitate their personal preferences as they relate to workplace options, but does work to enhance their understanding of classroom-taught theory. It is reassuring that the introduction of learning outcomes has enhanced the students' understanding of theories taught in the classroom (i.e. linking theory and practice).

Another interesting result can be shown with regard to Question 3 (again, when the 5-point Likert scale response data is analyzed on the basis of work term length) concerning workplace culture, health and safety, networking contacts, and effective workplace contribution. Results are shown in Figures 6 and 7 for the extended work term respondents and the regular work term respondents, respectively. While the sample sizes are reduced for this data (extended control versus experimental: 48 vs. 12; regular control versus experimental: 146 vs. 15), administration of the survey to more students in the next few years will be necessary to acquire further data necessary to draw meaningful conclusions.

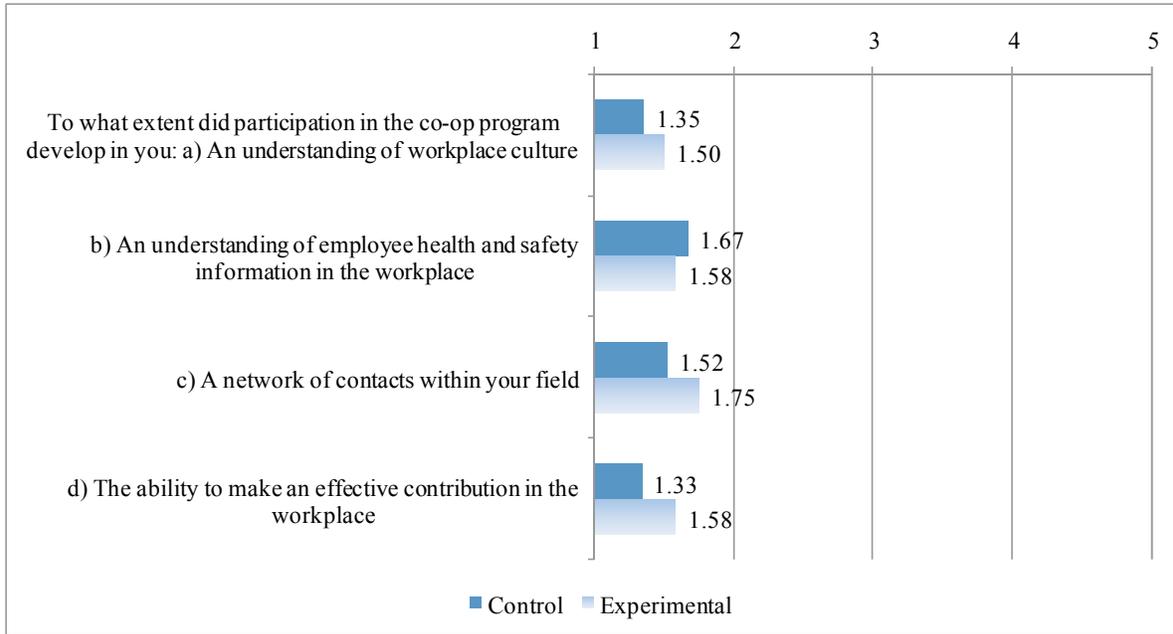


Figure 6: Question 3 responses for control versus experimental groups, extended work term respondents only.

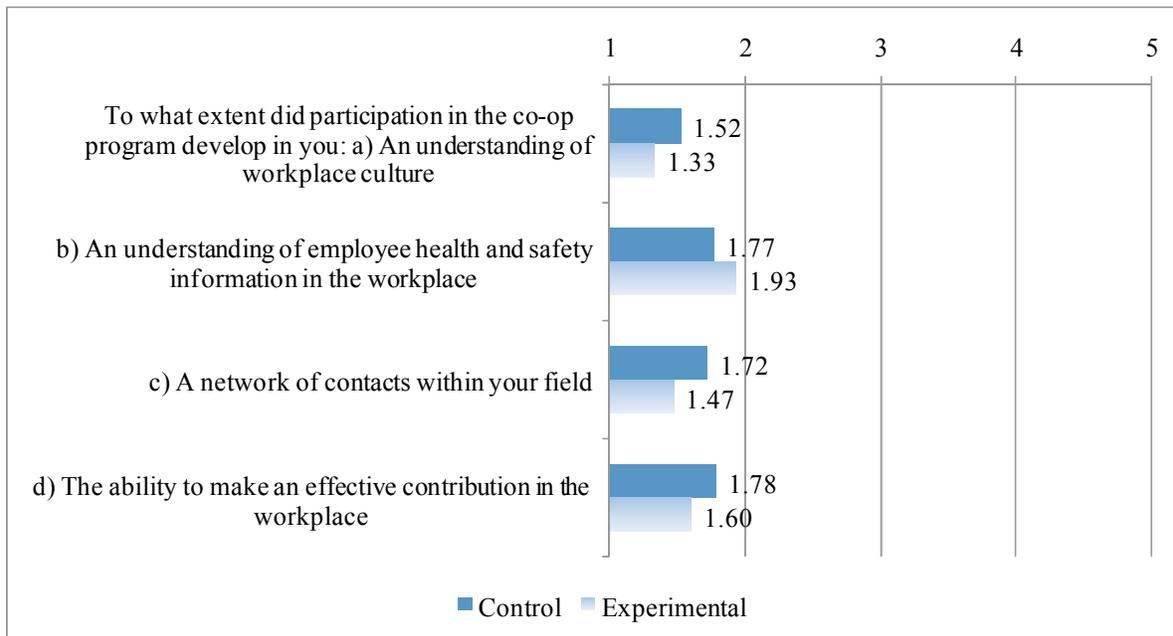


Figure 7: Question 3 responses for control versus experimental groups, regular work term respondents only.

Note that while none of the results in Figures 6 and 7 shows statistical significance at the critical α -level of 0.05 when comparing control and experimental groups, the general trends are reversed for extended and regular work term students. While development of an understanding of workplace culture, networks of contacts, and the ability to contribute in the workplace are seen to decrease for those respondents having experienced at least one extended work term of eight months or more (as indicated by a larger average number according to the Likert scale used), the opposite is true for those respondents having only work term placements of four months each.

Similarly, while regular work term respondents reported a decreased understanding of employee workplace health and safety, extended work term respondents did not.

As briefly mentioned in the “Introduction” section, timing (when and for how long?)¹⁸ is one of the practical issues facing the conceptualization of “best practice”. Smith et al.¹⁸, in their inter-institutional study in Australia, found the salient issue was that timing was highly dependent on students having sufficient technical knowledge to make a worthwhile contribution. “No-one argued for industry-based learning to occur until at least one year has been completed.” The “ideal” duration of the work terms was unclear, with durations of one year, six months or sixteen weeks being preferred by different sets of students and faculty.¹⁸

Fleming and Eames²⁴ note that amongst cooperative education programs, there is a great diversity in placement length and structure and that this diversity in placement structure “is governed more by organizational influences such as institutional timetabling, placement availability and faculty commitment than by educational imperatives”. They also found that the students’ learning changed over time in the placement, as they moved from doing simple tasks and became involved in more complex tasks and thinking, suggesting that they were learning through their participation. Hodges et al.²⁵ contend that although the structure of the cooperative education experience may not affect the overall outcomes, it does influence the types of learning strategies that can be devised.

With respect to the study reported here, it is worth noting that many of the extended work terms are international placements. Students gain the benefits of a global work experience and exposure to the implications of cultural factors on workplace issues.²⁶

Conclusions

During the first years following the implementation of the revised cooperative education program at the University of Windsor, trends indicate positive responses in subjective data with regard to learning outcomes achievement, but more data is required to derive significant results from which program development recommendations can be made. Nonetheless, some interesting results have been found with regard to the feedback from respondents participating in work terms of four months versus those working at least one extended work term of eight months or more.

While positive effects are noted for all respondents, in general, working shorter, varied placements appears to nurture a greater understanding of workplace culture, development of a network of contacts, and the ability to make contributions to the workplace. These results lead one to conclude that students may benefit from tailored cooperative education learning outcomes based on work term length.

What is evident, however, from the survey is that cooperative education is valuable in academic progress, career enhancement, and development of generic skills and attributes.²³ As noted by Smith et al.¹⁸, “For us, and many others involved in such cooperative learning, its value is non-contestable. The contested space is how this is organized to maximize the participants’ learning.”

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