

AC 2009-1151: INTEGRATING CO-OP AND CLASSROOM LEARNING EXPERIENCES

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Integrating co op and classroom learning experiences

Abstract

Due to the relative absence of intentional design in co-op experiences, there is a perceived lack of consistent quality control by many participating students. Often the benefits of co-op learning cannot be clearly visualized. To communicate the vision that co-op education contributes to student learning, the existence of measurable co-op learning outcomes is necessary. Once the learning outcomes are known, then educational activities to produce these learning outcomes must be designed and implemented in the worksites. To foster deep learning in students, the learning experienced in co-op must be linked with educational activities in the classroom. While currently anecdotal evidence is often used for co-op's benefits, true scientific evidence that knowledge is constructed in a superior fashion when students engage in both co-op and classroom learning is necessary to prove that co-op is an indispensable and complimentary component of engineering education. This paper will outline a pilot study based upon one learning outcome selected through student assessment. A concept will be presented to utilize the pilot study results to design a process for integration of co-op learning with classroom learning to increase student success.

Background

Each discipline has a skill set that one must acquire in order to become an expert in that field. The Accreditation Board for Engineering and Technology (ABET)¹, for example, has tried to institute learning outcomes for accreditation which will instill the set of skills for successful engineers. Many of these skills are not technical but are considered “soft” or “interpersonal” skills. Unfortunately, though, engineering graduates have been documented to have deficiencies for some outcomes, especially those pertaining to the “soft” skills, such as effective communication and multidisciplinary teamwork²; however, Davis et. al.³ recently developed an expert profile that is broadly applicable to all engineering disciplines, and which El-Sayed⁴ used to determine how co op education can address the deficiencies apparent in engineering education.

This expert profile outlines the characteristics that, once mastered, would make an engineer deemed an “expert” in his profession. This set of behaviors is broader than the ABET educational outcomes and lists the outcomes in terms of roles with corresponding observable actions for each role. The roles of Analyst, Problem Solver, Designer, Communicator, Collaborator, Self-Grower and Practitioner can be mapped to the ABET learning outcomes, but the profile by Davis et. al. goes farther by including the roles of “Leader,” “Achiever” and “Researcher,” as well. El-Sayed⁴ has shown that all of these behaviors are enhanced through co-op experiences.

Academic value of co-op education

In co-op, the undergraduate alternates between working for an industrial sponsor and participating in classroom instruction at a university. Through co-op, a student is exposed to the type of complex environment that she will face as an engineer. When prepared properly, she is able to complete increasingly more difficult assignments with less supervision. The experts in the field model the characteristics of an engineer in industry, not the characteristics of an engineering professor, so the student can observe and attempt to mimic these behaviors until she gains mastery. Because the co-op student is still a student and not a full-fledged engineer, she has more flexibility to experiment with different methodologies to accomplish tasks, and through reflection she can construct the knowledge of what works and what does not. Through this experience she understands and builds a framework about what it takes to be successful.

Significantly, however, current research suggests that the experiential learning provided in a co-op experience is augmented by a clear connection to the student's academic curriculum. As Baber and Fortenberry⁵ state, "The use of the classroom must be re-examined in educating future engineers, broadening the curriculum focus to include competency development." Similarly, for researchers at the Cambridge-MIT Institute⁶, experiential learning, like co-op, is most valuable pedagogically if it allows students to use in the experiential setting what they have learned in the classroom. Clearly, the research is now suggesting that, in order to increase the efficacy of the academic and experiential components of the students' education, classroom learning must be clearly and methodically connected with experiential learning in the co-op setting.

The need for a pilot study

Unfortunately, though, the relative absence of intentional design in co-op experiences leads many students to perceive a lack of consistent quality control—a perception shared by students at many organizations of higher education. Also, the benefits of co-op learning cannot always be clearly visualized. To communicate the vision that co-op education contributes to student learning, the existence of measurable co-op learning outcomes is necessary. Once the learning outcomes are known, then educational activities to produce these learning outcomes must be designed and implemented in the worksites. Moreover, to foster deep learning in students, the learning experienced in co-op must be linked with educational activities in the classroom. In addition, work-integrated learning through co-op must be assessed for quality control and continuous improvement. While currently anecdotal evidence is often used for co-op's benefits, true scientific evidence that knowledge is constructed in a superior fashion when students engage in both co-op and classroom learning is necessary to prove that co-op is an indispensable and complementary component of engineering education.

The study outlined in this paper, therefore, seeks to understand the relationship between the engineering expert profile³ and the ABET¹ learning outcomes in order to deduce a

realistic set of learning outcomes for engineering co-op students and to determine missing components and overlaps. This understanding will allow the systematic design of a set of complementary and integrated co op and classroom activities, focusing on one outcome at a time. The pilot study would utilize a subset of selected learning outcomes, preferably only one.

Pilot study approach and methodology

The Kettering Office of Institutional Effectiveness is overseeing the preparation and administration of the surveys. The first survey was developed and will be returned before the start of this research work. The Office of Institutional Effectiveness utilizes the professional standard practices necessary for statistically valid results.

The research methodology used for the educational pilot study will be the experimental design outlined in Gall, et. al.⁷ It is called the “Pretest-Posttest Control Group Design.” This is known to be of greater validity than a simple “One-shot Case Study” or the “One-Group Pretest-Posttest Design.” The One-shot Case Study features an experimental treatment and a posttest to determine the effect of the experimental treatment. In this method it is not possible to determine the causality of any changes found in the test subjects. The One-Group Pretest-Posttest Design involves more steps: administration of a pretest that measures a dependent variable, implementation of the experimental treatment, and administration of a posttest to measure the dependent variable again. This methodology is applicable when extraneous factors can be estimated with a high degree of certainty and therefore assumed negligible.

The Pretest-Posttest Control Group Design that will be used in this study uses two groups: the experimental or “test group” and the “control group”. The use of a control group is almost always superior to the single group design methodologies outlined previously. The control group is composed of subjects that receive no treatment, but other than this their experiences are held as close as possible to the test group so that extraneous factors can be assessed. The Pretest-Posttest Control Group Design involves these steps: administration of a pretest to both the control group and the test group, administration of the treatment of the experimental group but not to the test group, and administration of a post test to both groups.

For this pilot study, survey results will be compiled and utilized to update the expert profile based upon stakeholder views in order to develop an optimized, meaningful, and realistic set of learning outcomes. Once a set of learning outcomes is determined, educational activities can be designed for the co-op work site that will ensure that these learning outcomes are met by each student. A subset of the co-op learning outcomes will be chosen and implemented in the design of one co-op learning activity for the work place. This activity will be tied to a classroom experience in the school term immediately preceding the co-op work term, as well as to an activity in the school term after the co-op work term. The objective is to design a process to integrate the co-op and classroom experiences in order to increase student success.

At the same time, however, an expert profile published in the literature will be used as a basis for the development of realistic and optimum learning outcomes for co op education. An expert profile is the long-term vision of an engineering program and contains desired characteristics and behaviors. For engineering, ABET learning outcomes are the immediate measured outcomes for accreditation. One hypothesis for this research work is that ABET learning outcomes are a subset of the engineering expert profile.³ In order to understand the relationship between the expert profile and the ABET learning outcomes, a study will be completed to reconcile the two schemes to determine missing components and overlaps (gap analysis). From this gap analysis, questions will be developed to survey stakeholders (co-op employers, alumni, faculty and students) based upon the expert profile. The survey results will be compiled and then used to update the expert profile based upon stakeholder views. This will provide an optimized, meaningful and realistic set of learning outcomes which can then be used for engineering and the portion of these learning outcomes that are satisfied by co op education.

Kettering University provides an effective context in which to perform this research: it has a unique academic schedule and is the only fully co-operative university in the US.⁸ Students are divided into two sections called “A-section” and “B-section,” which rotate between school and co-op work terms every three months. A-section starts with a “school term” and, simultaneously, B-section starts with a co-op or “work term.” Therefore, while A-section is at school, B-section is at work, and then vice versa. The two sections are not present on campus at the same time and go through their academic careers as basically two separate student bodies. There are four terms: Summer, Fall, Winter and Spring. Summer term begins in July, and Spring term ends in June.

Once a set of learning outcomes is determined, educational activities can be designed for the co-op work site that will instill these learning outcomes into the student. These activities will be designed after surveying Kettering University alumni and students to compile a list of assignments/activities that were particularly meaningful to them. This list of activities will be used as templates and best practices to develop a prototype for co-op learning experiences.

More specifically, for this pilot study a subset of the comprehensive set of co-op learning outcomes will be chosen and used to design one co-op learning activity for the work place. This will be tied to a classroom pre-activity in the school term immediately preceding the co-op work term and post-activity in the school term after the co-op work term. The goal is to design a process for co-op activity design, as well as a process for integrating co op learning with classroom learning to increase student success.

Pilot study tasks and phases

Phase 1

1) Identify one co-op company with a large number of same-year co-op students. This cohort of students will be divided into two groups. One will be the test group and one will

be the control group. The test group will engage in the pre-activity, co-op activity and post-activity sequence. The control group will follow the established Kettering curriculum for comparison.

2) Distribute survey. The survey questions have been written by Dr. Jacqueline El-Sayed and included in the 2008 Kettering Alumni Survey by Jennifer Dunseath, Director of Office of Institutional Effectiveness at Kettering University.

Phase 2

- 1) Compile surveys.
- 2) Perform gap analysis.
- 3) Update Engineering Expert Profile.
- 4) Determine the set of learning outcomes for co-op.
- 5) Determine the subset of co-op learning outcomes to be studied.
- 6) Design co-op activity with the corresponding pre- and post-classroom activity.
- 7) Design assessments for each phase.

Phase 3

- 1) Administer pre-assessment to student cohort.
- 2) Provide student test group with structured classroom activity antecedent to their co-op term.

Phase 4

- 1) Administer pre-assessment to student cohort.
- 2) Provide student test group with structured, pre-designed co-op activity. (Control group of students will follow standard co-op plan.)
- 3) Administer post-assessment to student cohort.

Phase 5

- 1) Administer pre-assessment to student cohort.
- 2) Provide student test group with a specific classroom activity subsequent to their co-op term.
- 3) Perform final assessment of co-op and classroom learning for student cohort (both groups).
- 4) Determine research results and disseminate.

Pilot study impact and outcomes

The outcomes of the pilot study would include one thread of this overall integration, by focusing on a subset of selected learning outcomes and designing one corresponding set of templates and best practices for co op companies, and a complementary set of

classroom activities. However, through assessment of the pilot study outcomes, instructors could then build upon this work to eventually include all learning outcomes for co-op education and systematically design complementary, integrated co-op and classroom learning activities.

Work completed to date

Phase 1 has been completed and Phase 2 is currently underway. One survey, the 2008 Kettering Alumni Survey⁹, has been distributed and the results compiled. Phase 1 included the modification of the 2008 Kettering Alumni survey in assessment of all of the roles outlined in the expert profile. The Kettering University alumni surveys are conducted by the Office of Institutional Effectiveness, which adheres to the standard practice in higher education. The surveys are administered to alumni three years out from graduation. The typical number of graduates surveyed is approximately 400 per class, with a return rate of approximately 16%.

Below, the results of the 2008 Kettering Alumni Survey were mapped to the roles outlined in the engineering expert profile. Table 1 shows the percentage of alumni (former co-op students) responding that the co-op learning experiences accounted for a large increase in ability. The data in Table 1 is shown in graphical form in Graph 1. From the data it can be inferred that co-op contributed significantly to the roles of “Analyst,” “Problem Solver,” “Designer,” “Collaborator,” “Achiever,” “Practitioner,” and “Problem Solver.” However, a large increase in ability was not reported for the roles of “Researcher,” “Leader,” and “Self-Grower.”

The largest percentage of alumni reported that their co op experience increased their ability in the role of an “Achiever” to a large extent. The role of the “Achiever” includes taking initiative and being accountable to deliver high-quality results in a timely manner. Co-op students in an industrial setting must take ownership of their assigned duties for their sponsor and complete professional work by the deadline given. They will receive immediate feedback from their team peers and their supervisors if this is not the case. A large increase in the ability to be a “Practitioner” was the second highest reported role. A “Practitioner” must understand engineering practice and professional conduct, which is modeled by expert engineers at the co-op student’s sponsors. “Analyst,” “Collaborator,” “Designer,” and “Problem Solver” are the next highest ranked roles by the alumni who answered the survey. These are all roles that would be modeled by professionals in industry who must analyze data, work in teams, design solutions and troubleshoot problems. Indeed, co-op students are consistently asked to perform in this way and would be held accountable for such behaviors.

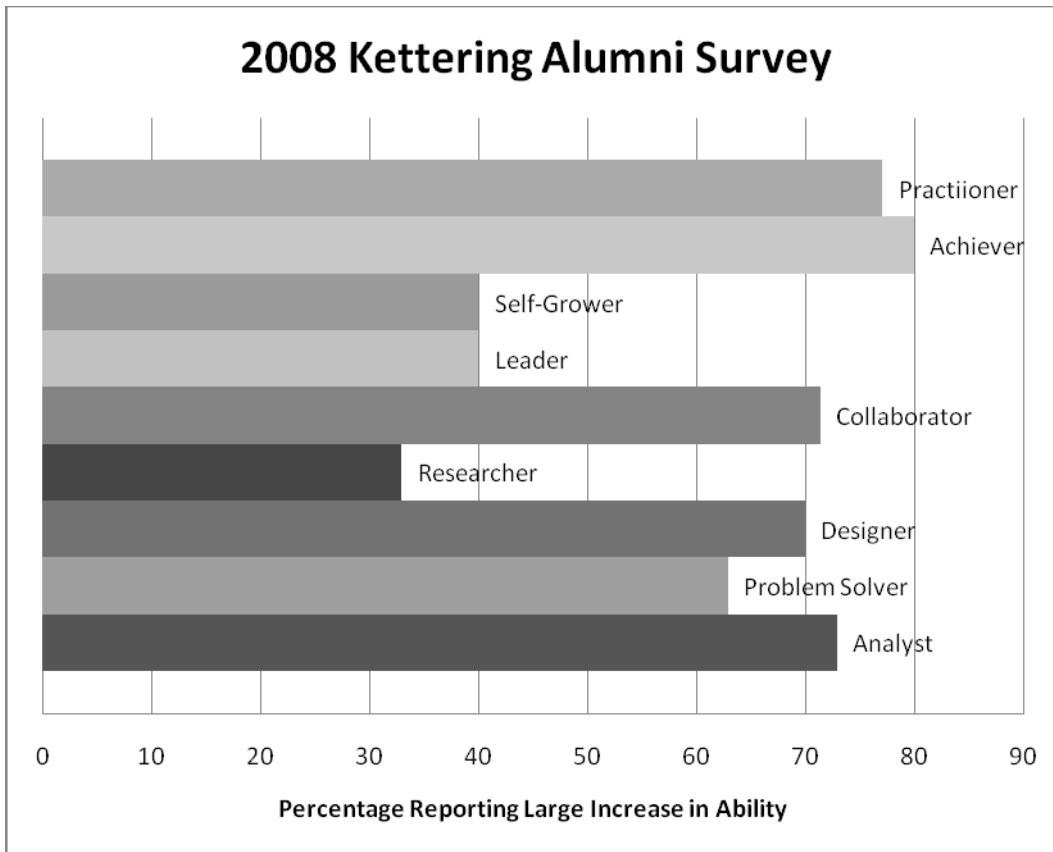
At the lower end, roles receiving less than a majority percentage from the alumni include “Leader,” “Self Grower” and “Researcher.” Pertaining to the role of “Leader,” co-op students have a variety of work sites and placements. Because they are still students and not yet graduate engineers it is highly likely that many students do not perceive that they are given leadership roles. Students placed in supervisory roles in manufacturing would

most likely perceive this activity as leadership; however, students working on a CAD station may not. As for the role of “Researcher,” co-op sponsorship by research companies or assignments in research departments within industrial sponsors would be only one subset of the placement of students in co-op; therefore, it is highly likely that many students would not have this experience. The role of “Self Grower” includes self assessment and managing one’s professional growth. Students are still inexperienced and not yet fully mature; therefore, unless a student connects with a mentor who models this behavior, “Self Grower” is a role that may not be transmitted consistently well to all co-op students. Based upon this one survey, the preliminary results would indicate that these three roles would be considered the “gaps” in a gap analysis of the expert profile. To obtain proficiency in these lower reported roles, the co-op experience must be designed to include applicable learning outcomes, and complementary education must be included in the classroom learning as well.

The results of this alumni survey appear to accurately reveal the experiences of co-op students at Kettering University. Co-op students receive high-quality learning experiences pertaining to most roles of the engineering expert profile; however, three roles are not being addressed sufficiently for the majority of co-op students. To continuously improve the co-op learning experience, the learning activities for these roles should be designed into the co-op experiences, as well as and integrated into the classroom experience.

Table 1: Percentage responding that the co-op experience accounted for a large increase in ability (2008 Alumni Survey)

Expert Behavior	Percentage
Analyst	72.9
Problem Solver	62.9
Designer	70
Researcher	32.9
Collaborator	71.4
Leader	40
Self-Grower	40
Achiever	80
Practitioner	77.1



Graph 1: Percentage responding that the co-op experience accounted for a large increase in ability (2008 Alumni Survey)

Conclusion

Through assessment of students, faculty and former co-op students and through comparison with the expert profile, the learning outcomes for co-op education can be determined. From these outcomes, a set of templates and best practices can be developed which, in turn, can be used by co-op industrial sponsors in order to offer the companies either suggested or required activities which will enable consistent student learning. In addition to the design of the co-op learning experience, complementary learning should be designed in the classroom that will foster overall deep learning in the students. Therefore, the set of co-op learning outcomes, a set of learning activities in the form of templates and best practices for co-op companies, and a complementary set of classroom activities would establish much higher student success for co-op education and work-integrated learning.

The work completed to date includes the modification of the 2008 Kettering Alumni Survey to include the spectrum of roles in the engineering expert profile. Based upon the overall research goals outlined, the results of the pilot study will be assessed upon conclusion and then used to design a larger study to realize a methodology for integrating

co-op learning experiences with classroom learning experiences. The ultimate goal of this work is to foster deeper learning for increased student success.

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