University and Community College Students can share a Learning Experience

Barrie Jackson and Dale Dilamarter

Queen’s University
jacksonb@post.queensu.ca
dilamarter@chee.queensu.ca

Peter Spasov

Fleming College
p spasov@fleming.on.ca

Abstract

This paper describes a pilot collaboration between Queen’s University and Sir Sandford Fleming College of Applied Arts and Technology in Peterborough Ontario. Since 1994 Queen’s has offered projects where students learn by solving problems for fee paying industrial clients. Known as Technology Engineering and Management (TEAM) student participants form multidisciplinary teams to consult for business clients. In addition to engineering students, commerce and arts students have often participated in the teams. In the Applied Projects program at Fleming College, third year engineering technology student teams solve problems for enterprise sponsors.

A pilot group of engineering technology students from Fleming College worked with students in two Queen’s University TEAM projects. In industrial practice, engineers and engineering technologists often collaborate on solving problems. This collaboration rarely occurs in an educational setting. In the 2002-2003 academic year the pilot exercise simulated the professional working relationship between engineers and technologists. This paper gives a description of the experience and the motivation to undertake this unique collaboration. The most important aspect of the presentation is a critical assessment of the University/College collaboration -- what worked, what problems arose, and what improvements are suggested.

Introduction

Faculty at the Queen’s and Fleming programs share several underlying beliefs. First, there is a belief that the opportunity to learn scientific fundamentals, in the context of an appropriate industry application, leads to a deeper understanding, better retention of subject matter and encourages development of learning skills. The oft quoted expression certainly applies here.

Tell me and I will forget
Show me and I might remember
Involve me and I will understand

Secondly, this type of learning experience provides a ‘real-world’ opportunity for students to practice the interpersonal skills critical to teamwork, workplace communication, and conflict management. Lastly, both programs see a growing and critical industry need for engineers and technologists to work more closely together. This pilot project provided a unique opportunity for engineering students from a University and engineering technology students from a College to simulate this professional working relationship.

Workplace Changes Provides Motivation for the Queen’s-Fleming Pilot Project
Over the past two decades, the workplace has experienced deep and significant change. Examples include workplaces that are more culturally diverse, organizations that are much flatter in their structure, work teams that are self-managed and, a more participatory style of management. Time-based competition has become prevalent. Fierce competition based on price and quality is the new norm. Trade barriers have been reduced and communication technologies have provided the ability to communicate easily and quickly around the globe.

North American industry has responded to this increased domestic and global competition by reducing the input amounts and costs of goods and services while increasing the amount and value of outputs. Increased competition has revealed the need to become more responsive to client needs. Further, the North American economy has undergone structural changes resulting from the movement of many manufacturers to China, India and other low cost locations. The movement of computer jobs to overseas countries such as India and the movement of specialized engineering services to a variety of overseas countries show these changes.

Graduates need to adapt to changing situations and develop a greater capacity for interpersonal effectiveness. The scientific fundamentals and technical skills required to succeed must meet or exceed global standards. There is an expectation that graduates will have well-developed interpersonal or “soft” skills such as conflict management, communication skills and teamwork to cope with this changed economy and workplace.

Economic and workplace changes also require a greater degree of understanding and co-operation between engineers and technologists as these individuals adopt different roles. Increasingly, the roles of engineers and technologists are becoming integrated within the same work team.

Since the roles of engineer and technologist are learned in different educational settings, engineers and technologists rarely, if ever, work together prior to employment.

For several years, Queen’s Technology, Engineering and Management (TEAM) and Sir Sandford Fleming College’s Applied Projects has had students working on industry projects as part of their program of studies. Seeing the need for engineers and engineering technologists to gain experience by working together, both schools joined forces on this pilot project. A group of Fleming’s engineering technologists moved from Peterborough to Kingston for one semester to work on two (2) projects with engineering students. Both groups of students had the opportunity to work with others who had different skill sets and backgrounds. This gave each group the opportunity to broaden their perspective.

Many universities and colleges use problem-based industry projects. To the best of our knowledge, Queen’s TEAM and Fleming’s Applied Projects are breaking new ground by having engineers and technologists working together on the same industry projects.

The Learning Context: A Comparison of the Two Programs

Queen’s and Fleming programs have different missions, different student populations and different places within the education system. However, the two programs have a very similar approach to problem-based based learning. Specifically, there are shared values and beliefs regarding the usefulness of problem based education, a multidisciplinary approach to problem solving, the application of project management concepts and skills, and the importance of setting technical or industry problems within a business context. Both programs emphasize the importance of cooperative projects to practice interpersonal skills like communication, trust building, and conflict resolution. Despite the obvious differences in students’ background, there were sufficient similarities to have engineering and engineering technology students work on the same project. A more detailed comparison of the two programs follows.

The TEAM at Queen’s University began in the 1994-1995 academic year. It is open to all engineering students in final year as well as to Commerce students, and students from the Arts and Science Faculty. Where appropriate, graduate students have participated in the program. Recently well qualified third years students have participated. At Queen’s, TEAM is the equivalent of two (2) full courses. Fleming’s Applied Projects started in 1999. All
third year computer and engineering technology students must enroll in this program. Student groups spend their entire sixth semester completing an industry-sponsored project. This project is the equivalent of six (6) full courses. Program faculty may add additional activities depending on learning expected from the students. To prepare for the sixth semester, students complete a project planning course in their fifth semester. The faculty guide students through the process of planning their chosen project.

The basic structure of both programs is a problem solving exercise where diverse student groups choose an industrial problem that they wish to work on. Faculty carefully select projects to ensure that they have sufficient rigour and are of real interest to the client. Although the size of student team will vary depending on the problem, the usual team size ranges between three (3) and five (5) students. At Queen’s, the project is carried out as a consultancy for a fee paying client. At Fleming, a small fee is collected from project sponsors to cover the cost of incidentals such as travel, report preparation, presentations and other minor program costs.

Although there are exceptions, Fleming’s clients tend to be smaller private and non-profit enterprises from eastern Ontario. Queen’s client base consists of large and small companies, some of which are local and some international. Projects have been carried out for clients in Switzerland, Korea and Singapore. Projects come from across Canada and from the United States. Examples of previous Queen’s projects may be found at www.chemeng.queensu.ca/team/. Examples of Fleming projects may be found at www.flemingc.on.ca/programs/aces/appliedprojects/.

Both programs try to place students in situations they will experience in their professional careers. The project is a vehicle to provide opportunities to develop vital technical and business skills such as teamwork and conflict management. These skills are critical for successful professional careers.

Communication is an important element of both programs. Once students have selected a project and formed teams, they visit the client, and become familiar with the client’s workplace. They have to communicate and establish new relationships with their industry contact, project advisor(s) and faculty mentors. For Queen’s international projects, plant visits have not been feasible, however, teams have traveled to clients across eastern Canada, Alberta, Ontario, and the United States. Fleming teams have to produce a business issues report describing the enterprise in an industry-wide context. This requires students to conduct in-depth interviews with the company. For the 2004-2005 academic year at Queen’s TEAM students have been able to use their TEAM project as a basis for their business plan requirements in a parallel course dealing with management issues.

At both Queen’s and Fleming, considerable effort is put into the initial selection of team members. There is an attempt to ensure that student groups are both discipline and skill balanced. Every attempt is made to break up cliques. After a student team has been established, it is the student group’s responsibility to ensure that work is completed on time and in a competent manner. TEAM coordinators have regular meetings with the teams and will intervene as a last resort or when a problem arises.

In any problem solving exercise, the first and most important issue is problem definition. While some clients are quite specific in their needs, in many instances considerable negotiation on the part of the teams is needed to resolve specifically what they are expected to produce. The student teams have to learn to deal with “scope drift” on the part of the client. This is an excellent skill to master, and program co-coordinators, mentors and advisors spend considerable time helping teams deal with this issue. Students do not have unlimited time and we make sure that deliverables and time lines are precise and reasonable.

Project definition and project management are learned in context of real contractual agreements. At Fleming, students and clients develop an Intellectual Property (IP) agreement that is binding on both parties. At Queen’s, confidentiality agreements as well as waivers of liability and IP agreements are legally binding. These agreements present another vital lesson for would be professionals.

Once problems have been determined and achievable project timelines and deliverables put into place, students attack the problem. Each team has an advisor. Most advisors are
practicing professionals from industry and some are from the university or College. In Fleming’s case, student teams are also assigned a faculty mentor. All advisors and mentors are expected to be coaches who provide guidance on process rather than giving students the “right answers”.

Hopefully, the majority of the learning takes place during the problem solution phase. Students rarely have a prior deep understanding of the issues. In most instances, the fundamentals may not be adequately understood, and learning new concepts, techniques or technologies are required. In most instances, however, student teams become quite enthusiastic about acquiring knowledge. The most important skill acquired is the ability to learn and develop expertise in the context of the problem at hand.

The final presentation of the report to the client takes place at the client’s office. This requires high levels of skilled communication. Fleming students are graded on their written and oral work while Queen’s students are not. Both programs work continuously with the teams to ensure that the collaborative writing meets effective standards of workplace communication. One aspect of the TEAM program that consistently receives favourable comment from clients is the level of written communication. There have been several instances where student papers were circulated widely within large international organizations. Two of these papers have been published. Students in both programs have come to “own” their work and realize that their task is to satisfy fee-paying clients rather than University or College faculty.

Neither TEAM nor Applied Projects have examinations. At Queen’s, the program is “pass/fail” exercise where the “pass” mark is mark is 80%. Outstanding projects are awarded a higher value. If a project is unacceptable, students receive a “Not Written” grade and have the option of completing an acceptable project or repeating the course. At Fleming, there each component of a project is graded and a mark assigned.

Simulating the Working Relationships of Engineers and Technologists

There were two projects where a mixed group of engineering and engineering technology students worked together. One project involved simulating a ‘Soft Mixer’ for a biochemical company while the other student team simulated a manufacturing process for a major petrochemical client. The idea was to create a solution for the client while developing working relationships between student engineers and engineering technologists. Engineering students and engineering technologists took different roles depending upon their skill and conceptual base. However, students were equally accountable for the final product and its presentation.

In the case of the “Soft Mixer”, the client was a manufacturer of biochemical process equipment in Staffe Switzerland. Standard process mixers are not satisfactory for many biochemical processes as the tip speed of the rotor will destroy many of the biological entities. The ‘Soft Mixer’ uses a variable vertical movement of a perforated plate to achieve a much gentler mixing action. Although there is an enormous amount of data pertaining to conventional rotary mixers there is next to nothing concerning the ‘Soft Mixer’. The student team undertook the development of a CFD model of the mixer.

While the engineering students struggled with the need to learn enough CFD background to develop the requisite models the technology student developed quite an esoteric experimental rig to “calibrate” the CFD results. This resulted in an excellent demonstration of synergy. The client was sufficiently impressed that one student was flown to Europe for ten days and presented the findings of the team at an international conference.

Unfortunately as a result of the client changing the parameters of the second project, it was not as applicable to the technologists as we had hoped. However that was all part of the learning experience for those of us who conducted the pilot experience.

Students from both schools had positive comments on the pilot project and clients were very satisfied with the completed product.

One factor that contributed to this success was that students were eager to participate in the pilot project. Both Queen’s and Fleming students chose the experience and were coached on its context and day-to-day realities. They were also made clearly aware of the expectations placed on them. The cooperating students were “special”,
and as a part of a pilot project, were aware that their progress was being evaluated. Knowing they were part of a “special” group may have contributed to the successful outcome of the student teams.

Despite the many similarities between the programs, there were enough differences to provide a challenge. For example, each program had to satisfy its own institution’s grading requirements. Further, Fleming’s Applied Projects are the equivalent of an entire semester’s work. Therefore, additional tasks were provided for the College students to meet provincial standards for technologists. Finally, it was difficult for Fleming students to meet with Queen’s students during the fall when most of the project planning took place. The two (2) hour drive between Peterborough and Kingston and the additional course load each student was carrying made matters challenging.

On a personal note, the three (3) Fleming students gave up their accommodation in Peterborough and found four (4) months accommodation in Kingston during the winter term. Students also gave up frequent contact with classmates with whom they had spent the previous two and a half years. Perhaps the personal sacrifices these students made indicated their readiness to undertake the assignment and their ability to adapt effectively.

Frontiers in Education Savannah 2004

The Queen’s and Fleming participants in this pilot program were invited to present an Interactive Session-Synergy: Can University and College Students Share a Learning Experience? At the 34th ASEE/ISEE Frontiers in Education Conference October 20-23, 2004, Savannah, GA

This session generated a lively discussion. Unfortunately we had failed to take into consideration the fact that in the United States, the term College and University are to a large degree interchangeable, whereas Community Colleges are quite distinct from Universities in Canada.

There of course were a varied of inputs and viewpoints, which is not surprising since participants ranged all the way from academics to a representative of the National Science Foundation. There were several general areas of interest, in particular what were the learning expectations for students in the multidisciplinary teams. The pilot exercise was in many instances the participants’ first job. It presented issues that are not readily “taught” in class. Although a good grounding in fundamentals was necessary, the students had to deal with many issues related to professional practice. In most instances the projects required a “quick learn” of unfamiliar technology under conditions of time and resource constraints. As an example it was necessary to have the students involved in the CFD simulation of the ‘Soft Mixer’, the students had additional tutoring by the manufacturer of the software “Fluent”. Communication within the groups, with the client, course coordinators and advisors was critical. Although this course was essentially a “pass-fail” situation, the standard for an acceptable “Pass”, 80%, was set quite high and there was zero tolerance for unacceptable work. This was a novel experience for most students however they seemed to respond quite well to the challenge.

There was a considerable discussion of interpersonal relationships and crisis management within the teams. Although we feel that this is the point in the student’s education where as a group they must take personal ownership for team behaviour there is a strong mechanism in place to intervene at a last resort to sort out problems of “free-loaders”, “dictators” in teams and the many other issues that are inevitable in teamwork situations. These issues may not be pedagogical in nature however, they are critical for our proto engineers to understand and deal with in their new career as emerging professionals.

Client Expectations

Although we have concentrated on the student aspect of the Industrial Project courses it is appropriate to mention the client response. Although over the period that the TEAM program has been in operation there has been quite an eclectic array of projects there have been some outstanding successes.

There have been several projects for DuPont Canada research which over the years have represented major economic advantages for the company. These have been the result of situations where DuPont simply didn’t have the manpower to look at these issues, but a group of enthusiastic young people without preconceived baggage were able to come up with innovative solutions to outstanding problems.
There were several projects this past year of considerable interest. The students have developed a novel approach to the manufacture of “paintballs” that if proven in the manufacturing facility could result in very significant savings for the client.

One of the most interesting projects this past year was the development of a novel use for a modified acrylic polymer as a most interesting material for casts and splints. This material has a number of significant advantages over the current materials in use and could potentially become a major factor in the orthopedic field. This was a collaborative effort between TEAM and the Kingston General Hospital here in Kingston.

The Future

This successful pilot project is worthy of repeating at Queen’s and Fleming and should be replicated at other institutions. To succeed on a wider scale, it would be useful to assess individuals on their ability to adapt quickly to new situations and their readiness for undertaking such an assignment. Secondly, if greater numbers of students are to become involved, information packages, brief orientation, mid-term and debriefing workshops have to be developed.

Choosing individuals who can adapt effectively and build relationships in a new situation will increase the chances of success for individuals and the schools they represent. Based on the experience of the pilot project, we propose that these factors be considered when choosing participating students: personal situation, motivation, positive attitude, realistic expectations, initiative, flexibility, patience and perseverance, self-confidence, tolerance for ambiguity, relationship building skills, respect for others and diplomacy.

It would also be useful to provide all participants with an information package to help them develop the essential competencies (knowledge, skills and attitude) to work and live successfully in the Queen’s context.

Short workshops at orientation, mid-term and departure would speed up the adoption process for both engineering students and engineering technologists. Discussion topics at orientation could include effective communication, clarifying roles and objectives, and identifying differences in learning and management styles. At mid-term, students would focus on the practical, day-to-day considerations of project work and on adjustments to maximize learning. Specific topics could include methods of decision-making, conflict resolution and how to set realistic expectations for the remainder of the term. Prior to departure, a debriefing session could be held where lessons learned could be captured. This discussion would provide feedback on methods to improve the experience, focus on how the knowledge and insights acquired would be applied to new situations and bring closure to the experience.

Materials and Manufacturing Ontario, a division of Ontario Centers of Excellence have been approached with a proposal to develop the concept of multidisciplinary teams involving engineering and technology students across Ontario.