A Summer Leadership Development Program for Chemical Engineering Students

Annie E. Simpson
Coordinator
Engineering Leaders of Tomorrow Program
Toronto, Ontario, Canada
annie.simpson@utoronto.ca

Greg J. Evans, Ph.D.
The Engineering Leaders of Tomorrow Program
Faculty of Applied Science and Engineering
University of Toronto
Toronto, Ontario, Canada

Doug Reeve, Ph.D.
The Engineering Leaders of Tomorrow Program
Faculty of Applied Science and Engineering
University of Toronto
Toronto, Ontario, Canada

Abstract

The Engineering Leaders of Tomorrow Program (LOT) is a comprehensive curricular, co-curricular, extra-curricular leadership development initiative for engineering students. LOT envisions: "an engineering education that is a life-long foundation for transformational leaders and outstanding citizens." Academic courses, co-curricular certificate programs, departmental programs, and stand alone workshops emphasize four domains of leadership: Self, Relational, Organizational, and Societal Leadership. This article introduces the 14 week summer leadership initiative for research students in the Department of Chemical Engineering and Applied Chemistry. Students gather on Friday afternoons from early May to late August to learn and practice leadership. Based on student assessment data, the program is having positive impact.

Introduction

The Engineering Leaders of Tomorrow Program (LOT) was born out of the belief that the full potential of engineering graduates to contribute to society was not being realized and that engineers with significant leadership skills contribute more

societal value than those without (Florman, 1996). In the wake of global challenges such as climate change, economic upheaval, energy issues, and food security, engineers will need more than technical skill to generate solutions to contemporary problems; they will need leadership ability (Douglas & Papadopoulos, 2010). The LOT summer program in the Department of Chemical Engineering and Applied Chemistry is one such opportunity for students to develop their leadership. LOT envisions life-long engineering education that is the foundation for transformational leaders and outstanding citizens.

Overview of the Leaders of Tomorrow Program

LOT began in 2002 in the Department of Chemical Engineering and Applied Chemistry and became Faculty-wide in 2006. The program has expanded rapidly since then. In the 2007-2008 academic year 142 leadership-related events took place with 4064 student attendees. In the 2007-2008 academic year 199 events occurred with 8383 student contacts. In 2009-2010, 255 events took place with 7646 student contacts and in 2010-2011 that number continued to grow to 288 events and 8286 student contacts.

Other components of the LOT program include three academic courses focusing on leadership studies, three five-week, co-curricular certificate programs which emphasize self-leadership, team leadership and organizational leadership, Departmental programs, and numerous other leadership-related events and workshops. This article discusses the Summer Leadership Program, a 14-week leadership development series for undergraduate research students in the Department of Chemical Engineering and Applied Chemistry. An overview of the program philosophy, structure, and pedagogy is provided along with a discussion of the learning outcomes and student feedback.

Program Philosophy

The field of engineering leadership education is growing. The Massachusetts Institute of Technology, Pennsylvania State University, Tufts University, and other prominent engineering schools in the United States have recognized the need to augment engineering students' technical skills with opportunities to develop as leaders, innovators, and agents of change (Graham, Crawley, and Mendelsohn, 2009). While more initiatives have begun to support the development of professional skills and intensify team learning (Seat, Parsons, & Poppen, 2001), LOT takes a humanistic approach and aims to foster the development of self-aware, interpersonally skilled, and socially engaged graduates equipped to succeed both as leaders in organizations and in society at large.

There are a number of core beliefs that shape LOT curriculum and programming. The first is that leadership can be learned and can be taught. We believe that there are skills and competencies that everyone can develop in the realms of self, team, organizational, and societal leadership. Secondly, LOT is founded on the belief that leadership starts with oneself and that emotional intelligence and self-awareness are essential to effective leadership; it is essential to know one's strengths and also ones areas for growth (Jackson, 2011). Thirdly, self-reflection is necessary to self-awareness so priority is given to creating opportunities for meaningful, structured reflection. Fourthly, we believe that leadership is a shared responsibility – each person will be called upon to lead, whether by supporting a team to make its best decisions, having the courage to advocate in one's community, or collaborating with stakeholders to influence public policy. These beliefs among others infuse LOT programming.

Teaching leadership to engineers is not without its challenges. Engineering is a highly technical discipline and engineering students have highly demanding schedules. In addition, the processes of the engineering discipline lead to an emphasis on task-completion over the quality of relationships. As Thomas (2010) states in his discussion of teaching leadership to students at the U.S. Naval Academy, the rigor, demands on time, expectations of detached professionalism, and technical competence produce a perverse effect by making our graduates socially inept (Thomas, 2010). Much of our work aims to provide opportunities for engineers to expand their emotional intelligence and self awareness. However, these objectives need to be achieved in ways that appeal to engineering sensibilities. Engineers like to be taught practical, tangible skills which can be immediately applied. This impacts the way that curriculum is developed and facilitated. Whereas with students studying social work for example, the emphasis or motivation for students may be to develop strong relationships with clients, for a professional faculty such as engineering, high value is placed on career success, management skill and problem solving which may also come at the expense of relationship building.

LOT Summer Program

Since 2002 more than 325 students have completed the summer program. Sessions are held on Friday afternoons from May to August. Students who wish to participate and who are working as summer research assistants get approval for release time from their supervisors. Students who attend 80% of the program receive a non-credit, Engineering Leaders of Tomorrow Summer Program Certificate.

The program has been heavily influenced by the Social Change Model of Leadership Development (Komives, 2011). Since 2007 it has been divided into three sections: (a) Personal Leadership, which includes topics such as self-awareness, emotional intelligence and personal vision, (b) Team Leadership, which includes group dynamics, facilitation skills and conflict transformation, and (c) Societal Leadership, which emphasizes engineering and public policy, current issues, and active citizenship. Four weeks are dedicated to each of these three overarching competencies. Table 1 presents a sampling of sessions which have been delivered in the last three summers.

As well as attending seminars and workshops, students participate in research and design team projects, tour local industry facilities and engage in community

Table 1: Examples of Sessions, Grouped by Program Segment

Personal Development	Group Leadership	Leadership in Society
Myers-Briggs Typology	Leadership Styles and Myers-Briggs	Engineering and Public Policy
Leading Transformational Change	How to Build a Strong and Successful Team Atmosphere	Ethics and Leadership
Emotional Intelligence	Transforming Conflict: Skills for Resolving Conflict While Strengthening Relationships	Debate Practice
Who Could You Be in the World? (personal visioning workshop)	How to Effectively Facilitate Groups and Meetings	Habitat for Humanity Build
Ethics and Leadership	Team Tune-Up (team project reflections, focusing on group processes)	Day of Community Service
Navigating Your Career	Debate Practice (topics relating to current issues)	Networking lunch with Alumni and Final Team Presentations
Leading with Integrity: Living Your Values	Giving Active Feedback	History of Leadership
The Secret of Successful Failing		
A Guide to Structured Reflection		

service activities. The rationale for group projects is to allow students to apply their newly acquired knowledge, self-awareness, and team skills to an engineering problem (Colbeck, Campbell, & Bjorklund, 2000). While completing their project students are encouraged to integrate their developing leadership skills into their team process. Past group projects have included:

- designing a green roof.

- designing green chemistry labs.
- designing a compost system for an apartment building.
- developing a website for recruiting future chemical engineering students.
- designing an energy efficient home insulation plan.
- designing a bio-engineering facility harnessing bio-methane.
- organizing student tours.
- designing and facilitating leadership workshops.

In summer 2010 the group projects changed from an engineering design project to a curriculum design project. Students were placed in teams and tasked with designing a 15-minute mini-leadership workshop which they facilitated for a panel of alumni judges and their peers. By learning to design and teach a leadership topic such as conflict resolution, public speaking, or diversity in teams, students have to engage with the material more deeply, and embody their learning as they teach others. By introducing a team project that involves teaching others, organizers are better able to assess the level at which students have internalized their leadership learning.

Program Pedagogy

LOT programming emphasizes experiential learning. Staff in the LOT Office design curriculum that engages students in active skill development and intentional reflection activities. Other facilitators of sessions include educators from beyond the Faculty and University who have backgrounds in education and in leadership development. As expressed by Kolb's (1984) experiential learning theory, learning should not only involve cognition, but also thinking, feeling, perceiving and behaving. Efforts are made to engage students mentally, emotionally and kinesthetically in their learning. For example, at a workshop on facilitation skills students would first be introduced to the topic, discuss the role of a facilitator, and brainstorm some responses to common interpersonal challenges that occur in groups. They may then observe a scenario or engage with a case study. Next, students practice a new skill-set in the context of a simulation or group discussion and are given feedback on their facilitation skills. Finally, they are guided to reflect on their learning and experience as a way of taking their new knowledge into future situations.

Another example of program pedagogy is a leadership styles workshop based on the work of Bolton and Grover Bolton (1996). After learning about four styles and identifying their own, students are placed in small teams and given 10 minutes to build a tower which will suspend a raw egg. Their only tools are 10 straws and some masking tape. The emphasis of the activity is not on the final product, but on the process (although students do not know this until their structure is built). A group discussion follows where students are led to reflect on questions such as:

- Was everyone's voice heard?
- How did decisions get made?
- What did each team member contribute?

Experiential learning asks more from students. This kind of learning might require them to step out of their comfort zone as they practice facilitating a simulated team meeting while being observed by their peers, or receive feedback about the impact of their leadership style. Due to the experiential nature of the program, time is dedicated in the first sessions to support students in developing personal relationships with each other. Group guidelines are established to encourage a supportive and committed atmosphere. Students in the LOT program repeatedly respond well to experiential opportunities. Many of the most favored sessions are the ones which emphasize active learning. This kind of learning promotes confidence in leadership practice and a deeper awareness of the challenges and nuances involved in leading. In addition, engaging the same cohort of students in active leadership learning over a 14-week period results in a comfort level, and trust that allows for greater impact than individual workshops.

Student Feedback

Assessing learning outcomes has been a consistent feature of the program for the last four summers. Since 2007 a pre-survey has been administered where students are asked to rate their perceived skill level on a scale of one to five, one being very low and five being very high, for a variety of skills that relate to the three major competencies of the program (personal leadership, team leadership, and societal leadership). Survey questions address skills such as interpersonal skills, listening skills, offering feedback, resolving conflict, coaching and developing others, delegating tasks, making ethical decisions and communicating advances in technology to the public. The same survey is then given at the end of the summer to track changes in students' perceived ability. The expectation is that average

values will change, up or down, after students have had opportunities to practice their leadership.

There are limits to this kind of indirect assessment as Goertzen (2009) points out in his article, *Assessment in Academic based Leadership Education Programs*. However, when used in combination with the direct assessment of students final workshop presentations it can be determined that leadership learning is increasing.

Results for all cohorts, and for many of the specific competencies measured on the pre- and post- surveys, indicate that there has been a tendency for increase in perceived confidence. All three cohorts were asked the question: "On a scale of one to five how strongly do you value self-awareness in your group interactions?" For all groups there was an increased value. In 2007 the incoming average was 3.3 which rose to 4.3, in 2008 the average rose from 3.9 to 4.3, in 2009 there was an increase from 4.0 to 4.3, and in 2010 responses rose from 3.9 to 4.5. This data, however, was not tested for statistical significance. For other competencies such as listening, resolving conflict, acknowledging the contributions of others in group settings, making ethical decisions, delegating tasks, clearly articulating views, and critical thinking, students were asked to rate their perceived ability before the program and after the program. In almost all cases scores went up.

While the data is encouraging and useful, there is still work to be done in refining the assessment strategy. A tension exists between keeping the survey the same to gather consistent data year to year, while balancing the need to change the survey to reflect specific sessions offered each summer. Moving forward, the program assessment strategy is being enhanced to include more qualitative data such as the following testimonials, as well as direct assessment of students' final workshop presentations.

Student Testimonials

The following testimonials were provided by students who participated in the LOT summer program:

> *I had never noticed how often people try to solve other peoples' problems instead of just listening to them. From this workshop I took away the fact that to actually listen to the person you do not have to listen with your ears, you also have to listen with your mind. You reserve all judgment and advice and you let the person speak, while you Listen. As a person whose passion is relational leadership, this skill really has helped me build my*

> *professional and personal relationships, as well as take learning to a new level.(Saeed Kaddoura, Chemical Engineering Student)*
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> *As a result of LOT, I think I've learned more about myself as a person. The experiences within LOT have caused me to reflect on my personal beliefs and values. I've also learned how to work more effectively in teams and communicate my ideas to others much more clearly and confidently. A lot of these skills may fall under leadership, but I also think they are just life stills everyone needs to learn. Technology is an increasingly pervasive element of our society, yet engineers are by-in-large unrepresented amongst key decision makers. Leadership education is required to empower engineers to speak up and contribute to these key decision making processes. Engineers must seek to develop themselves as leaders to better understand and influence the effect that the technology they develop has on society. (Shahed Al-Haque, Engineering Science Student)*
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> *After being involved in LOT, I find that I am more self-aware. I know what my leadership type is and what my tendencies are when working in a group setting. Becoming involved in this program has shown me that I can take on many other extracurricular activities and enrich my academic experience as an undergrad. LOT has given me the opportunity to learn networking, organizational and event-planning skills that are invaluable to the skill set that I have as an engineer. (Rosanna Kronfli, Chemical Engineering Student)*

Offering Feedback

Moving forward we seek more ways to offer students meaningful feedback on their personal leadership practice. The Gordon Engineering Leadership program at the Massachusetts Institute of Technology, among others, have inspired deeper thought into the ways that individual feedback can accelerate student's growth (Graham, Crawley, & Mendelsohn, 2009). For a co-curricular program such as the LOT summer program where experiential learning and leadership practice are emphasized, there is a need for creative ways to deliver feedback. We are in the process of translating our program philosophy into specific and measurable learning outcomes which will support our growing team to offer personalized feedback to students.

Conclusion

The Engineering Leaders of Tomorrow program promotes and facilitates the development of engineering leaders. By incorporating leadership education into

engineering curricula and the student experience, graduates will be positioned to contribute more effectively to positive social change and innovation. Special attention is paid to the importance of experiential leadership learning and to the assessment and measurement of student learning outcomes. The summer program in the Department of Chemical Engineering and Applied Chemistry is one component of the Engineering Leaders of Tomorrow Faculty-wide leadership development initiative. The program offers a cohort of students the chance to come together for 14 weeks to learn and practice their leadership in an informal setting. Participant-completed surveys suggest that the program is producing positive impact on students' perceived leadership skill. The summer program is one initiative within the Engineering Leaders of Tomorrow program that aims to promote student leadership, enhance student experience, and empower graduating engineers to be effective leaders and change-agents in the world.

References

Bolton, R., & Grover-Bolton, D. (1996) *People styles at work: Making bad relationships good and good relationships better.* Ridge Associates.

Colbeck, C. L., Campbell, S. E., & Bjorklund, S. A. (2000). Grouping in the Dark: What College Students Learn from Group Projects. *The Journal of Higher Education, 7*(1), 60-83.

Crawley, E., Graham, R., & Mendelsohn, B. (2009). *MIT White Paper: Engineering leadership education: A snapshot review of international good practice.*

Florman, S. (1996). *The introspective engineer* New York: St. Martin's Press.

Goertzen, B. J. (2009). Assessment in academic based leadership education programs. *Journal of Leadership Education. 8*(1), 148-162.

Haghighi, K., Smith, K., Karl, A., Olds, B., Fortenbery, N., & Bond, S. (2008). The time is now: Are we ready for our role? *Journal of Engineering Education, 97*(2), 119-121.

Jackson, D. (2011). Perception is Reality: Your Strengths Matter. *Journal of Leadership Education, 10*(1), 115-122.

Kolb, D. (1984). *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Komives, S., Duggan, J., Owen, J., Slack, C., & Wagner, W. (2011) *The Handbook for student leadership development*. National Clearinghouse of Leadership Programs (NCLP).

Seat, E., Parsons, J. R., & Poppen, W. (2001) Enabling engineering performance skills: A program to teach communication, leadership, and teamwork. *Journal of Engineering Education, 90*(1), 7-12.

Thomas, J. (2010). Bet you never heard of this leadership trait. *Journal of Leadership Education. 9*(2), 1-4.

Author Biographies

Annie Simpson is a doctoral student in Curriculum, Teaching and Learning at OISE/University of Toronto. She is also the Coordinator of the Engineering Leaders of Tomorrow Program and the Assistant Director of the Institute for Leadership Education in Engineering (ILead). She has taught in the community college system and has also worked as a counselor, conflict mediator, restorative justice facilitator, and trainer.

Greg Evans is a Professor of Chemical Engineering and Applied Chemistry and the Director of the Southern Ontario Centre for Atmospheric Aerosol Research at the University of Toronto. He is co-leader of Engineering Leaders of Tomorrow and the Associate Director of the Institute for Leadership Education in Engineering (ILead). He is a licensed engineer (P. Eng.) and holds a bachelor of science, master of science, and doctorate (Toronto).

Doug Reeve is Professor and former Chair (2001-2011) of Chemical Engineering and Applied Chemistry at the University of Toronto. He is co-leader of Engineering Leaders of Tomorrow and the Director of the Institute for Leadership Education in Engineering (ILead). He is a licensed Engineer (P. Eng.), holds a bachelor of science (UBC), a master of science, and doctorate (Toronto).