
AC 2012-3871: THE ROSE-HULMAN INSTITUTE OF TECHNOLOGY LEADERSHIP ADVANCEMENT PROGRAM: PREPARING ENGINEERING, MATH, AND SCIENCE STUDENTS FOR LEADERSHIP SUCCESS

Dr. Julia M. Williams, Rose-Hulman Institute of Technology

Julia M. Williams is Executive Director of the Office of Institutional Research, Planning, and Assessment and professor of English at Rose-Hulman Institute of Technology. Her publications on assessment, portfolios, and engineering and professional communication have appeared in the Journal of Engineering Education, IEEE Transactions on Professional Communication, Technical Communication Quarterly, and the European Journal of Engineering Education. She is also Co-founder of the Rose-Hulman Leadership Advancement Program.

Dr. Jameel Ahmed, Rose-Hulman Institute of Technology

Jameel Ahmed is Associate Professor and Interim Head of the Department of Applied Biology and Biomedical Engineering at Rose-Hulman Institute of Technology

Prof. James H. Hanson, Rose-Hulman Institute of Technology

James Hanson is an Associate Professor of civil engineering at the Rose-Hulman Institute of Technology, where his teaching emphasis is structural analysis and design. For the past three years, he has served as part of the Leadership Advancement Program by helping develop and administer the Leadership Academy, the Workshop Series, and other leadership development events.

Samuel N. Peffers, Rose-Hulman Institute of Technology

Samuel Peffers currently serves as Director of Planning at the Rose-Hulman Institute of Technology in Terre Haute, Ind., rated the number one math, science, and Engineering institution in the nation by U.S. News and World Report magazine. He directs the Institute's long range strategic planning effort. The Institute entered the data collection and synthesis phase of its next recurring planning cycle at the beginning of the 2011-12 academic year. Peffers has 24 years of planning and program management experience in public service and has donated his professional skills to various non-profit organizations numerous times.

Ms. Shannon M. Sexton, Rose-Hulman Institute of Technology

Shannon M. Sexton is currently the Director of Assessment at Rose-Hulman Institute of Technology where she designs and implements assessment activities ranging from small projects such as classroom assessments to large projects such as assessment of the Institute-wide student learning outcomes. She also assists faculty in planning, conducting, and analyzing projects and provides professional development opportunities in the area of assessment. She has presented her work in assessment and psychology at both national and regional conferences and has published in the areas of political and social psychology, as well as assessment and engineering education.

The Rose-Hulman Institute of Technology

Leadership Advancement Program: Preparing Engineering, Math, and Science Students for Leadership Success

Introduction

Recently numerous publications have focused on curricular changes needed in engineering education to prepare students sufficiently to meet the challenges of their technical professions. These changes appear to relate less to revisions needed in the technical curriculum and more to revisions that will allow students to develop interpersonal skills, global awareness, and other abilities before graduation.¹⁻² For instance, the National Academy of Engineering's *The Engineer of 2020* points out the need for leadership training for engineers in order to bridge public policy and technology, as well as to encourage engineers to take on roles that they have traditionally been reluctant to take.³

At Rose-Hulman Institute of Technology, the faculty have responded to these needs by adopting undergraduate student learning outcomes across the institution; these six outcomes (available at <http://www.rose-hulman.edu/reps/>) include communication, teamwork, global and cultural awareness, and ethics, outcomes that are also part of the ABET Engineering Criteria. Adoption of these outcomes has required curriculum changes to ensure that each undergraduate student has the opportunity to develop his or her skills before graduation. Although not an ABET-required outcome, leadership and service outcomes are also part of Rose-Hulman's institutional student learning outcomes. The decision to add an outcome for leadership occurred following Rose-Hulman's ABET re-accreditation visit in 2006 and was created in response to a demonstrated need on the part of Rose-Hulman alumni.

Graduates of Rose-Hulman are recognized in industry for their superior technical skills, a result of our technical curriculum. Based on their problem-solving abilities, many of our graduates advance quickly, often assuming leadership roles in their organizations. Assessment of Rose-Hulman alumni (through an Academic Alumni Survey conducted in 2008 and again in 2010) indicated that while alumni felt well-prepared to meet the technical challenges of their professions, they felt less prepared to take on the challenges associated with leadership responsibilities. In 2010, in a stratified sample of Rose-Hulman graduates from all engineering, math, and science programs, 377 respondents evaluated the importance of each of the Rose-Hulman college-wide Student Learning Outcomes to their current professions and indicated the degree of preparation (expressed as "Rose-Hulman's contribution to the development of the skill") they received while undergraduates (see Table 1). These alumnae indicated that leadership is an important skill that is necessary in their current professional positions, but they also believe that Rose-Hulman did not prepare them to the level equal to the importance of the skill.

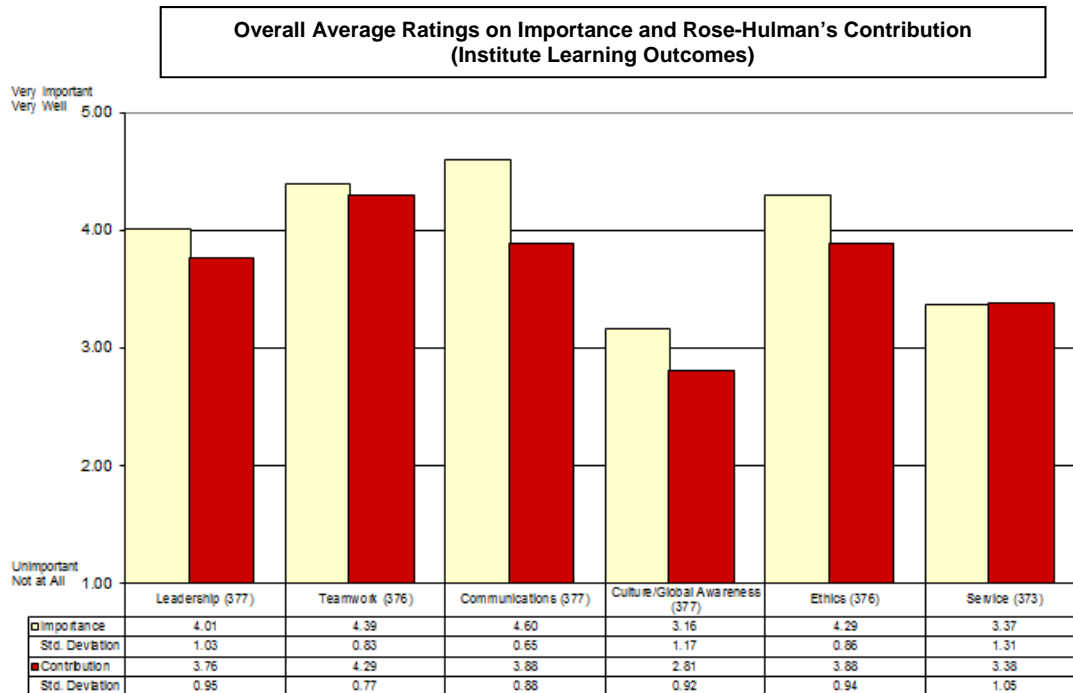


Table 1 : Rose-Hulman Alumni Survey Results 2010

Given the national discussion regarding leadership in engineering education and as a response to the demonstrated need of our alumni, in 2007 a group of faculty and staff instituted a program that would provide support to students in their leadership development. Now in its fourth year of existence, the Rose-Hulman Institute of Technology Leadership Advancement Program (LAP) provides undergraduate students with educational opportunities for leadership development that match their opportunities for developing technical skills.

The purpose of this paper is to present the development of the LAP through its initial stages and then to explain its current components. There is also presentation and discussion of the preliminary assessment results for this pilot project. We believe that by sharing this information, we can encourage other engineering, math, and science programs to adopt the LAP model for their own students.

Review of Literature and Leadership Programs

In order to create our own leadership development approach, we conducted a literature review, as well as a review of current leadership programs that serve engineering, mathematics, and science students at a variety of institutions. Both reviews yielded important information that contributed to the final model for the Rose-Hulman Leadership Advancement Program.

Engineering educators have acknowledged the challenge of providing leadership development opportunities for students, given the crowded curriculum of most engineering programs and the lack of leadership expertise among engineering faculty. Cox, Cekic, and Adams, writing in a special Leadership issue of the *Journal of STEM Education*, conducted a research study with engineering faculty at a Midwestern university; the purpose of the study was to “identify

perceptions of engineering faculty about efforts needed from colleges and universities to develop the leadership skills of undergraduate engineering students.”⁴ Four recommendations emerged from the study. First, rather than creating leadership majors or minors that are housed in the college of engineering, faculty recommended that engineering programs partner externally with programs that “emphasize leadership development . . . business, education, other social sciences, or the humanities.” Second, faculty saw the utility in course modules on leadership that could be incorporated into their current courses, but they believed these modules should be developed by leadership experts, rather than engineering faculty. Third, the respondents believed that the introduction of leadership principles in engineering courses could expose a higher number of students to leadership concepts. Examples such as allowing students to rotate team roles during projects were given. Fourth, respondents argued that the reward structure in colleges and universities would need to be altered in order to allow engineering faculty to incorporate leadership into their technical courses, since currently such activity only counts as service rather than teaching or research (the two major promotion and tenure areas).⁴

From this study (which was conducted under the auspices of a larger study focused on engineering student attributes related to the National Academy of Engineering’s *Engineer of 2020* project in 2004), we were able to see the advisability of partnering with non-engineering departments in the creation and implementation of our leadership development program. We also concluded that providing multiple opportunities for students to enhance their skills, whether in an engineering course or in a co-curricular activity, provided the most promise for impacting the highest number of students. Review of additional sources provided additional suggestions in terms of leadership themes to cover, activities to include, and other useful information.⁵⁻⁹

We also conducted a review of existing leadership programs (via website searches and a series of on-site visits) in order to understand the available models being offered for engineering students’ leadership development. Programs at Iowa State University, Pennsylvania State University, and the University of Michigan (to name only a few) provided important templates upon which we could base our own design. In addition to leadership programs housed within engineering colleges, we considered models not located in engineering and not serving engineering students primarily, such as the Franklin College Leadership Center.¹⁰ We also used the Greenleaf Center for Servant Leadership, located in Indianapolis, Indiana, as a resource.¹¹ Our connection with the Greenleaf Center was a natural one, since Robert Greenleaf, the founder of the Center, had a family connection with Rose-Hulman (he was a student at our institution and his father was on the faculty).

Components of the Rose-Hulman Leadership Advancement Program

The mission of the Rose-Hulman Leadership Advancement Program is as follows:

Recognizing that every person has leadership potential, the Rose-Hulman Leadership Advancement Program provides education and opportunities to lead, thereby enriching the academic, professional, and personal lives of all members of the Rose-Hulman community.

The vision of the LAP is to:

- Integrate leadership training into the academic and co-curricular experience of our students.
- Enhance self-awareness and self-confidence to lead for all members of campus.
- Provide opportunities for focused experience in leadership development for all students, staff and faculty.
- Recognize student commitment to leadership development with credentials (e.g., a Certificate in Leadership, a Leadership Minor).

From its inception, LAP was designed by a multi-disciplinary team representing many different functional units of Rose-Hulman: administrators, faculty, student affairs staff, and staff drawn from other areas. The purpose of this cross-functional approach is two-fold. First, unlike other undergraduate leadership development programs that are sponsored by student affairs staff only or are taught within the context of an academic class, the Rose-Hulman approach integrates leadership development into both a student's academic and co-curricular experience. This integration highlights for students that leadership does not exist separately from their technical work but is integral to it. We also avoided the common faculty concern about adding additional courses to an already crowded technical curriculum. Second, the range of experiences among the LAP team helps bring a diversity of perspectives and abilities to the development of students' leadership. In this way, students can see firsthand that leadership skills as they are embodied by members of the LAP team, each of whom is a leader in his or her own right.

Drawing on successful leadership development models at other institutions, the Rose-Hulman LAP is comprised of five components: Leadership Academy, Leadership Case Study Competition, Workshop Series, and Speaker Series.

Rose-Hulman Leadership Academy

The Rose-Hulman Leadership Academy provides students the opportunity to develop their personal leadership style and equip themselves with tools to make a difference in society. The Academy is open to all students, with or without previous leadership experience. The two-day Academy is an intensive workshop designed by Rose-Hulman faculty and staff to build each participant's confidence in his or her ability to lead, consciousness of various leadership approaches, and connection to leadership resources and mentors. The curriculum cultivates skills through lectures, guest speakers, team interactions, team building activities, and assessment through self-reflection. Topics include character development, leadership communication, leadership theories, and personal leadership development.

Leadership Speaker Series

The Leadership Speaker Series brings noted speakers on topics related to leadership to the Rose-Hulman campus. The events are open to all campus community members, as well as to the general public. Previous speakers have included Dr. Samuel Hulbert, former president of Rose-Hulman and Mr. Bill Cook, president of Cook Biomedical.

Crisis Simulation Exercise

This role-playing exercise invites students to immerse themselves in a challenging, high-pressure leadership scenario. It allows them to practice their leadership skills in a rapidly changing, high-stakes environment. In January 2011, the crisis simulation focused on a potential eruption of

Mount Rainier. Students assumed different roles as members of the community to manage the impending event.

Case Study Competition

The competition provides students with the opportunity to find a solution to a business case by applying problem-solving skills and leadership theory and principles. Students receive the case on Friday evening and have until the next morning to review the scenario and develop a solution. Student teams present their solution in a written report and deliver a presentation to a panel of judges on Saturday. Awards are given to the first and second place teams. Dr. Dean Bartles, VP and General Manager, Large Caliber Ammunition, at General Dynamics, Inc., served as guest judge for the 2011 Case Study Competition.

Leadership Workshop Series

This series brings students together to explore specific leadership topics and to further develop their leadership skills. The 2011-12 Series consists of three workshops:

- An interactive team leadership workshop led by Dr. Jason Winkle, CEO of WinkleCorp, a leadership development and coaching company.
- A workshop on Leadership, Innovation & Career Coaching, co-presented by National Instruments and Rose-Hulman faculty and staff
- And a Rose-Hulman alumni panel discussion on the topic of leadership.

We initiated the LAP in the summer of 2008, with the first Leadership Academy. We repeated the Academy again during the 2008-09 academic year (in 3 two-hour sessions over 6 months) and added the additional components. Beginning in 2009, we settled on the two-day Leadership Academy (taking place over the college's Fall Break in October), with the rest of the LAP components occurring regularly throughout the academic year.

Assessment Plan and Results 2008-2010

As part of the Leadership Advancement Program at Rose-Hulman, we have developed an assessment plan and developed specific tools to measure the impact of the Leadership Advancement Program activities on our students. A mixed method design for assessment tools has been used.

First, quantitative data on each activity are collected (see Figure 1). These data include the number, gender, class standing, and major of each student participating. In addition, we calculate the cost of conducting each activity per attendee. While we are primarily focused on impact related to students, we also track the number of faculty and staff who attend an event and/or are participating in an event as a mentor, moderator, or coordinator. These data are important for our future planning, since we wish to expand the reach of LAP to include leadership development activities for our faculty and staff. At this point, however, our financial resources have limited the scope of LAP to students primarily.

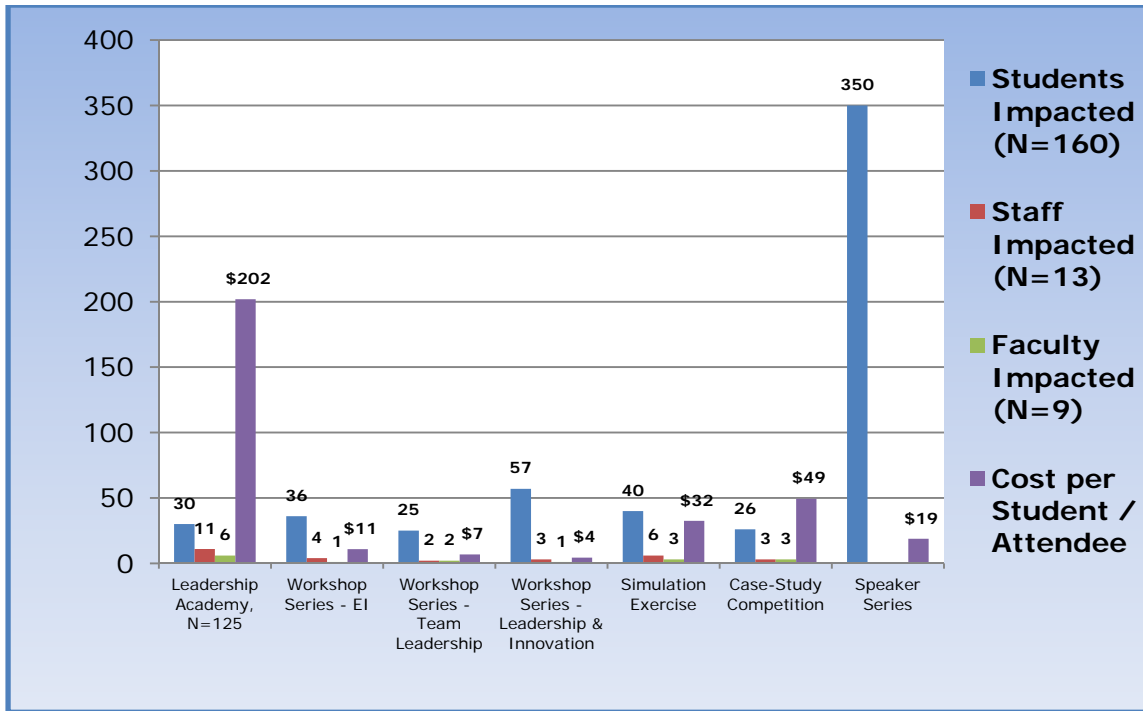


Figure 1: LAP Quantitative Data, 2010-11

Second, qualitative data are also collected for each LAP event, in the form of comment cards (see Figure 2). Each student who attends the event is asked to provide their feedback by rating different aspects of the event and is encouraged to provide qualitative feedback as well.

Leadership Advancement Program
Team Leadership; National Instruments Leadership Team
 Wednesday, February 16, 2011

Place an "x" in the box that best matches your response.

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1. The information was presented in a way I can easily understand.				
2. I learned something of value from the session.				
3. I will apply the information from the session in developing my own leadership ability.				
4. I would recommend this workshop to others.				

The most important thing I learned from this session was:

If you would like to suggest a topic for next year's workshop series, please do so on the back of this card.

Figure 2: LAP Comment Card Sample

Both qualitative and quantitative data are collected regarding the Rose-Hulman Leadership Academy, and because the Academy is the centerpiece of the LAP, we devote both time and effort to assessing the success of this event (see Figure 3).

Rose-Hulman Leadership Academy Assessment Plan (2009-2012)
Contact: Julia Williams

Target Group	Goals	Objective	Assessment Activity	Timeline	Comments
Students	Improve leadership skills and understanding in student participants	Develop self-confidence in his/her leadership ability	*SLPI	Start of Academy & 1 month out	Revise SLPI to measure self-efficacy not behavior. Put on Angel – Needs more testing
		Develop his/her own leadership style	*Survey	End of Academy & 6 months out	Map to Institute Outcomes (Leadership B1 & B2) and submit to portfolio for rating
		Create a plan for his/her own leadership development	Personal Leadership Plan	End of Academy	Plan submitted to Angel Alumni Survey (SLO)
	Engage and involve a higher number and percentage of RHIT students in leadership academy	Engage 30 students per year in leadership academy	Score Card	Annually	Create a score card similar to RHV to monitor various quantitative data
		Increase awareness of Academy opportunities on campus	SIQ	Annually	Add item on academy awareness and impact to SIQ
	Achieve operational excellence	Achieve over 90% of students satisfied with their Academy experience	<ul style="list-style-type: none"> Exit Interview Survey* Program Content Eval* 	Daily, 1 month out & 6 months out	Exit interview to gather formative feedback on academy. Similar to department senior exit interviews Program Content Evals done daily.
		Achieve over 90% of alumni applying their Academy experience	Institute Alumni Survey	Every other year	Add item to Institute Alumni Survey asking about Academy experience. Monitor leadership skill application.
Faculty/Staff	Engage and involve a higher number of RHIT faculty & staff in Leadership Academy programs	Achieve over 90% of faculty/staff/mentors satisfied with their Academy experience	Survey	End of each Academy	Examine the impact of participating in the Academy on faculty/staff
		Disseminate Academy information	Score Card	Annually	Faculty forums, NASPA, conferences, table tents
		Implement Academy experience in class	Survey	Annually	

* Current assessment item

Figure 3: Leadership Academy Assessment Plan

Several assessment activities listed above require further explanation. The Student Leadership Performance Inventory (SLPI) is a nationally normed inventory that we ask students to complete. In addition, we collect data from incoming first-year students on the Student Interest Questionnaire (SIQ) as a way to measure how much knowledge they have about the Leadership Academy before they enroll at Rose-Hulman (information that was circulated via first-year student orientation materials, on-campus presentations, etc.). Students who enroll in the Leadership Academy are asked to complete a pre-Academy survey in which they indicate their agreement with a variety of leadership statements. They are also asked to indicate which of 5 leadership areas they view as a strength or a weakness. Finally, they are asked to compare themselves to their peers on their ability to perform 5 leadership activities. At the end of the Academy, students rate themselves on these same items again, with additional questions regarding which areas were most improved as a result of the Academy. In the post-Academy survey, in addition to the quantitative items, students are asked to provide qualitative feedback on areas of their lives that leadership training has helped them and aspects of the training they implemented most and least (see Appendix).

In 2010, we compiled data collected over 3 occurrences of the Rose-Hulman Leadership Academy. A total of approximately 91 participants took part in the assessment process over the 3 years.

On the pre-Academy survey, students most often cited “character” (76%) as a strength and “communication” (54%) as a weakness (see Figure 4). The same pattern was true on the post-Academy survey. Students most often cited “character” (85%) as a strength and “communication” (48%) as a weakness. There were no statistical differences pre- to post-Academy on student reports of strength or weakness.

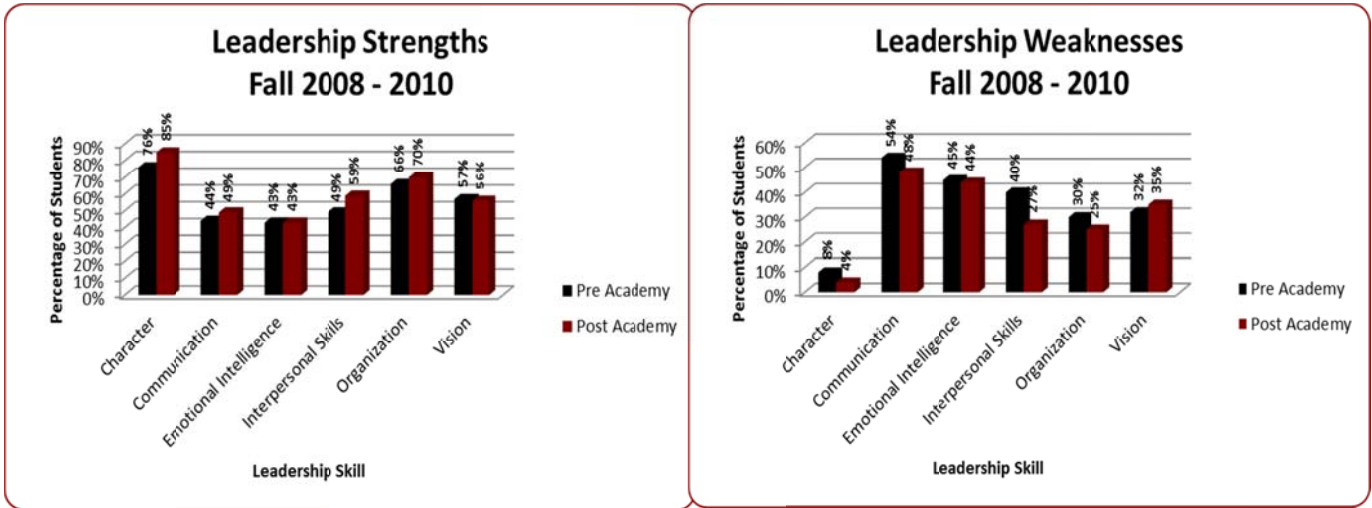


Figure 4: Leadership Strengths and Weaknesses, Pre- and Post-Academy

On the post-Academy survey, students most often cited “interpersonal skills” (51%) as most improved. They cited “communication” (69%) as most beneficial in the long-term (see Figure 5).

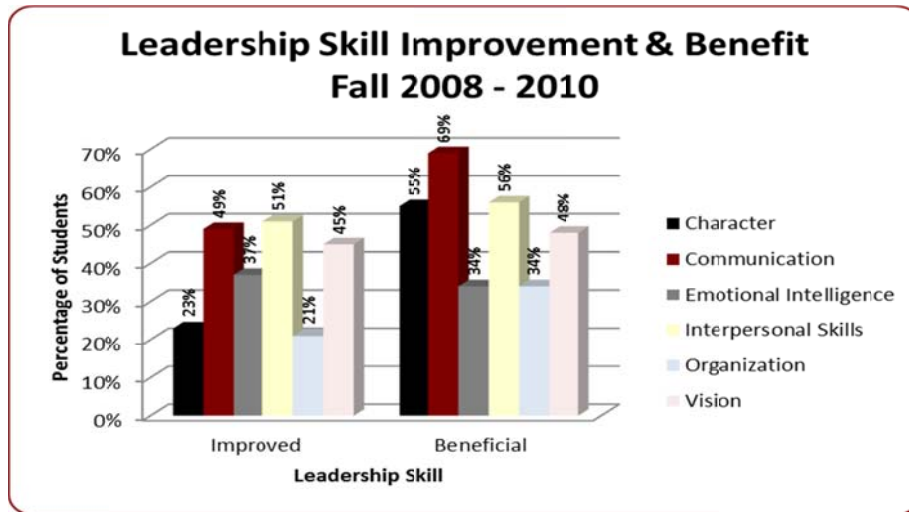


Figure 5: Leadership Skill Improvement and Benefit, Post-Academy

Overall, students agreed “leadership is a *learned skill*” and disagreed that “leadership is an *innate ability*” (Scale: 1=Strongly Disagree through 4 = Strongly Agree). There was no statistically significant difference in agreement pre- to post-Academy. There was a statistically significant increase pre- to post-Academy on student agreement with “I have the *potential* to be an effective leader.” However, even though the mean difference is significant, both pre-and post-Academy ratings were "agree" (see Figure 6).

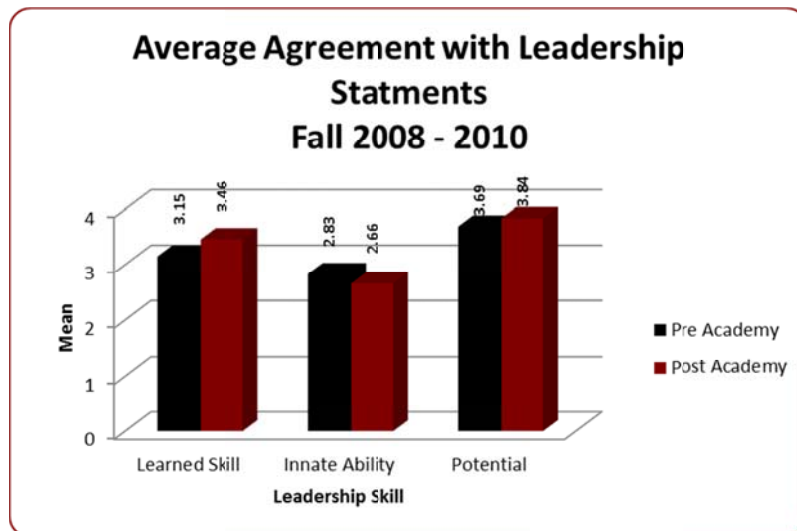


Figure 6: Average Agreement with Leadership Statements, Pre- and Post-Academy

Overall, students felt they were “average” to “above average” compared to peers on each of the five leadership skills. There was no statistically significant difference in student rating pre- to post-Academy for the majority of the items. There was a statistically significant decrease pre- to post-Academy on student ratings of their ability to “*listen* to other people’s opinions.” However, even though the mean difference is significant, both pre-and post-Academy ratings were "above average."

Discussion and Conclusion

As we assess the Leadership Advancement Program components and the student results, we acknowledge that we must address several challenges as we move out of the pilot stage of our project. These challenges relate both to the programming that comprises the LAP and to the assessment dimensions of our effort.

First, we have gained important campus support from students, faculty, and staff for the LAP. In general, members of our campus community recognize the importance of leadership development for our students; these views are shared by our alumni who also support the effort. Unfortunately we have yet to secure a funding line, and so our activities must rely on one-time funding from separate departments and offices, like the office of the Dean of the Faculty. Also, because of limited funding, we have not yet been able to accomplish our goal of offering leadership development to faculty and staff; we believe that this development is crucial if faculty and staff are to serve as role models for our students.

Second, our assessment efforts have permitted us to develop and refine LAP components, and we have initial self-report data from students on how LAP activities contribute to their development as leaders. We have not yet, however, been able to implement a nationally-normed assessment instrument, such as the SLPI, to help us determine student development beyond self-report. Our use of the SLPI has only occurred with one Academy cohort because we noted that our students were being asked to evaluate their leadership skills over an extended period of time. We have begun initial development of an alternative assessment, but it has not yet been tested and validated. The use of such an instrument is crucial if we are to argue for the far-reaching impact of LAP on students. We would also like to track the leadership development of any student who participates in LAP activities. Such tracking is currently beyond our resources now, but we hope to identify strategies that will help us implement such tracking in the second stage of our project.

Bibliography

- [1] "Educating Engineers for the New Market," *Bloomberg Businessweek*, February 27, 2007.
- [2] Sheppard, S.D., K. Macatangay, A. Colby, W.M. Sullivan, and L.S. Shulman. *Educating Engineers: Designing for the Future of the Field*. New York: Jossey-Bass, 2008.
- [3] *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. Committee on the Engineer of 2020, Phase II, Committee on Engineering Education, National Academy of Engineering 2005.
- [4] Cox, M.F., O. Cekic, and S.G. Adams. "Developing Leadership Skills of Undergraduate Engineering Students: Perspectives from Engineering Faculty." *Journal of STEM Education: Innovations & Research*, Vol. 11, Issue 3/4 (2010): 22-33.
- [5] Siller, T.J., A. Rosales, J. Haines, and A. Benally. "Development of Undergraduate Students' Professional Skills." *Journal of Professional Issues in Engineering Education & Practice*, Vol. 135, Issue 3 (2009): 102-108.
- [6] Feldhaus, C.R., R.M. Wolter, S.P. Hundley, and T. Diemer. "A Single Instrument: Engineering and Engineering Technology Students Demonstrating Competence in Ethics and Professional Standards." *Science & Engineering Ethics*, Vol. 12, Issue 2 (2006): 291-311.
- [7] Farr, J.V., and D.M. Brazil. "Leadership Skills Development for Engineers." *Engineering Management Journal*, Vol. 21, Issue 1 (2009): 3-8.
- [8] Cox, M.F., C.A. Berry, and K.A. Smith. "Development of a Leadership, Policy, and Change Course for Science, Technology, Engineering, and Mathematics Graduate Students." *Journal of STEM Education: Innovations & Research*, Vol. 10, Issue 2 (2009): 9-16.
- [9] Athreya, K.S. and M.T. Kalkhoff. "The Engineering Leadership Program: A co-curricular learning environment by and for students." *Journal of STEM Education: Innovations & Research*, Vol. 11, Issue 3/4 (2010): 70-74.
- [10] Franklin College Leadership Center. <<http://www.franklincollege.edu/academics/minors/leadership>>
- [11] The Greenleaf Center for Servant Leadership. <<http://www.greenleaf.org/>>

Appendix: Rose-Hulman Leadership Academy Survey (Post-Academy Survey)

1. I have the potential to be an effective leader.

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

2. Leadership is a *learned* skill.

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

3. Leadership is an *innate* ability.

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

4. Which of the following leadership areas do you view as your strengths (mark all that apply)?

- Character
- Communication
- Emotional Intelligence
- Interpersonal Skills
- Organization
- Vision (direction)

5. Which of the following leadership areas do you view as your weaknesses (mark all that apply)?

- Character
- Communication
- Emotional Intelligence
- Interpersonal Skills
- Organization
- Vision (direction)

6. Which of the following leadership areas do you feel you have improved the most as a result of this training?

- Character
- Communication
- Emotional Intelligence
- Interpersonal Skills
- Organization
- Vision (direction)

7. Please explain your answer to item 6.

8. Which of the following topics do you think will be most beneficial to you long-term?

- Character
- Communication
- Emotional Intelligence
- Interpersonal Skills
- Organization
- Vision (direction)

9. Please elaborate more specifically on your answer to question 8.

Please rate your current ability to perform each of the activities below compared to your peers.

10. Conduct a meeting

- One of the Best
- Above Average
- Average
- Below Average
- One of the Worst

11. Inspire someone to take action

- One of the Best

- Above Average
- Average
- Below Average
- One of the Worst

12. Resolve a conflict between yourself and another person

- One of the Best
- Above Average
- Average
- Below Average
- One of the Worst

13. Make a presentation to a group of people

- One of the Best
- Above Average
- Average
- Below Average
- One of the Worst

14. Listen to other people's opinions

- One of the Best
- Above Average
- Average
- Below Average
- One of the Worst

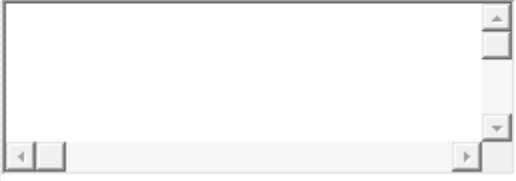
15. In what areas of your life do you think this leadership training will help you? Please be as specific as possible.

16. What aspect of this training did you enjoy the most?

17. What aspect of this training did you enjoy the least?

An empty text input field with a light gray background and a thin border. It features a vertical scrollbar on the right side and horizontal scrollbars at the bottom.

18. Additional comments:

An empty text input field with a light gray background and a thin border. It features a vertical scrollbar on the right side and horizontal scrollbars at the bottom.

Done