

Quality Approaches in Higher Education

May 2013 • Volume 4, No. 1

Editor

Fernando F. Padró
qahe@asqedu.org

Special Issue Editor
Cindy P. Veenstra

Associate Editors
Sid Nair
Theodore Allen

Copy Editor
Janet Jacobsen
janetjake@msn.com

Production Administrator
Cathy Milquet
cmilquet@asq.org

Layout/Design
Laura Franceschi
Sandra Wyss

Founding Editor
Deborah Hopen

©2013 by ASQ

IN THIS ISSUE:

Guest Commentary: Real-World Engineering Education: The Role of Continuous Improvement 2
Paul D. Plotkowski

Using Assessments to Determine the Quality and Effectiveness of a Collaborative Internship Program in Research 5
Thomas E. Pinelli, Cathy W. Hall, and Kimberly M. Brush

Case Study: Application of Blended Learning for an Engineering Simulation Course 13
Theodore T. Allen, Sharnnia Artis, Anthony Afful-Dadzie, and Yosef Allam

Investing in Engineering Student Leaders Through Industrial and STEM Partnerships 23
Rhonda K. Kowalchuk, Bruce D. DeRuntz, and John W. Nicklow

Editor's note: This issue of *Quality Approaches in Higher Education* is focused on STEM education and partnerships among universities, industry, and government that enhance and provide experiential learning to STEM and engineering majors. This issue celebrates the ideas and planning behind the upcoming ASQ Education Division's Advancing the STEM Agenda Conference, co-sponsored with Grand Valley State University's Seymour and Esther Padnos College of Engineering and Computing on June 3-4. Significantly, the theme of the conference is "Collaboration with Industry on STEM Education." We asked Dean Paul Plotkowski to introduce this issue with a commentary on the engineering program at Grand Valley State University and the collaboration it has with industry. We further highlight advances in STEM learning, education, leadership, and collaboration with articles from NASA's Langley Research Center, The Ohio State University, and Southern Illinois University Carbondale. Together, these articles represent different and critical perspectives on how the STEM agenda is impacting STEM programs to develop better prepared professionals.

—Cindy P. Veenstra, special issue editor

The Journal That Connects Quality and Higher Education

Quality Approaches in Higher Education (ISSN 2161-265X) is a peer-reviewed publication that is published by ASQ's Education Division, the Global Voice of Quality, and networks on quality in education. The purpose of the journal is to engage the higher education community in a discussion of topics related to improving quality and identifying best practices in higher education, and to expand the literature specific to quality in higher education topics.

Quality Approaches in Higher Education grants permission to requestors desiring to cite content and/or make copies of articles provided that the journal is cited; for example, Source: *Quality Approaches in Higher Education*, Year, Vol. xx, (No. xx), <http://asq.org/edu/quality-information/journals/>

Questions about this publication should be directed to ASQ's Education Division, Dr. Fernando Padró, qahe@asqedu.org. Publication of any article should not be deemed as an endorsement by ASQ or the ASQ Education Division.



Education
Division
The Global Voice of Quality™

ONLY @ asq.org/edu

An innovative
partnership
program that
develops
community college
graduates into
engineering
leaders

Investing in Engineering Student Leaders Through Industrial and STEM Partnerships

Rhonda K. Kowalchuk, Bruce D. DeRuntz, and John W. Nicklow

Abstract

Students, universities, and industry are all struggling during these economically-challenging times. Students face rising tuition costs, universities face a reduction of state funding, and industry has a looming shortage of future technical leaders. Creating industrial and government partnerships to support the development of America's future technical leaders has become imperative. The Southern Illinois University Carbondale's (SIUC) Leadership Development Program (LDP) meets many of these pressing problems. The LDP has received more than \$1 million from corporate sponsors and the National Science Foundation's (NSF) Science, Technology, Engineering, and Mathematics (STEM) program to attract and develop engineering technical leaders. The university strives to graduate community-college-degreed transfer students within two and one half-years in an engineering leadership program.

Keywords

STEM, Leadership, Training

Introduction

In its broadest perspective, the STEM initiative is about jobs for the American people that help grow the economy, maintain national security, and sustain the standard of living in the United States. Of course, achieving these objectives is all predicated upon the United States having a highly technically-educated workforce, capable of developing innovative products and processes. The America Competes Act, which was signed into law on August 9, 2007, seeks to double spending on NSF STEM education programs in response to a shortfall of college graduates in the technical fields (Kuenzi, 2008).

Historically, there has been little change in the total number of undergraduate and graduate students enrolled in engineering majors from 1989 to 2006 (National Science Board, 2012, Appendix Table 2-22). While this relatively flat statistic may suggest that students graduating with STEM majors are holding their own; the U.S. Bureau of Labor statistics is projecting an 11% increase in the demand for engineering professionals between 2008-18 (Bureau of Labor Statistics, 2010). With the launch of NSF's successful STEM initiative in 2007, there has been a significant increase in engineering majors (National Science Board, 2012, Appendix Table 2-22).

The National Association of Colleges and Employers salary survey (NACE, 2009) gives further evidence of the ongoing need for engineers. Their report presents data indicating that graduates with a bachelor's degree in engineering received the highest starting salary offers. This statistic, coupled with basic supply and demand market principles, confirms the ongoing shortage of new engineers entering the marketplace.

While it is a widely recognized that the United States is in need of an increasing number of STEM graduates, a greater crisis looms over a shortage of technical leaders. In his book *Where Have All the Leaders Gone?* Lee Iacocca (2007) focuses on the issue of a leadership shortage in the United States. He considers this core issue to be the greatest challenge facing the country and goes on to say:

Name me an industry leader who is thinking creatively about how we can restore our competitive edge in manufacturing. Who would have believed that there could ever be a time when 'The Big Three' referred to Japanese car companies? How did this happen, and more important, what are we going to do about it? (p.13)

A great opportunity to fulfill the STEM mission has presented itself if key stakeholders from industry and academia can work collectively to attract community college graduates to baccalaureate-level degrees (President's Council of Advisors on Science and Technology, 2012). The public/private partnerships can create successful technical leadership development programs that can bring about a paradigm shift in the way technical leaders are created (Astin & Astin, 2000). This paper describes SIUC's success with such a program which helps to remove economic barriers that may otherwise prohibit college graduates from achieving an engineering degree and entering a technologically-challenging workforce.

Background

The SIUC's College of Engineering's LDP has achieved excellent growth and success in just its first five years. In 2006, Advanced Technology Services (ATS) CEO, Dick Blaudow, donated \$250,000 to SIUC's College of Engineering (COE) to establish a leadership development program that would benefit all parties involved. This program was created with the intent and direction of supporting his alma mater, providing financial and career opportunities for students, and developing future leaders for ATS and the United States. The scholarship offers participating college students \$18,000 toward the cost of two years of tuition, a summer internship with ATS, an opportunity for a fast-track career, and early leadership training and development. The early success of this program has inspired key stakeholders to expand the LDP model to more students, majors, and sponsors. In addition, NSF has recognized the potential of this program and has funded \$600,000 toward its outreach to more students. NSF's investment is funding 30 scholarships over the next five years (2010-2015). Additionally, Blaudow continues to donate to the program and has invited the College of Business to participate with its students.

The LDP is a human resource development program that requires much more leadership than coordinating the allocation of scholarships. The LDP should be more closely identified with an ROTC program or top university scholarships because of the challenging program requirements and the commitment by recipients. The LDP enables recipients to make measurable progress toward developing their leadership skills by taking leadership classes with the engineering curriculum, assuming leadership roles in Registered Student Organizations (RSO), leading service projects throughout the year, developing and attending leadership workshops, and completing a summer internship.

A university's primary mission is to provide education for students and outreach services for the community. To support that mission, SIUC realized it could capitalize on its talent resources and invest in programs that attract business partners. Today, it is commonplace for the best universities to invest in research parks

and centers of excellence as well as to provide matching funds for grants. Universities make these investments because the comprehensive financial returns they receive make it an attractive business proposition as well as a valuable service to the community.

The LDP is similar to other successful programs across the United States. Other prominent universities have realized the value of technical leadership programs and have made commitments to support their programs (Gordon, 2012). A few examples include: Bernard M. Gordon-MIT Engineering Leadership Program (pp. 85-91), Gordon Engineering Leadership Program (pp. 93-107), Bernard and Sophia Gordon Engineering Leadership Center University of California San Diego (pp. 133-140), the Iacocca Institute at Lehigh University, Tufts Engineering Leadership Program, University of Colorado Engineering Leadership Program, UC Berkeley Engineering Leadership Professional Program, and the Miami University Lockheed Martin Leadership Institute. The LDP has realized many positive outcomes for its students and stakeholders in a short time. A few of those outcomes for students include: generous financial assistance; advanced career placement; industry internships leadership training and experience; as well as increased performance, including increased graduation rates, higher GPAs, and leadership recognition. The college receives multiple prestigious scholarships to offer, trained student leadership in most of the COE's 14 RSOs, the prestige of having one of the few technical leadership programs in the country, significant funding for their RSOs, an ability to attract high caliber students, national recognition at student competitions, greater student body participation in RSOs, tutoring support of the student body, larger and more successful service projects, stronger relationships with community college partners, and long-term industry relationships. The university receives strengthened relationships with industry and a proven student leadership model that can be expanded across the campus. Finally, industry receives future technical leaders that will allow them to meet their strategic objectives.

Project Goals

The goals associated with the LDP have evolved beyond meeting the needs of the financial sponsor. The corporate sponsor sought to attract graduates into their company, realize a financial return from intern Six Sigma projects, and recognize a high degree of leadership potential in the program graduates. The early success realized by the corporate sponsor led the way to winning an NSF STEM grant in 2010 to expand the program. NSF requires ongoing evaluation of the project to assess the progress toward achieving its primary objective.

The STEM grant aims to achieve a two and one half-year graduation rate (e.g., four and one half years after beginning at the community-college level) of at least 90%. Support activities

for scholarship recipients build upon existing student support programs (e.g., peer mentoring, minority support programs, and tutoring). The intellectual merit of this funded project is the determination as to whether retention, graduation, and job placement rates of students attracted to engineering and technology can be increased by providing financial support and by implementing student support and leadership programs. The broader impact of the project is an increase in the breadth of social and economic backgrounds of students graduating in engineering and, thus, of prepared individuals entering the job market.

Methodology

Evaluation Design

The evaluation design for the NSF-funded project includes quantitative methods to assess the success of the LDP. Funding for the NSF project began in 2010 and, thus to date, only data for the first cohort is complete; however, preliminary data is presented for the 2011 cohort. Ongoing evaluation of the program for each cohort includes the following assessment tools: Student Leadership Practices Inventory (SLPI) (Kouzes & Posner, 2006); Grit Scale (Duckworth, Peterson, Matthews, & Kelly, 2007; Duckworth & Quinn, 2009; Jaeger, Freeman, Whalen, Payne, 2010); and student performance data (e.g., retention status and GPA). The LDP cohort group completes the SLPI and the Grit Scale at the start of their first year, at the start of their second year, and at the end of their second year of studies. A paired comparison with a peer group is identified from the current cohort of transfer students.

Instruments

The SLPI consists of 30 items with “six statements to measure each of The Five Practices of Exemplary Student Leadership” (Kouzes & Posner, 2006, p. 6). The five practices include Model the Way (finding your voice, setting the example); Inspire a Shared Vision (envisioning the future, enlisting others); Challenge the Process (searching for opportunities, experimenting and taking risks); Enable Others to Act (fostering collaboration, strengthening others); and Encourage the Heart (recognizing contributions, celebrate the values and victories) (pp. 11-16). The scores for each of the five practices range between six and 30. The internal consistency of the five practices varies from .68 (Model the Way) to .80 (Encourage the Heart) (p. 83).

The Grit Scale (Duckworth et al., 2007; Duckworth & Quinn, 2009; Jaeger et al., 2010) consists of 17 items measuring four subscales, and grit is defined as “perseverance and passion for long term goals” (Duckworth et al., 2007, p. 1,087). The four subscales include: Ambition, Perseverance of Effort, Consistency of Interest, and Brief Grit. For example, ambition is characterized

by achieving something of lasting importance, high perseverance of effort relates to overcoming setbacks and challenges, and low consistency of interest relates to being distracted by new ideas and projects. In addition, there is a total grit score that has shown an internal consistency of .77 to .85 across studies (Duckworth et al., 2007). The brief grit is a subset of eight items from the Total Grit Scale. The scores for each subscale are averaged across their respective items and can range between 1 and 5.

Participants

Selection of first-year scholarship recipients was based upon financial need, community-college cumulative grade point average (GPA), an essay that outlines their career goals, and a personal interview. Peer comparison students were selected based on being admitted to the COE as a transfer student in the respective fall semester with a junior classification and a transfer GPA of 3.00 or greater. The GPA criterion was lowered to 2.75 or greater to increase the sample size for the peer comparison group in 2011 from 10 to 15 students.

In the 2010 cohort eight (80%) students were male and two (20%) were female, whereas in the 2011 cohort, all students were male. In the 2010 peer group, 16 (80%) students were male and four (20%) were female and in the 2011 peer group, 12 (80%) students were male and three (20%) were female. Student ethnicity distribution was: 2010 cohort, two (20%) Black and eight (80%) White; 2011 cohort, eight (100%) White; 2010 peer group, three (15%) Asian/Pacific Islander, one (5%) Hispanic/Latino, and 16 (80%) White; and 2011 peer group, 13 (87%) White and two (13%) unknown. The LDP cohorts are comprised of students primarily from Illinois' southernmost eight community colleges.

Findings

Retention and GPA

In the 2010 cohort ($n = 10$), three students left the LDP but remained enrolled in the COE, and one student left the university after his first semester. The two and one half-year graduation rate is six out of 10 (60%) for those students completing the LDP and eight out of 10 (80%) when including those students who left the LDP. In the 2010 peer comparison group ($n = 20$), one student switched majors in her second year, and one student left the university after his second year for academic reasons. The two-year graduation rate from the COE for the 2010 peer group is 11 out of 20 (55%) with an anticipated three-year graduation rate of 18 out of 20 (90%). No statistically significant difference ($p = 0.05$) was found for graduation rates between the 2010 cohort and peer groups. In the 2011 cohort ($n = 8$), one student switched majors after his first semester. The remaining seven students have been retained in the LDP. In the 2011 peer comparison group ($n = 15$),

one student left the university in her first semester, and one student left the university after his second semester for academic reasons. Currently, retention rates are similar between the 2011 cohort and peer comparison groups.

Table 1 contains descriptive statistics for cumulative GPA for the LDP cohort and peer comparison groups at the end of year one and year two (e.g., their junior and senior years, respectively). It is noteworthy that all groups maintained an average cumulative GPA above 3.00, which is a requirement for the LDP. Furthermore, the LDP cohorts compared to their peer counterparts maintained a higher minimum GPA with less variability (e.g., smaller standard deviation). The 2010 cohort had higher average cumulative GPAs compared to their peer group, although not statistically significant ($p=0.05$).

SLPI and Grit Scale

Figure 1 contains the average scores for each of the five practices of the SLPI for the 2010 LDP cohort ($n = 7$) at the beginning of year one (Yr1), at the start of year two (Mid), and at the end of year two (Yr2); and the 2010 peer ($n = 12$) comparison group during their first year (Yr1) and at the end of year two (Yr2).

Examining the SLPI scores in terms of percentiles has shown that a “high” score is one at or above the 17th percentile, a “low” score is one at or below the 13th percentile, and a score that falls between those ranges is considered “moderate.” (Kouzes & Posner, 2006, pp. 34-35). All scores fall in the moderate range with the following exceptions: the 2010 peer (Yr1) group score for the challenge subscale is high; the 2010 cohort (Yr1) group score for the enable subscale is high; the 2010 cohort (Yr1) group score for the challenge subscale is low; the 2010 cohort (Mid) group scores for the model, inspire, challenge, and encourage subscales are low; and the 2010 cohort (Yr2) group scores for the model, inspire, and encourage subscales are low.

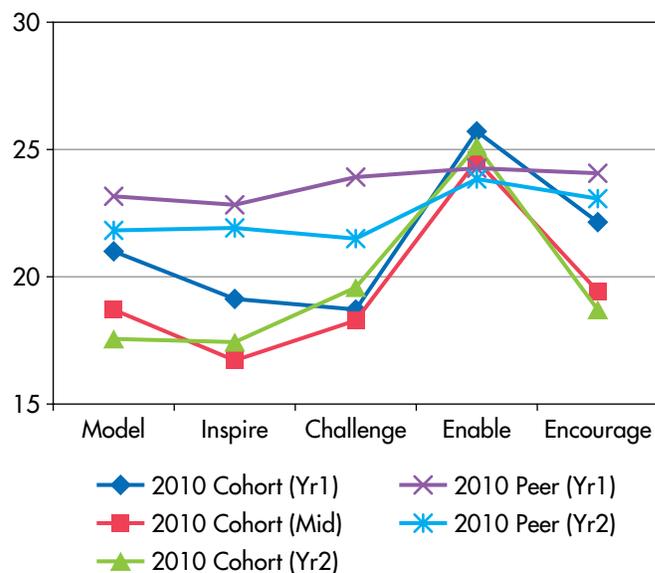
An interesting finding is the drop in SLPI scores for the 2010 cohort and the consistency in pattern from the start of their second year (Mid) to the end of their second year (Yr2). Similarly, the 2010 peer comparison group also showed a drop in SLPI scores. Students complete the SLPI themselves throughout the program, during that time their education and experiences enlighten them as to what it truly takes to be a leader (per The Leadership Challenge workshop training and LDP). By the conclusion of their training and leadership experiences most of them have become “humbled” leaders who feel that there is so much more they need to do to become competent leaders who have earned the trust of their team. An improvement to this data collection methodology was made by conducting a 360-degree evaluation of the future leaders by their peers and program director (implemented in the spring 2012). One shortcoming of this approach would be the lack of data attainable at the start of the students’ program because none of their peers or director

Table 1: Descriptive Statistics on Cumulative GPA for LDP Cohort and Peer Comparison Groups

Group	Time	N	Min/Max	Mean	SD
2010 Cohort	Year 1	7	2.29/4.00	3.38	0.59
	Year 2	6	2.94/4.00	3.47	0.44
2010 Peer	Year 1	20	2.08/4.00	3.19	0.65
	Year 2	18	2.48/4.00	3.24	0.53
2011 Cohort	Year 1	7	2.57/4.00	3.25	0.53
2011 Peer	Year 1	14	1.54/4.00	3.34	0.62

Note. Min = minimum score, Max = maximum score, SD = Standard Deviation. None of the mean comparisons between the respective cohort and peer groups were statistically significant at the 0.05 significance level

Figure 1: SLPI Mean Scores for 2010 LDP Cohort and Peer Comparison Groups

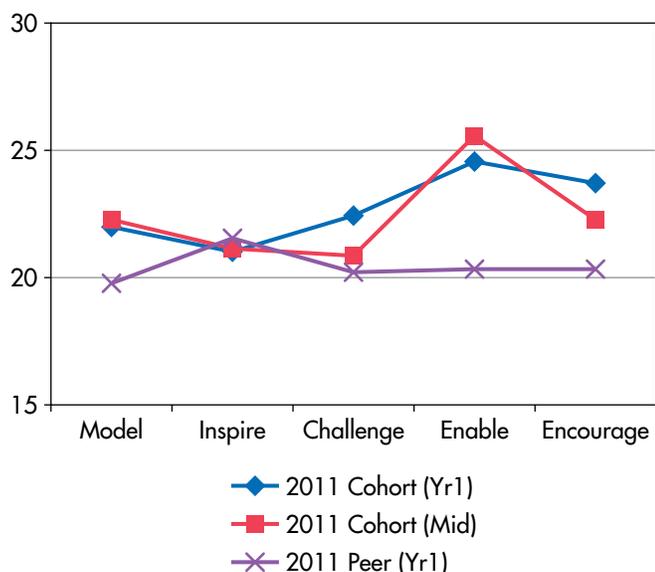


would know them well enough to evaluate them and establish an absolute beginning baseline, more like a mid-training baseline.

Figure 2 contains the average scores for each of the five practices of the SLPI for the 2011 LDP cohort ($n = 7$) at the beginning of year one (Yr1) and at the start of year two (Mid); and the 2011 peer ($n = 9$) comparison group during their first year (Yr1). All scores fall in the moderate range with the following exception, the 2011 peer (Yr1) group scores for the Model, Enable, and Encourage subscales are low.

The 2011 cohort has a similar overall profile pattern compared to the 2010 cohort; however, the mean scores across subscales are higher for the 2011 cohort with the exception of the enable subscale.

Figure 2: SLPI Mean Scores for 2011 LDP Cohort and Peer Comparison Groups



In addition, for the 2011 cohort, the mean scores across subscales is fairly consistent from year one to the start of year two (Mid) with a slight drop in mean scores for the challenge and encourage subscales, whereas in the 2010 cohort, mean subscale scores showed a drop in scores for three out of the five subscales (e.g., model, inspire, and encourage). Also noteworthy is that the 2011 peer group has lower mean scores for four out of the five subscales compared to the 2011 cohort group. This finding is opposite to the pattern observed in the 2010 cohort and peer groups on the SLPI.

Table 2 contains descriptive statistics for the Grit Total Scale score and the subscales (ambition, perseverance of effort, and consistency of interest) for the 2010 LDP cohort at the beginning of year one (Yr1), at the start of year two (Mid), and at the end of year two (Yr2); the 2011 LDP cohort at the beginning of year one (Yr1) and the start of year two (Mid); the 2010 peer comparison group during their first year (Yr1); and the 2011 peer comparison group during their first year (Yr1). For the 2010 cohort group, there was a drop in total scale scores from year one, to the end of year two, whereas for the 2011 cohort group, there was a slight increase in total scale scores from year one to the start of year two (Mid). The respective peer comparison groups have lower overall total scale scores, albeit still above the mid-point on a five-point scale.

Although the SLPI and Grit Scale are measuring different constructs, the drop in Grit scores for the 2010 cohort mirrors the drop in scores for the five practices of the SLPI, whereas for the 2011 cohort, the Grit scores are fairly consistent across measurement occasions, similar to the pattern of scores for the SLPI. Furthermore, the 2011 peer group shows lower Grit scores compared to the 2010 peer group, which is consistent with the scores on the SLPI. The lowest subscale scores for the Grit Scale occur for the consistency of interest subscale, yet remain above the mid-point of a 5-point scale. These results are consistent with those found by Jaeger et al. (2010) for engineering majors. To assist in interpreting the Grit Scale, one can compare the results for the total scale score to previously published studies (see Table 2 from Duckworth et al., 2007 and Table 1 from Jaeger et al., 2010). These results show that our engineering transfer students are grittier than engineering freshmen and Ivy League undergraduates and are more similar to West Point Cadets in terms of overall grit. Not surprisingly, it takes perseverance and passion (grit) to become an engineer.

Table 2: Descriptive Statistics on Grit Scale for LDP Cohort and Peer Comparison Groups: Mean (Standard Deviation)

Group	Time	n	Total	Ambition	Perseverance of Effort	Consistency of Interest
2010 Cohort	Year 1	7	3.94 (0.20)	4.40 (0.40)	4.26 (0.27)	3.62 (0.44)
	Mid	7	3.67 (0.48)	4.00 (0.67)	4.05 (0.51)	3.29 (0.47)
	Year 2	6	3.61 (0.45)	3.93 (0.47)	4.06 (0.52)	3.17 (0.43)
2010 Peer	Year 1	13	3.85 (0.42)	4.25 (0.50)	4.17 (0.65)	3.53 (0.39)
2011 Cohort	Year 1	8	3.73 (0.62)	4.25 (0.92)	4.02 (0.88)	3.44 (0.56)
	Mid	7	3.83 (0.23)	4.26 (0.30)	4.14 (0.35)	3.52 (0.26)
2011 Peer	Year 1	11	3.52 (0.47)	3.87 (0.92)	3.79 (0.85)	3.24 (0.46)

Note. None of the mean comparisons between the respective cohort and peer groups were statistically significant at the 0.05 significance level.

Summary

It is important to note that the LDP began with a private donation in 2007. Since that time, there have been four cohorts of students graduate from the program. The first cohort of NSF-funded students began the two-year training program in 2010 and completed it in 2012. Only the NSF-funded cohorts have peer comparison data due to the program evaluation aspects of the grant. The tangible and intangible rewards associated with a successful leadership program are numerous and many will not be recognized for years to come. It has been our experience that the more successful the program becomes the more opportunities that are presented. The achievements of the program since 2007 have been divided into the groups that represent the major stakeholders: students, university, industry, and NSF.

Student leadership achievements: Above 3.0 cumulative GPA at graduation, four recipients of the Illinois Technology Foundation's "50 for the Future" Award, three recipients of the Outstanding Senior Awards in the COE, presidents in nine student organizations, more than \$40,000 raised for other student organizations, two national robotic championships, three new student organizations established, a sixth place showing in NASA's Great Moon Buggy design competition, first place finishes in two campus-wide blood drives, and leadership of more than 30 university and community service projects.

University achievements: Named best ATMAE student chapter in the nation, earned the best student organization award for the university, achieved 80% graduation in two and one half-years for the 2010 cohort, raised more than \$325,000 in donations from sponsor for scholarships, and awarded \$600,000 NSF STEM grant for the expansion of the program.

Industry achievements: Delivered more than \$2 million in six sigma cost savings during the internships and signed 13 out of 17 students interns to work for ATS; both early positive indicators of LDP's success.

NSF achievements: Eighty percent graduation rate and all students who completed the LDP are employed in a STEM field for the 2010 cohort.

Suggestions for Best Practices

Every program of this nature will experience successes and disappointments. It is important to realize the lessons that can be learned from a disappointment. Suggestions can be divided into three groups: program development, student leadership development, and industry partnership.

To improve the development of the program: First, it is suggested to lengthen the student's participation to three years. It has been observed that the mastery of leadership skills increases greatly in the second and third years for students. Second, program directors should consider developing a team-building week that will unite all of the incoming and present students the week before the

school year starts. Third, while NSF or corporate financial funding can often be generous, it is equally important to secure university support so the program is truly valued by all stakeholders.

For improving student leadership development: First, the majority of the best learning occurs through experiences. The LDP students realized most of their best learning by serving as a student organization president or leading an applied project. Second, having upperclassmen mentor younger students accomplishes two goals. One, it develops the younger students faster by giving them a steady stream of experienced feedback and two, it teaches the older students how to give constructive feedback for developing the maximum potential in someone else. Third, it was determined that using service projects to learn how to lead a team, coupled with a structured evaluation system was a very effective method for accelerating a young leader's development.

For improving industry sponsorship: The easiest way for a corporate sponsor to contribute to the program is to donate money. While this is an important element to making the program operate, providing meaningful internships, offering career planning within the sponsoring company, and conducting professional development seminars for the students have shown to produce the greatest benefit for the sponsor to achieve its objectives.

Conclusions

The SIUC LDP will graduate its fifth cohort of future technical leaders in May 2013. From all indications, the program is gaining acceptance, momentum, and success. A couple of prime indicators are the award of an NSF STEM grant, additional financial support from the sponsoring company, addition of a second corporate sponsor, and the many positive endorsements by the key stakeholders, including the following:

"The technical leadership program in manufacturing is integral to ATS' future growth and development of our leaders. The program has met and exceeded our expectations and initial goals. We are fortunate to have such a unique program to feed our future pipeline and are able to hire based on results versus just their interview."

—Jeff Owens, president, Advanced Technology Services

"The LDP has been the most beneficial student development and corporate sponsorship I have ever been associated with as a college dean. The program continues to exceed the goals and expectations I have set for it."

—John Warwick, dean, College of Engineering

"Program has greatly impacted not only my career but also my outlook on life. Through this experience, I have learned about the impact I can make in business and my community."

—Nick Turnage, LDP graduate

From the NSF's perspective, the primary objective of the project is to achieve a two and one half-year graduation rate of at least 90%.

For the 2010 cohort, six out of 10 students remained in the LDP and three students remained enrolled in the COE. A two and one half-year graduation rate of 80% has been achieved if we broaden the definition to include students retained in the COE. For the 2011 cohort, seven out of eight students (88%) remain in the LDP and are on track to graduate within that time frame. A goal of the project is to determine the impact of providing financial support and implementing a leadership program on retention, graduation, and job placement rates. Ongoing evaluation of the project will assess these rates and the broader impact of the program.

Future Work/Research

The success of the program has generated a lot of interest with the primary stakeholders. The authors believe that they have developed a successful model that can be expanded across campus to benefit STEM majors first, followed by other interested colleges. Research could be conducted to study the LDP model's success as it is applied to these different fields.

Perhaps the greatest opportunity for future research is already underway with the LDP's corporate sponsor, ATS. From the very beginning of the program, ATS insisted that a longitudinal study be conducted with the new hires who graduated from the LDP. While a program evaluation is scheduled for year five of the program, the researchers do not anticipate being able to determine any significant findings in the graduates' careers until year 10. Additionally, conversations have begun with the SIUC College of Business as it now expressed the need for business-minded graduates with leadership skills.

The last promising opportunity for future research requires a macro research project that would bring together a consortium of the technical leadership programs at universities. Consortium members could use their collective experience from their training programs and sponsor outcomes to develop a best practices guide that would become the curriculum for STEM-funded leadership programs.

Editor's Note: This article is updated from the conference paper, "Industrial and STEM Partnership Creates Engineering Student Leaders," presented at the 2012 ASQ Advancing the STEM Agenda Conference at the University of Wisconsin-Stout, Menomonie, WI.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. DUE 0966274 and Advanced Technology Services (ATS).

References

Astin, A. W., & Astin, H. S. (2000). *Leadership reconsidered: Engaging higher education in social change*. Battle Creek, MI: W.K. Kellogg Foundation. Retrieved from <http://www.naspa.org/leadership%20reconsidered.pdf>

Bureau of Labor Statistics. (2010). Architecture and engineering occupations. *Occupational outlook handbook* (2010-11 ed.). Retrieved from <http://www.bls.gov/oco/ocos027.htm>

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*(6), 1087-1101.

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the short grit scale (Grit-S). *Journal of Personality Assessment*, *91*(2), 166-174.

Gordon, B. (2012). *Toward a new engineering education consensus: Ideas from industry and academia for inculcating and fostering leadership skills*. Franklin, MA: Via Appia Press.

Iacocca, L. (2007). *Where have all the leaders gone?* New York, NY: Scribner Publishing.

Jaeger, B., Freeman, S., Whalen, R., & Payne, R. (2010, June). *Successful students: Smart or tough?* Proceedings of the 2010 American Society for Engineering Education Conference, Louisville, KY.

Kouzes, J. M., & Posner, B. Z. (2006). *Student leadership practices inventory: Facilitators guide* (2nd ed). San Francisco, CA: Wiley.

Kuenzi, J. J. (2008). *Science, technology, engineering, and mathematics (STEM) education: Background, federal policy, and legislative action*. (CRS Report for Congress, RL33434). Retrieved from <http://www.fas.org/sgp/crs/misc/RL33434.pdf>

National Association of Colleges and Employers. (2009). Top employers for 2008-09 bachelor's degree graduates. *Salary Survey*, *48*(2), 1.

National Science Board. (2012). *Science and Engineering Indicators 2012* (NSB 12-01). Retrieved from <http://www.nsf.gov/statistics/seind12/c0/c0i.htm>

President's Council of Advisors on Science and Technology. (2012). *Capturing a domestic competitive advantage in advanced manufacturing*. Report of the Advanced Manufacturing Partnership Steering Committee Annex 3: Education and Workforce Development Workstream Report. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/amp_final_report_annex_3_education_and_workforce_development_july_update.pdf



Rhonda K. Kowalchuk, Southern Illinois University Carbondale

Rhonda K. Kowalchuk, Ph.D. is an associate professor of educational measurement and statistics at Southern Illinois University Carbondale (SIUC). She received her B.A. (Hons., 1990), M.A. (1993), and Ph.D. (2000) from the University of Manitoba, Canada. She joined SIUC in 2004 and prior to that she worked at the University of Wisconsin Milwaukee. Her research interest focuses on the performance of statistical procedures when applied to data that do not satisfy the assumptions underlying these procedures. A goal of her research is to provide recommendations to improve the quality

of data analyses. Other research-related activities involve working as a statistical consultant. Contact her via email at rkowal@siu.edu.



Bruce D. DeRuntz,
Southern Illinois
University
Carbondale

Bruce D. DeRuntz, Ph.D. is a professor in the College of Engineering at Southern Illinois University Carbondale (SIUC) where he teaches classes in leadership, quality, and project management. Prior to teaching in academia, he worked in the automotive and defense industries as a quality professional. He began teaching at SIUC in 1998 and in 2006 was appointed the director of SIUC's Blaudow Leadership Development Program. His research interest is in identifying the critical characteristics that all technical leaders possess. He is a Fellow with ASQ and the former editor of the *Quality Management Forum*. His email address is bruce@siu.edu.



John W. Nicklow,
Southern Illinois
University
Carbondale

John W. Nicklow, Ph.D. is the provost and vice chancellor for Academic Affairs at Southern Illinois University Carbondale (SIUC). Nicklow earned B.S. and M.S. degrees in civil engineering from Bucknell University in 1993. He earned a Ph.D. in civil engineering from Arizona State University in 1998 and began his career as a faculty member in the College of Engineering at SIUC. His research interests are focused on STEM education and on environmental and water resources systems optimization. He is a registered professional engineer, a certified professional hydrologist, a Fellow of the American Society of Civil Engineers, and a Diplomate of the American Academy of Water Resources Engineers. His email address is nicklow@siu.edu.

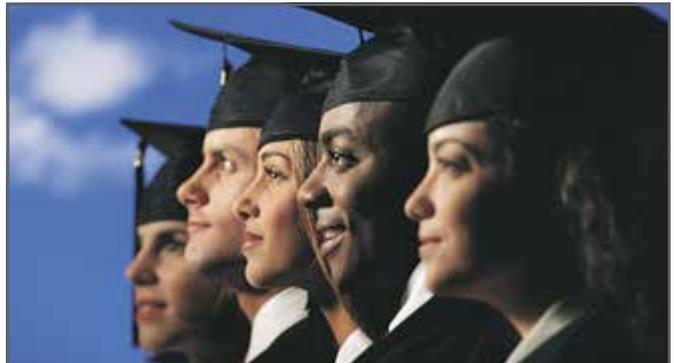


Shape the Future Through Quality

Quality Approaches in Higher Education Sponsored by ASQ's Education Division

Submit an article for our peer-reviewed journal on best practices in higher education.

Visit our website at asq.org/edu/quality-information/journals/ to read the Call for Papers and read *Quality Approaches in Higher Education*.



Best Paper Award

Beginning in 2013, *The Quality Approaches in Higher Education* editors will announce an annual best paper award to the author(s) of a paper published in *Quality Approaches in Higher Education*. The award will be announced in January of each year for the best paper from the issues of the previous year and will be based on the largest single contribution made to the development or application of quality approaches in higher education. There is no nomination form for this award.

Visit our website at asq.org/edu/quality-information/journals/today!

