



Building Piece by Piece: Teaching Engineering Leadership through Integrated Modules

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Industry needs for engineering graduates increasing include training in both technical skills and leadership skills. The technical skills are necessary, but insufficient to be successful in many engineering companies today. Further, engineering students are recognizing the importance of developing and practicing leadership skills during their undergraduate studies. Research shows these skills are best learned in combination of academic courses and co-curricular practice (Guthrie & Osteen, 2013). However with current curricula structures in many schools of engineering, there are few opportunities for engineering students to forgo an engineering course to take a course studying leadership. We have addressed these challenges directly on our campus and successfully implemented a new model of teaching engineering leadership while students continue to pursue their engineering degree and graduate on time.

This paper will move beyond a case study and share transferrable insights, assessment tools, and curriculum to support engineering programs integrating leadership education into their existing offerings. First we will summarize the theoretical framework used, then discuss each of the four modules. This discussion will include the target experience levels of students in engineering, an overview of the content of the module with resources for educators to access more detail, recommendations for learning assessments, and finally examples of how we implemented the module.

Through sharing these, the objective of this paper is to impart practical insights and resources for engineering educators to integrate leadership development into their existing engineering courses or develop a new class focused on engineering leadership development.

Theoretical Framework

For our framework in developing curriculum we use Astin and Astin's Social Change Model of Leadership (1996), the most widely-used theoretical model taught in leadership education (Owen, 2012). This model offers three leadership perspectives—individual, group, and community—which we developed into four modules that can be taken in any sequence for engineering students to study leadership in each perspective when students are ready. For each perspective's module, we will share our insights from experiences in developing the module, including learning objectives developed. Then we will highlight tools for assessing these student learning objectives. Finally, we will outline curriculum examples that engineering educators can use in their own work.

Individual Perspective

The individual module focuses on defining leadership concepts and challenges engineering students to increase their self-awareness through values identification, outcomes planning, and feedback. Self-leadership characteristics are identified and enhanced through assessments, introspection, and developing goals to strengthen the congruence of one's values and actions. The individual module is ideal for first-year and second-year students as they begin to think about the desired outcomes for school, including the development of technical and leadership skills.

The main focus of the individual module is on analyzing the definition of leadership and the role of development for the individual leaders with attention to leadership engagement as an engineering student. Students deconstruct pre-conceived definitions of a leader and leadership, identifying that leadership is a process and a leader engages individuals in the process (Guthrie, Jones, Osteen, & Hu, 2013). Students also evaluate the role of followers in the leadership process. Challenging students to consider personal values and beliefs about leadership, they are asked to design personal vision statements that will demonstrate their commitment to ongoing technical and leadership development. Professional outcomes include technical success, degree program completion, resume development, and resume building. Individual outcomes include congruence of values and actions.

Assessing the individual learning module, we recommend students write and justify their personal definition of a leader and leadership. Students are asked to identify and interview a leader of their choice, analyzing the information gathered from the interview using their personal definitions. As a final reflection, students create a self-commitment plan consisting of personal definitions of a leader and leadership, personal values, vision statement, and identifiable leadership opportunities while in college.

We have implemented this module as a course facilitated by a graduate assistant. Discussions and the self-commitment plan were spread throughout half of the semester in an eight-week course. Students who have completed the module are invited as to serve as peer mentors that facilitate discussion and activities. A more abbreviated module could use two or three workshop sessions focusing on the deconstruction of definitions and on the self-commitment plan. Integrating these workshops into introductory courses would work well.

Group Perspective

The group perspective engages students with team development activities where students apply what they are studying about group processes to in-class simulations. Together, groups create a team contract; develop a team purpose and norms, member roles, and team goals to successfully complete the final project. Teams undergo mid-module and post-module 360 evaluation reviews, where students evaluate self and team members, and the instructor evaluates individuals and the team as one unit. The group module is ideal for sophomore and junior level students beginning degree-specific courses utilizing group projects. The group module is available to all students who are interested in developing group and team leadership skills.

The group module focuses on team development and effectiveness. Students are placed on teams in which they work with for the duration of the module. Team placement is purposeful—each student is asked to complete a personality assessment, which is used to create teams with representation from each personality type category. Together, teams develop a contract utilizing the guide provided in Levi's book *Group Dynamics for Teams* (2013). Each group is required to identify job roles, norms, outcomes, and evaluation methods. Groups participate in team-development activities on topics of communication, conflict resolution, problem solving, and evaluation. Students debrief their experiences during each activity, leaving with clear strategies to effectively lead teams. Professional outcomes are team development and strategies for team effectiveness.

Assessment of learning may include the content of their team contract and a 360-degree feedback evaluation conducted by the individual student, team members, and instructor. As a final assessment of the module, teams work with an industry mentor complete a case study, evaluating an engineering team based on team dynamics and processes. It is recommended that teams be assessed on their ability to apply concepts and adhere to the team contract.

We have implemented this module as a half semester, eight-week course, facilitated by a graduate assistant on our campus. Professional engineers, or industry mentors, were invited to share experiences working in teams and establishing networking relationships with students. As a more abbreviated module, the development of a team contract could be covered in a single workshop session. Other sessions could be conducted based on specific team dynamics and processes, such as team communication, conflict resolution, problem solving, and evaluation. This would be highly applicable in a mid-level team-based project course.

Community Perspective

The community module focuses on students involved in student organization, using their leadership position to apply theory and practice. Students create a strategic plan for the organization's future by evaluating their purpose and function, member roles and responsibilities, and framework for organizational dynamics. The community module is ideal for leaders of an engineering student organization and advanced students interested in becoming a leader of a student organization. This module was designed to be accessible to students already serving as leaders or who have interest in becoming a student leader. Participation in previous modules is not necessary.

The community module focuses on the organizational development of engineering student organizations. Students begin the course analyzing the current state of the organization by identifying the organization's strengths, weaknesses, opportunities, and threats (SWOT). Based on the results, a strategic plan is designed using the existing constitution and mission of the organization. A vision, as well as strategic outcomes are developed based on engaging apathetic members, conflict resolution, addressing diversity, risk management, and team dynamics. Students discuss how to effectively lead an organization and prepare for the transition of a new leader. Professional outcomes include strategic planning and member engagement skills.

For module assessment, we suggest students complete a strategic plan to utilize in a student organization leadership position. It is recommended for students to plan an event that aligns with the organizational mission and meets the outcomes of the strategic plan. Event planning must follow university and department policies. Students complete a reflection of Sullivan's book *Motivating the Middle* (2011) identifying specific strategies for fighting apathy in their student organization.

We implemented this module as a course facilitated by a graduate assistant and the Director of Engineering Student Services, engineering student affairs administration. Topics of discussion, including strategic planning, engaging members, conflict resolution, diversity, and team dynamics, occurred throughout half of the semester, eight weeks, while students developed

their strategic plan. Guest speakers from industry were invited to share about the use of strategic plans and working in professional engineering organizations. The module could be structured with the use of multiple workshops focusing on each of the five topics of discussion. Student leaders, as well as industry mentors, familiar with the module could be invited to discuss experiences and insights on organizational topics.

Capstone: Putting It All Together

Finally a capstone experience is provided to advanced engineering students who are ready to deepen their understanding and tie together all three perspectives. In this capstone, students study leadership through the lifetime experiences of seasoned engineers. They discuss case studies and ask difficult questions with retired executives, astronauts, and the Dean of the Engineering College. This capstone module is ideal for students who have completed the three prior modules on individual, group, and community perspectives. But we designed the capstone module to also be accessible to students who have not had the prior modules, but are in advanced stages of their program and this may be the only leadership development course they take before graduating.

The capstone module focuses on the five practices of leading as delineated in Kouzes and Posner's book *The Leadership Challenge* (2012). The five behavior-based practices are: Model the Way, Inspire a Shared Vision, Challenge the Process, Enable Others to Act, and Encourage the Heart. Within each of these practices the students are encouraged to discuss how they can enacted each practice in from the individual, group, and community perspectives. Students not experienced in the prior modules find these as new perspectives to consider. But students who have completed one or more of the prior modules recognize the perspectives and we challenge them to go more deeply in applying the five practices.

To assess learning in this module, we recommend the Student Leadership Practices Inventory (Kouzes & Posner, 2005). Further, at the end of each chapter in book by Kouzes and Posner are discussion questions. The supplementary instructor's guide has a lengthy set of going-further questions. These can be resources to develop into take-home worksheets or in-class essay exams to measure student understanding of the principles and the practices.

In our campus we implemented this module as a course facilitated by the Dean of Engineering. The five practices were spread throughout the semester. Guest speakers were invited to focus on the week's practice. Students completed worksheets of how they were applying each practice in their engineering project team or student organization. For a more abbreviated module, the five practices could be covered in five workshop sessions. Or a one-workshop approach would be feasible with students split into five teams and focusing on one practice each before then teaching it to their peers.

Conclusion

Meeting the industry needs for engineering graduates with both technical skills and leadership skills is challenging. But by weaving the leadership education into existing curriculum, engineering educators can advance both skillsets. The format outlined here is versatile. We gave examples of how on our campus we offer one-credit courses, but these same

learning objectives can be achieved through a multitude of formats using the same curriculum resources which we detailed. This versatility is important for reaching engineering students without compromising the curricula structures in many schools of engineering.

Important work being done by Hartmann (2015) will contribute to improving this curriculum. Hartmann's research involves the study of employers' espoused and implicit needs in engineering graduates' leadership capacities. Building on her findings, the field of engineering leadership educators will be able to iterate on this curriculum with improvements to focus on the leadership values, skills, and behaviors that the engineering industry is seeking.

This paper highlights four modules to deliver leadership development within existing engineering curriculum. As more schools of engineering add leadership education this contribute to doing so in ways that make leadership education more accessible to more engineering students. This will be necessary as graduates will need these skills to complement their technical skills in order to be successful in industry.

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