

Leadership and Teamwork Education for Engineering and Technology Students

An Experiential Learning and Community Service Approach

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1. Introduction

The history of technical education in the United States over the last two hundred years can be traced back to the American Revolution; it evolved from both military and craftsmanship needs. Over the years, the trends in technical education changed from teaching of craftsmanship and basic science, to assembly and design of sophisticated projects. The present trend in technical education focuses on complimenting the design skills of technologists and engineers with communicative interpersonal skills that encourage them to plan and lead complex technical projects. This paper discusses the course, "Leadership and Teamwork from Within" that uses a mix of experiential learning approach, community service, and problem based learning to teach basic concepts of leadership and teamwork. The course was created and coordinated by two faculty members, an engineer and a historian, and served Honors Students in Technology Programs at the College of Applied Science, University of Cincinnati. The paper provides a brief historical overview of applied or technical education in the U.S. Next it discusses the objectives of the course and the pedagogy that the faculty used to accomplish these objectives. Finally, the paper outlines the challenges and rewards experienced by the faculty involved in the course. The faculty members who taught this class strongly believed that this course followed not only the long established practices of applied learning at the College of Applied Science, but also felt it fit within the traditional frameworks of American applied engineering and engineering technology education

2. A Brief History of American Engineering and Technology Education

When the American Revolution broke out in 1775, two engineering education approaches existed in Europe, which the Americans could model. By the time of the Revolution, the French (or continental European) method was fully developed and a proven success. Beginning in the 16th century, the French state centralized the education of engineers by building government-sponsored institutions. Increasingly, the education provided at these state funded schools shifted away from apprenticeship as a means to train engineers and instead emphasized scientific and mathematical principles as the underlying guides to the profession.

In Great Britain, the Industrial revolution gave the nation and individuals unprecedented opportunities. Commercial and industrial expansion provided the necessary capital to permit individuals and corporations to take on large, complex, and privately funded projects. These early venture capitalists required full-time, technically trained experts to supervise their commercial projects. British engineers came from all social classes and relied heavily upon apprenticeship training in educating the next generation of technologists.

During most of the 19th century, outside of the military academies ^[1], most American engineers received their training through apprenticeship or some other similar on-the-job training system. Many of the large-scale internal improvement projects of this era, like canal construction, served as training grounds for American novice engineers supervised initially by British experts. Advancement from a survey crewmember to civil engineer came through practical education and experience. A similar development occurred within American mechanical engineering at this time. The size and floor culture of early machine shops permitted apprenticeships to flourish as means to educate and enabled some machinists to develop design skills. The shop experiences also taught some the importance of engineering economics. Despite, the practical nature of American civil and mechanical engineering education there were emerging characteristics that reflected not the British, but rather the French model and its influences.

A distinctly American engineering educational tradition emerged as civilian programs assumed a growing importance^[2]. By the turn of the 19th century, the American engineering system paralleled the French model, but also incorporated elements of the hands-on traditions of the British approach. The continuation of shop work requirements and the development of co-operative education in most engineering curricula distinguished American engineering instruction from the French method.

The twentieth century witnessed a rapid advancement of Engineering and Technology education. Applied laboratories coursework and formal co-operative experience enhanced the growing educational programs. In addition, ABET accreditation introduced criteria to make engineering and technology programs well balanced with mixes of basic sciences courses, technical theory and laboratory courses, and a breadth of communication, humanities and social science courses that form General Education requirements. The idea is that the overall experience in the college leads the student to attain the conceived outcomes of the program. However, with all the educational requirements, students in engineering and technology are seldom exposed to integration of humanities and teamwork to build on management concepts. Their coursework requirements allow them few opportunities to explore practical approaches to leadership and teamwork. Many of the students are often employed after graduation in leadership positions. Present trend in technical education is focusing on complimenting the skills of graduate technologists and engineers with communicative interpersonal skills that prepare them to plan and lead complex technical projects.

3. Course Objective

In the Spring Quarter 2004, at University of Cincinnati College of Applied Science, a pilot course "Leadership and Teamwork from Within" gave Honors students in engineering technology programs the opportunity to explore concepts in leadership and teamwork. The course examined the integration of humanities, leadership and teamwork to build on management concepts. Leadership in organization can be established in many different ways. A leadership that focuses on needs of individuals within organization for the benefit of the team has a lasting impact that promotes the organization well beyond other leadership styles. The course reflected on methods for promoting personal growth of individuals while enhancing teamwork to achieve organizational objectives. The objective of the course was for the students to:

1. Learn about Styles of Leadership,
2. Learn Approaches to Team Building
3. Learn of Promoting Growth of Individuals
4. Experience Personal Growth with Service
5. Experience Team Building and Leadership
6. Examine their behavior in special situations

The course used Problem Based Learning pedagogy to enhance teamwork; it was designed to be applied and experiential. It also used community service component, a leadership camp component, and a seminar component with speakers from industry and community to discuss with students their own approach to leadership. The three components compliment the pedagogy of Problem Based Learning (PBL) and provided the students with resources for problem solving to achieve the objectives of the course.

4. Service Learning Component

Very early in the term, the students engaged in experiential opportunity to explore leadership and teamwork concepts; Junior Achievement was selected as a community service experience that allowed engineering technology students to influence and observe synergies of teams of children to achieve common goals. In addition to the experiential nature of the exercise, it highlighted the importance of community service for personal growth in leadership. In this exercise, the students served as Junior Achievement consultants and coordinated instructional module to third and fourth grade children of a school of their choice. The module for Junior Achievement (JA) was named “Our Cities.”

In this exercise, teams of two to three engineering technology students (consultants) selected an elementary school of their choice from a pool of schools in the Greater Cincinnati area that expressed interest in offering Junior Achievement program to third grade children. After a short training period, the consultants contacted the teacher to begin the exercise. They assisted the teacher in teaching the class for one session to become acquainted with the children and to develop a certain level of comfort. In the ensuing five sessions, the consultants coordinated activities using the JA module. They first assigned the children to teams; they then worked interactively with them to develop understanding of the various crafts and engineering professions responsible for constructing the infrastructures and various building projects in the cities. They often employed tools to “show and tell” like construction tools, hardhats, safety belts, building models, blue prints, videos, etc. They also worked with them to develop understanding of the need for zoning. They employed a large size floor maps to identify commercial, industrial and residential zones in the cities. They then directed the children to construct cardboard models of different structures, from houses and banks, to factories and power plants, and place them in the appropriate zones. In some instances they asked the children to draw simplified plans or build a cardboard model of their homes. The students continuously praised the children and gave them rewards to motivate them for their teamwork and achievements. At the end of the class, they gave the children certificates of achievement for completing the module.

Once all engineering technology students in the leadership class completed their Junior Achievement exercise, they submitted a short report reflecting on their experience while addressing specific questions. In the report, they addressed the behavior of the children in their teams, their motivation and their learning. They reflected on special behaviors that promoted or distracted from teamwork. Finally they examined leadership principles that they learned from their research in influencing the behavior of the children. They presented the report to the class in the presence of the president of Junior Achievement organization.

Students' comments about the exercise were very positive, they included: "The children taught me so much about myself and about leadership and teamwork" and "Praise and recognition were strong motivating factors for children to engage in group activities almost as much as candy." Another comment reflecting on learning "Leadership principles we learned from Dale Carnegie's book -The Leader in You- such as Being open to Ideas, Showing Genuine Interests in Others, Recognizing, Praising and Rewarding all applied to the teeth even with children." Perhaps one of the most interesting comments about the exercise came from one engineering technology student: "the experience I gained from this service learning exercise is extremely valuable to my personal growth; I feel fulfillment when I assist others without being compensated. College is a time to learn and grow as a person, community service such as Junior Achievement allows us to give back to the community and grow from the experience gained."

5. Leadership Camp Component

In the middle of the Quarter, engineering technology students participated in "The Leadership Challenge" camp. The camp helped the students to understand their own leadership strengths and to search for opportunities to grow as a leader while they studied leadership and teamwork principles. The students had the opportunity to model leadership and help other students in fostering their leadership style as they were having fun.

The two-day camp started with indoor activities that helped the student to understand leadership principles. The students, assembled in groups of four, explored their understanding of leadership and teamwork, and compared their thoughts and ideas. This was done using symbolic interpretation of leadership concepts on paper without words, then translating the metaphors to words. The exercise was followed by exploring principles of leadership from the book "The Leadership Challenge,"^[6] these are: "Modeling the Way," "Inspiring a Shared Vision," "Challenging the Process," "Enabling Others to Act" and "Encouraging the Heart". The ensuing indoor activities further stressed the importance of each of these principles for success in teamwork and leadership. An example of these activities was one that stressed Challenging the Process. It comprised of students timing their action in stacking cups to form a pyramid, and then restacking them to form a single stack. After several trials the students improved their timing to the point of diminishing return. However, after discussing the activity in groups and challenging the process they originally used as individuals, they were able to significantly improve their previous time. The camp outdoors activities encompassed communication to untangle a long ribbon rapped around each student in a random manner to form a complete square; the students were blind folded during this exercise. The activity emphasized the principles of inspiring a shared vision, and enabling others to act. Blind folded, the students assigned a communication leader (recognizable by voice) who allowed individual students to

present their ideas, they then discussed methodologies for unfolding the ribbon, and finally set to work untangling the ribbon. Completing the construction of a bridge was yet another activity that required the students to plan and challenge the process to allow them to fasten missing planks of different length to a bridge while maintaining complete silence except for the individual placing the plank. Finally, the High Wire Adventure allowed teams of two students to model the way and help each others to overcome fear of height while pushing their comfort zone to have fun and enjoy the high wire adventure.

At the end of the Quarter, the camp director was invited to the class to hear the students report about the camp. All feedbacks were very positive. The group activities and the social effect of the camp itself allowed the students to trust each others and understand the leadership principles that they have learned. The camp allowed many to overcome fears that they had and explore their leadership potential.

While the previous two educational components for teaching leadership were completed outside the classroom, Leadership Seminars, Problem Based learning, and reading assignments enabled the students to work in teams inside the classrooms and explore their leadership potential.

6. Leadership Seminars

Class time in the Leadership course was devoted for discussion of leadership topics with knowledgeable speakers and for solving problems using Problem Based Learning format. During the very first class, the students and faculty discussed the Meyers-Briggs personality traits test. The traits Extroverted/Introverted (E/I), iNtuitive/Sensing (N/S), Feeling/Thinking (F/T), and the Judgmental/Perceptive (J/P) were first discussed, and then the sixteen M-B types were identified. Finally, the students took the M-B test and compared themselves to recognized leaders with the same M-B type. The website on Leadership out of the Box ^[3] served as an excellent reference for this purpose. The idea behind this exercise was to make students aware of how individual behavior is influenced by traits which in turn influence various leadership styles. Most of the students reflected positively on the exercise; they felt that they can now interpret some of their own behavior based on the M-B types that they obtained.

Leadership reading assignments for the class were numerous. Two books “The Leader in You How to Develop Friends and Influence People” ^[4] by Dale Carnegie and “Developing the Leader in You” ^[5] by John Maxwell were designated as required books. They were selected for their simplicity and for the many practical examples that demonstrate leadership principles that they promote. Several other books were selected as references: Kouzes and Posner’s book “The Leadership Challenge” ^[6] was used in the leadership camp. Stephen Convey’s book “The Seven Habits of Highly Effective People” ^[7], Jim Collins’ book “Good to Great” ^[8] and Spenser Johnson’s book “Who Moved my Cheese” ^[9] were all used as resources for Problem Based Learning. An alternative style of leadership, depicted in Michael Ledeen book’s “Machiavelli on Modern Leadership” ^[10] gave the students a look at leadership that is instilled with fear and trickery as methods to reach final goals.

For effective participation in each class session, the students were required to read various chapters of one book; they then individually prepared questions related to leadership principles

that they read. Finally, in groups of three they discussed the leadership principles they read and consolidated the questions they developed to ask the guest speakers. Guest speakers for the course provided valuable resources for the students to achieve the class objectives; they were selected based on their organizational function, expertise and on achievements. From the industry, one president of a Major construction engineering firm discussed practical aspects of leadership in a large firm. The Director of Construction Project Management department at University of Cincinnati discussed the skills required to lead a group of professionals managing one billion dollars worth of construction projects. From the Government, one Ohio State Representative reflected on leadership in government. A soccer coach of a well recognized high school team who won two consecutive state championships discussed the winning attitude and team leadership. One city manager discussed leadership in Civil Service that included city staff, public work staff, police and fire departments. The president of Junior Achievement reflected on leadership of nonprofit organizations, its challenges and rewards, he also commented on students' feedback on their Junior Achievement experience. The speakers were prompted on the topics and the books that the students read before coming to the class.

7. Problem Based Learning (PBL)

There are basic differences between traditional college learning environment and Problem Based Learning environment. On the surface, the difference is simple. In a traditional college learning environment, students are taught what they need to know, they then process mentally the information and finally, they are assigned problems to illustrate how to use the concepts learned. In a problem based learning environment, the problems are assigned to the students first, they then identify what they need to know, and finally, the students learn and apply the needed concepts to solve the problems. In a PBL environment, students work in teams to identify what they need to know and to help each others to learn it. The faculty role is to design the problems, select the resources and coach the teams to achieve the learning outcomes of the problems.

Problem Based Learning approach to learning provided a natural pedagogy to achieve the outcomes for the course "Leadership and Teamwork from Within". The pedagogy helped the students to learn approaches to teambuilding, develop skills to function in teams, and experience leadership.

In Problem Based Learning, the professors are mentors; they provide resources and experiences that help the students to solve the problems. As discussed in the previous paragraphs, the faculty selected the service learning component "Junior Achievement", the "Leadership Challenge Camp", the seminars with proven speakers, and many reading assignments, to provide the necessary resources for the PBL approach.

During the term, the faculty authored two non-technology related problems to challenge the students out of their comfort zone. In teams of four, students assumed different rotating roles of leadership. These included a "Facilitator" who stimulated discussions and kept the focus of the group on the purpose of the meeting, an "Evaluator" who elicited critique from group members and insured a level of participation from all individuals, a "Note Taker" who recorded and summarized the progress of the team, and a "Planner" who outlined where and how the group is proceeding through the problem and scheduled group meetings and chats outside the regular

class time. Using a set of rules that the students set for themselves, they researched the problems, submitted a report and gave a presentation on the topic of leadership

The first learning problem “Coaching Kids is more than Fun; It is an Adventure!” placed the students as coaches for a “Select” soccer team of thirteen-year old girls. The soccer team although not very experienced, competed in a very tough league. The parents of the girls were “too” involved. The coaching group had little coaching experience and has volunteered for this community service activity as part of a leadership exercise. In this problem, the students developed strategies for managing the team, training the player, handling winning and losing situations, dealing with the parents, etc. The students drew some knowledge from their JA experience, from the seminars they attended, particularly from the seminar delivered by the high school coach and from resources that they uncovered during their research on coaching soccer and soccer strategies. They applied concepts from their reading assignments and from a videotape that they viewed in the class “John Wooden: Values, Victory and Peace of Mind” [11].

Early in the solution of the problem, the students had to overcome the anxiety of working outside their comfort zone. However, they quickly assembled the information and resources to answer their own questions. The final presentations for all teams were excellent, they clearly reflected on the research that they conducted about principles of teamwork and leadership and the practical aspect of putting these principles in action.

The second learning problem was entitled “The Young Executive Association (YEA)”. In the problem, the teams of students were assigned the task to be guest speakers in a monthly meeting of young executives of the YEA association. The executives are risk takers, and have been known for their interest in outdoor activities with a sense of adventure. The students needed to build on the information given to them to give an interesting presentation on leadership in the YEA Monthly meeting. The students relied on their camping experience and their seminars to provide them with background for the problem. They used the example of Shackleton in the videotape “Shackleton’s Antarctic Adventure” [12] to make the presentation interesting. They also captured and summarized principles from the assigned references to provide them with bullets for their presentations.

Student’s feedback on this problem was positive as well. They commented that they were able to highlight most important principles of leadership that they learned, further enhancing their learning. They created various schemes, perks and fun activities, to help the executives in managing their employees. The only negative feedback in both problems was the ambiguity embedded in the problems.

8. Challenges and Rewards

The faculty in this course confronted several challenges that required creative solutions. A key component of the learning experience offered to students in the class necessitated identifying, soliciting, and coordinating selected speakers. The selection and appearance of guest lecturers demanded coordination and agreement between faculty members on the relevance of speaker topics to the larger rubric of the class.

The pedagogy agreed upon prior to the start of the term presented another challenge for faculty members. The purposeful use of problem-based learning forced instructors to rethink how to present materials to the students. The need to generate specific problems for the students to “solve” made the faculty reconsider information delivery systems in the classroom setting. This was also the first widespread use of problem-based learning for both instructors.

Finally, the service learning element of the class necessitated a great deal of coordination by the faculty. Initially, the faculty had hoped that students would complete the Junior Achievement service learning component prior to the beginning of the term. It became apparent though as the term began that not all of the students successfully began or completed this requirement. Consequently, the instructors permitted students to initiate and finish the service element during the term. Ultimately, all of the students successfully participated in the Junior Achievement component, although some did not finish it until mid-way through the term.

Despite these challenges, the feedback provided by the students after the term ended indicated widespread positive experiences. A survey was provided to the students at the end of the term to give them the opportunity to evaluate the course. Besides a quantitative measure, the survey offered students the chance to provide qualitative reactions. Overall students seemed satisfied with the learning opportunities presented to them. For example, when surveyed about whether the class fulfilled their expectations, several students responded anecdotally that “I feel that I have become a much stronger leader—this is a terrific course” and “[I] learned a lot about myself and my leadership skills, and inspired me to become a leader.” Others stated that “this class exceeded my expectations” and “I feel that I know what items of leadership that I need to work on more for developing my own leadership style.”

9. Conclusion

The present trend in technical education focuses on complimenting the problem solving skills of technologists and engineers with communicative interpersonal skills that encourage them to plan and lead complex technical projects. This paper discussed one course collaboratively created by faculty members at the OMI/Ohio College of Applied Science, University of Cincinnati, designed to encourage leadership and teamwork skills among college honors students in technical programs. The class, “Leadership and Teamwork from Within,” used a combination of experiential learning, community service, and problem based learning to expose students to some of the basic concepts of leadership and teamwork. The two faculty members responsible for coordinating the class confronted several challenges that needed to be overcome in order to ensure a positive learning experience for students. Student survey feedback demonstrated that they successfully navigated these obstacles. In addition, the faculty members who taught this class strongly believed that this course followed not only the long established practices of applied learning at the College of Applied Science, but also fits within the traditional frameworks of American applied engineering education. Although the course was a pilot course for Honors students in technology it can be incorporated in most engineering or technology curricula. It is also possible to incorporate individual components of the course without the need to add a new course in already crowded programs. Leadership education using community service component can be used in many Humanities and Social Science courses to train engineering and technology students on leadership. Problem Based Learning with leadership components can be inserted in

many technical courses in the programs. Camps and seminars on leadership and teamwork can be incorporated in activities conducted by various Engineering and Technology students' organizations. The advantage of this course was that it assembled many components for training in leadership and teamwork to prepare the students for life-long-learning.

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