Industry and Academia Collaborate for Student Success in Industrial and Engineering Technology Education

by

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Abstract: *One goal of industrial and engineering technology education is to provide students with experiential learning. Internships, plant tours, and mentoring are the typical ways of exposing students to these experiences. While projects and labs in the classroom provide valuable experiences, projects performed in industry permit the student to apply the technical and managerial coursework learned in the classroom to current industry problems. Industry personnel collaborated with faculty to develop a capstone project-based course. This paper presents the development, implementation and evaluation of the project-based course. The industry supported projects offered the students real-world experiences that reinforced concepts learned in industrial and engineering technology classes. Industry representatives rated the students as very high to high in achieving the skills of professionalism, quality of work performed, critical thinking, problem solving and overall communication. The results of the course indicated that students learned to work in collaboration and were able to communicate knowledge and skills gained from challenging projects. The project course pointed to evidence of student success in industrial and engineering technology education.*

I. Introduction

Quality is an important aspect of any industrial and engineering technology education program. Selingo and Hoover reported that most Americans are confident that higher education is providing students with quality learning (2004). For students, higher education is the place to gain valuable knowledge and skills that translate to success in the work environment. Industry employers want graduates who can solve difficult problems. Higher education administrators and faculty are interested in providing excellent programs for students. One way the university can meet these visions of quality in higher education is to let students gain real-world experiences before graduating, so they can apply their theoretical knowledge and test their abilities to perform in a supportive environment. Internships, plant tours, and mentoring are the typical ways of exposing students to these experiences. While projects and labs in the classroom provide valuable experiences, projects performed in industry permit the student to apply the technical and managerial coursework learned in the classroom to current industry problems and receive both theoretical and practical feedback. Industry projects are not new in industrial and engineering technology education programs. The purpose of this article is to present the development, implementation and evaluation of a project class developed in collaboration with industry personnel.

II. Course Creation

The reasons for developing a project-course were threefold: providing new graduates with the skills desired by employers, adhering to accreditation requirements, and providing additional quality in the education of students at Southeast Missouri State University.

Industry experts identified skills gaps of newly hired college graduates in industrial fields including the lack of skills in communication, project management, teamwork, and problem solving (Hutchins, 2004). Conversations with industry representatives (from an advisory council) uncovered similar gaps in skills that undergraduate students in an industrial and engineering technology program should possess upon graduation. These gaps were the starting place for developing a project-based course. Adding additional courses to an already full curriculum is not a step that was taken lightly by faculty. There was no need to remove a course to accommodate the addition of the new course. The Industrial and Engineering Technology (IET) department at Southeast collaborated with various industries including Nordenia, Boeing, Ameren and Dana to develop a project-based course called Manufacturing Research in a Global Society. This course is not an internship. Students do not work for the organization; they solve a problem for the organization. The course is the cap-stone class for industrial and engineering technology majors. Students take the course in their final semester at the university. The class provides an opportunity for students to demonstrate what they have learned at the university. Industry representatives had a role in the process by identifying the course outcomes and metrics of the outcomes. These outcomes became the objectives of the project-based course. The objectives of the course:

1. Complete research with analysis of work and operations in a modern enterprise
2. Prepare a technical report
3. Demonstrate proficiency in structured problem solving and critical thinking in a modern enterprise
4. Perform a professional presentation

Another reason for developing the project-course was accreditation requirements. The Accreditation Board for Engineering and Technology (ABET) in the United States mandates that an industrial and engineering program's final course should include design experiences that integrate the principles, concepts, and techniques explored in earlier coursework (ABET, 2006). The National Accreditation Board for Industrial Technologists (NAIT) also mandates that technology programs should include appropriate industrial experiences focusing on problem-solving activities related to industrial situations. These industrial experiences shall be designed to provide an understanding of the industrial environment and what industry expects of students upon employment (NAIT, 2006).

The final reason for developing the project course was to increase the quality of education at Southeast. The goal of university education is not only to impart knowledge, but to enable students to apply what they learn in other contexts. Universities have data on credit hours, number of degrees, and certificates, but these outcome measurements may not adequately evaluate what the student can actually do in the industrial environment. If a primary goal of higher education is impart knowledge, then the previously mentioned measures may work as a metric for evaluating quality; if not, there should be a better indicator of student success. Besides competency testing, data on actual learning outcomes can be persuasive evidence that the student can apply the knowledge and skills learned in the university. The implementation of the project-course can provide evidence of a quality education.

III. Course Implementation

Project-based learning combines instruction and learning in the context of a challenging workplace project. Thomas (2000) affirmed that project-based learning provides enhanced problem-solving, subject matter knowledge, communication skills and greater student interest, motivation and satisfaction. Students showed interest in applying their coursework to a real industry problem. In addition, problem-based learning emphasizes writing, presentation skills and problem solving in industry is an effective teaching strategy for student learning (Holter & Kopka, 2001). There are differences in approaches to learning between the traditional lecture course and a project-based course. Figure 1 (adapted from Kumar & Hsiao, 2007, p. 21) shows differences in learning from a lecture class compared to a project class.

Figure 1. *Differences in learning for a lecture class and a project-based class*

Traditional Lecture Class	Project-based Class
• Teacher directs students and evaluates • Student is a passive learner • Student work independently of each other • Students solve problems in the parameter given by teacher • Learning occurs in a lecture room	• Teacher facilitates learning and evaluates • Student is actively learning in the organization • Students work in teams • Students learn to think critically and develop the parameters to solve the problem • Learning occurs outside of the classroom

Rather than just using the traditional classroom setting, the instructional approach to this course was to create learning by allowing students the benefit of the classroom and the experience of solving complex industry problems on the workplace site. This instructional approach involved experiential learning by having students apply theory learned in their previous coursework. Students learned a plethora of skills in the project course. Students learned to work in collaboration and communicate knowledge and skills gained from challenging projects. The industry-based projects served as a catalyst for learning as students are presented with complex industry problems.

The first step in the implementation of the project course included selecting the organization of the course. The first three to four weeks of the course was devoted to classroom lectures on managing projects, working in teams, planning projects, problem solving, writing technical reports and performing professional presentations. These lectures helped prepare students to complete their projects in the selected industries. Next, teams of students received an industry problem to solve. Examples of problems included time studies, design of experiments, testing product specifications and reducing scrap. Students were allowed to tour the facilities and were given the necessary information to solve the problem. There was a project sponsor in the organization available as a contact person who also served as a project facilitator. It was important to consider security and privacy issues including time and resources when implementing the project course. Finally, evaluation of the course was two-fold by the professor and the employer.

IV. Course Evaluation

Students were required to complete a written technical report and present the results to the sponsoring industry representatives. The assessment of the technical report was based on the focus, organization, detail, format and grammar of the report. The oral presentation focused on covering the solutions, recommendations and conclusions. Additionally, the presentations were viewed as an opportunity for the students to reflect on their research in the organization and experiences in the course.

The project sponsor was asked to evaluate the students using an evaluation form containing a 5-point Likert scale with ratings: very high achievement (5); high achievement (4); achievement (3); low achievement (2); very low achievement (1), and no achievement (0). Based on the completed projects in the industries, employers filled out the evaluation form that allowed them to rate the students on the following skills: professionalism, quality of work performed, critical thinking skills, problem solving skills, and overall communication skills. The ratings of industry representatives on the skills of 224 student projects over a four year period (2000-2004) are presented in Figure 2. Unfortunately, names of the organizations and details of the projects cannot be provided for proprietary issues.

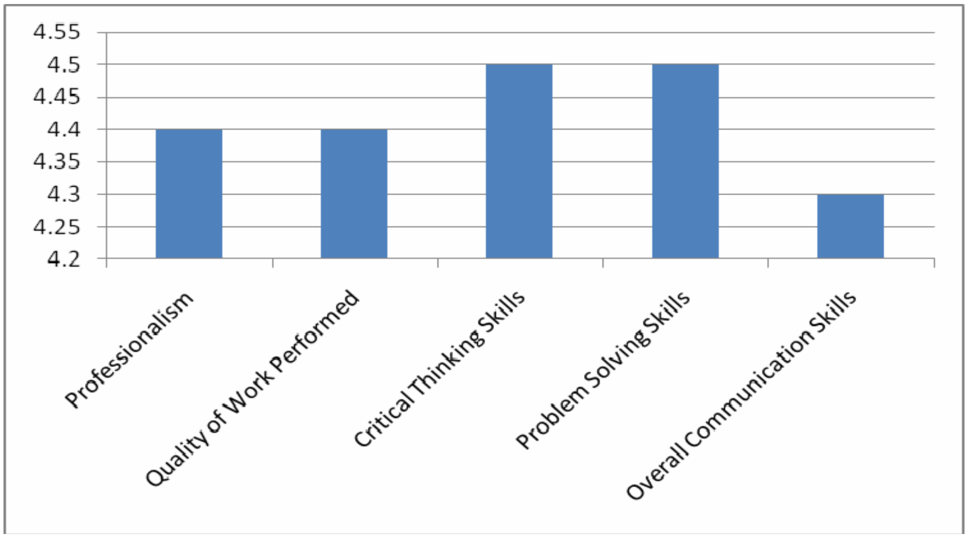

Figure 2. *Average Employer Ratings of Skills*
Note: ratings are based on a 5-point scale.

The data suggest that students are demonstrating skills in the areas that were rated. The data was consistent, which could mean that the lessons given to the students prior to the project had prepared them for the project. It should be noted that the students were given the expectations and evaluation measurements upfront, which could also account for the consistency of industry ratings. The results point to evidence of student success. The employers perceived that for the most part students demonstrated minimal skills gaps. Based on the four-year study, if employers had concerns, they were revealed in the area of written and oral communication. Industry representatives were also given the opportunity to write additional comments on the evaluation form. A sampling of comments is presented.

- The research of the student increased sales and made positive changes to the store. It helped to bring employees together.
- The company saw a side-by-side comparison of identical parts, how both time and money could be saved in the prototype making process.
- The company received cost reduction in piece price and scrap rates, as well as improvements in productivity.
- The company received a way to accurately check for missing features on crankshafts. The company will also benefit from reduced scrap and reduced customer complaints.

The comments indicate a measure of satisfaction from the perspective of employers. The industry representatives received answers to problems that the organization did not have the time to tackle, but were important. Students felt that they were able to apply concepts and principles learned in their previous classes to real problems in an industrial environment. Several random students commented on their experiences in the project-based class.

- The class taught me how to do valid research and gave me more confidence to apply to my life in the future.

- I benefited from the research and got a better understanding of paint and the paint processes, the ability to expand my knowledge and the opportunity to have some additional input to the success of the company I work for.
- I benefited from the experience of giving a presentation the most; the company will benefit from the huge cost savings.
- The experience allowed me to gain additional knowledge on different prototyping methods. This has already proven to be a help in my new job that I started two weeks ago.
- I received valued information on project management.
- I learned a lot about management communication skills, teamwork, and valuable points on how to present a presentation to a company.

The comments from the students indicate a measure of success from the student perspective.

IV. Discussion and Implications

Preparing students for success in the workplace is an obtainable goal for universities. Students can learn by performing projects in industry. Organizations also value the data that is provided by student projects. Comments from industry representatives indicated that the projects were a positive experience in their organizations. Often, the company experienced reduction in scrap, improvements in productivity, and time savings with the projects implemented. The industry representatives received answers to problems that the organization did not have the time to tackle, but were deemed important. The evaluation of the projects by industry personnel and faculty increased the assessment value because more than one person evaluated the quality of the work. Academia can show a measure of student success and close skills gaps by utilizing industry-driven projects. In addition, the success of past projects can secure future industry support of internships, future projects, employment and partnerships.

A project-based course allows students to solve problems in industry and is a great avenue for students to demonstrate their knowledge, skills, and abilities acquired through a pathway of industrial and engineering technology study. This experience may be the first time that students see how problems are handled in a natural work environment. They can see the complexities of getting work done while encountering various obstacles. In addition to providing value to the industries that host projects, students learn valuable skills that might only be experienced through a project-based course. For example, many students learned to prioritize, adapt, manage conflict and prepare for industry demands. Often, students had to cater to the needs of the industry and prepare for initial and follow-up meetings with industry personnel.

VI. Conclusions

As universities continue to prepare students for the work environment, opportunities to interact with industry will become increasingly more important as a culminating experience. Project-based courses may increase the student's and industry's confidence in higher education. Students are capable of applying the technical and managerial theory learned in the classroom to current industry problems and receive feedback from peers, instructors and industry personnel. Employers have the opportunity to see potential employees solving problems in a natural work environment. Industry may also obtain solutions to complex problems that could not be tackled in day-to-day activities. Faculty can be assured that curriculum is meeting accreditation standards. In addition, the university can show evidence of student success.

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