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By Dr. Sophia Scott and Dr. Greg Boyd

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A Case Study of a Project Course Developed to Close Competency Gaps in an Industrial Technology Program

By Dr. Sophia Scott and Dr. Greg Boyd

Dr. Sophia Scott is an Assistant Professor in the Department of Industrial and Engineering Technology at Southeast Missouri State University. Dr. Scott received her Ph.D. in Technology Management from Indiana State University. She teaches courses in technical communication, supervision and project management. Her research interests include high performance teams, leadership, ethics, experiential learning and project management.

Dr. Greg Boyd is an Associate Professor in the Department of Industrial and Engineering Technology at Southeast Missouri State University. His primary teaching responsibilities include Industrial Safety, Plastics Processes, and Materials Testing. Prior to teaching, he spent 20 years in industry in positions ranging from Materials Engineering to Director of Research and Development.

Abstract

The goal of the university is to produce quality graduates. Specifically, industrial technology programs are designed to prepare technical and/or technical management-oriented professionals for the work environment. This paper describes the creation, implementation, and employer perception of a project course developed to close identified competency gaps of graduates of an industrial technology program. The competency gaps identified included professionalism, quality of work, critical thinking, problem solving, and communication skills. In addition to closing the identified competency gaps, the course provided outcomes that adhered to both the National Association Industrial Technology and the Accreditation Board for Engineering and Technology ABET accreditation standards. Of the 224 industry representatives who filled out an evaluation instrument on student projects, the representatives rated those students as very high to high achievement in the identified competencies. This course appears to have closed the identified competency gaps. Furthermore, students learned to prioritize, adapt, manage conflict and prepare for industry demands. Overall, industry representatives were satisfied with the outcomes of the projects and felt that students demonstrated success in the competencies evaluated.

Introduction

Quality is an important aspect of any industrial technology program. Selingo and Hoover (2004) reported that most Americans are confident that higher education is providing students with quality learning. Although the average American may be confident in higher education, industry employers are not. Industry employers need technology graduates who can solve difficult problems, but Holter and Kopka (2001) reported that employers felt that college graduates had competency gaps in some essential skills needed to enter the workforce. Developing a quality education for industrial technology aimed at closing competency gaps is a problem that educators should tackle. One way the university can meet these visions of quality and address the problem of competency gaps is to let students gain real-world experiences before graduating so they can apply their theoretical knowledge. In addition, real-world experiences allow students to test their ability to perform in a supportive experiential learning environment. Industrial technology educators are not strangers to experiential learning. The use of machinery, materials, and various labs to teach manufacturing and technical concepts is the norm. Internships, plant tours, and mentoring are the typical ways of exposing students to these learning experiences.

While projects and labs in the classroom provide valuable experiences, projects performed in industry permit the students to apply the technical and managerial coursework learned in the classroom to current industry problems where they can receive both academic and practical feedback. The purpose of this study was to describe the creation, implementation, and employer percep-

tion of a project course developed to help close competency gaps of graduates enrolled in an industrial technology program. This research set out to answer the following questions:

1. What are the competency gaps of industrial technology graduates?
2. What is the best way for educators to close the competency gaps identified?
3. Did employers perceive the project course as closing competency gaps?

Theoretical Background

Developing workplace skills is recognized as being important for industry, educators and administrators of higher education. Shuman, Besterfield-Sacre and McGourty (2005) proclaimed that technical education should not only teach the knowledge of theory, but also prepare students for a successful diverse career. Moreover, students need to understand how technical and managerial concepts fit into the larger problems that industries face (ENR, 2004). 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 a work environment. If a primary goal of higher education is to 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. According to the National Center for Education Statistics (1995), higher education is charged with providing evidence of college graduates who can demonstrate competencies of communication, problem solving, and interpersonal qualities. The problem identified in this research was that college graduates in an industrial technology program had competency gaps in some essential skills needed to enter the workforce. In order to answer the research questions, the methodology used was a case study. The procedure involved the following steps:

1. Identifying competency gaps
2. Creating a course to close identified competency gaps
3. Describing the implementation of the course
4. Collecting and organizing data on employer perceptions

The paper will describe how the researchers identified competency gaps, created a course aimed at closing the competency gap, implemented the course, and collected data on employer perceptions.

Identifying Competency Gaps

Reviewing the current literature was the first step to answering research question one: What are the competency gaps of industrial technology graduates? Manufacturing industry experts identified competency gaps of newly hired college graduates in manufacturing which included communication, project management, teamwork, ethics, professionalism and problem solving (Hutchins, 2004; Shuman, Besterfield-Sacre &McGourty, 2005). Meier, Williams, and Humphrey (2000) confirmed and prioritized desired competencies for science, math, engineering and technology and found the following themes: contemporary business concepts, communication, customer-focused quality, problem solving and teaming. Additionally, in the late 1990's, the Society for Manufacturing Engineering (SME) investigated the competencies that employees would need to become a capable "knowledge worker" of the 21st century. The SME report identified several competency gaps including communication, teamwork, personal attributes, manufacturing principles, reliability, project management, manufacturing processes, business skills, quality, change management, statistics, human factors, materials, and lifelong learning (Manufacturing Education Plan, 1997). This report was the driver to identifying initial competency gaps. The second step of identifying competency gaps was by having conversations with industry representatives appointed to a departmental industrial advisory board at Southeast Missouri State University (Southeast). These conversations exposed that new graduates were not demonstrating all of the desired competencies in the work environment. Through several meetings, these industry representatives helped compose the following list of competencies that an entry level graduate of an industrial technology program should possess: professionalism, quality of work performed, critical thinking skills, problem solving skills and communication skills. These competencies were infused in the curriculum for a new course to be offered. Because the typical classroom setting alone is not adequate in preparing students with the skills, knowledge and attitudes needed to be successful on the job; faculty and industry representatives decided that a project course would be a great tool for closing identified competency gaps between what industry wants and needs and what the university provides.

Course Creation

A project course was the natural fit for educators at Southeast in an attempt to answer research question two: What is the best way for educators to close the competency gaps identified? In addition to the feedback from the advisory board, accreditation standards were included in the creation of a project course. The NAIT Board of Accreditation mandates that programs should include appropriate industrial experiences focused 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. The Accreditation Board for Engineering and Technology (ABET) also mandates that students should be exposed to a course that includes design experiences that integrate the principles, concepts, and techniques explored in earlier coursework (NAIT, 2007; ABET, 2007). The fact is that most industrial technology programs offer a capstone course designed to help students apply what they have learned in other classes. Often, this course represents theory and students

lack the opportunity to practice leading and managing projects in organizations (Kumar & Hsiao, 2007). A project course is not a novel concept, but is meaningful and important for technology programs. This course was intended to be a cumulating experience for the students. Zargari and Hayes (1999) expressed how students ranked culminating experiences. The order was:
1. independent projects
2. practical job-based projects
3. cooperative education
4. supervised work experiences (p.4).

This culminating experience can also be seen as problem-based learning.

Project courses lend themselves to problem-based learning. Problem-based learning can be defined as "the learning that results from the process of working toward the understanding or resolution of a problem" (Barrows & Tamblyn, 1980, p. 18). In addition, problem-based learning that 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 course. Kumar and Hsiao (2007) observed these differences in learning from a lecture class compared to a project class (see Table 1).

Thomas (2000) affirmed that project-based learning provides enhanced problem-solving, subject matter knowledge, and communication skills with greater student interest, motivation and satisfaction. 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. In an attempt to close the competency gaps identified, the Industrial and Engineering department at Southeast collaborated with various industries to create a project course called Manufacturing Research in a Global Society.

Table 1. Differences in learning for a lecture class and a project class

Traditional Lecture Class	Project 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 parameters to solve the problem • Learning occurs outside of the classroom

Adapted from Kumar and Hsiao (2007). Engineers learn "Soft skills the hard way": Planting a seed of leadership in engineering classes. *Leadership and Management in Engineering. 7*(1). 18-23.

Considerable time went into how to evaluate the success of the course. Because employers were personally involved in the development of course objectives, their perspectives were vital for defining success. The objectives of the course:
- Complete research with analysis of work and operations in a modern enterprise
- Prepare a technical report
- Demonstrate proficiency in structured problem solving and critical thinking in a modern enterprise
- Perform a professional presentation

In addition, industry representatives agreed to allow students to perform research in their organizations. The project course consisted of classroom lectures, team activities, team problem solving, technical writing, and technical presentations. A key component to the achievement of any program is demonstrated in the satisfaction of its customers. Utilizing the customer (industry representatives) in the development and evaluation of the project course ensured ownership and thus increased satisfaction.

Course Implementation

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 project management, 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. 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. Students were evaluated by the professor from beginning to end. 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.

Employer Perceptions

The project course served as an impetus for closing the identified competency gaps. In order to answer the final research question on employers' perception of the project course as closing competency gaps; data was collected during four years (2000-2003) of student projects with 224 industry representatives filling out an evaluation instrument. The Likert Scale evaluation

instrument was based on the assumptions that the values were relatively equal on an ordinal scale and potential semantic differentials did not contribute adversely to inter-rater reliability (Schloss, 1999). The evaluation instrument presented in this study contained a 5-point rating scale with 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 competencies: professionalism, quality of work performed, critical thinking skills, problem solving skills, and overall communication skills. The perceptions of industry representatives on the competencies of the student projects are presented in Table 2.

Industry representatives rated the student's achievement in the identified competencies with average scores ranging from 4.3-4.5 on a 5-point scale. The data suggest that students are demonstrating competencies in the areas that were evaluated. 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 perceptions. The results point to evidence of student achievement. Industry representatives were also given the opportunity to write additional comments on the evaluation form. 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.

Table 2. Average Employer Perceptions of Student Competencies

Competency Rated:	2000	2001	2002	2003	Total
Professionalism	4.3	4.4	4.6	4.3	4.4
Quality of Work Performed	4.3	4.3	4.6	4.5	4.4
Critical Thinking Skills	4.7	4.2	4.7	4.5	4.5
Problem Solving Skills	4.5	4.2	4.6	4.3	4.5
Overall Communication Skills	4.4	4.2	4.3	4.4	4.3
Total Number of Respondents	67	40	48	69	

Note: Ratings were made on a 5-point scale. Averages are presented.

Results and Implications

The intent of this study was to discuss the development and implementation of a course developed to close identified competency gaps. In addition, employer perceptions were collected. The results of the research questions follow.

Research question 1: What are the competency gaps of industrial technology graduates?
In answering research question one; the researchers identified the following competencies: professionalism, quality of work performed, critical thinking, problem solving and communication. These competencies were identified through a literature review and conversations with industry representatives. One limitation of this study was that the competencies represent a small Midwestern university and may not necessarily be applicable to other industrial technology programs.

Research question 2: What is the best way for educators to close the competency gaps identified?
One "best way" for educators to close the competency gaps was by creating and implementing a project course. From many perspectives, the project course was viewed as a success in closing the identified competency gaps. First, 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. Second, academia was able to show a measure of student success and close competency gaps by utilizing industry-driven projects. Third, the project course adhered to NAIT accreditation standards. Finally, the success of past projects can secure future industry support of internships, future projects, employment and partnerships. It should also be noted that this research was limited to the projects and evaluations from a small Midwestern university. Not all universities may experience the same success. Regardless, the project course allowed students to solve problems in industry and was a great avenue for students to demonstrate their knowledge, skills, and abilities acquired through a pathway of industrial technology study. As a result of the projects, students began to understand the nature of solving problems in a normal work environment; they discovered that defining goals and tasks and meeting deadlines in a team project was a very different experience from being an independent student.

Research question 3: *Did employers perceive the project course as closing competency gaps?*
Industry representatives agreed to fill out an evaluation instrument, based on the competencies identified (professionalism, quality, problem solving, critical thinking and communication) at the conclusion of the project. Figure 1 presents the average perception or ratings of employers of the identified competencies.

The employers perceived that for the most part students demonstrated minimal competency gaps. Based on the four-year study, if employers had concerns, they were revealed in the area of written and oral communication.

This experience may be the first time that students saw how problems were handled in the natural work environment. They also saw the complexities of getting work done while encountering various obstacles. 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.

Conclusions

This project course appears to have closed the identified competency gaps as evidenced in Figure 1. Employers perceived students to have had very high to high achievement in the competencies evaluated. Overall, industries where projects occurred were satisfied with the outcomes. As universities continue to prepare students for the work environment, opportunities to interact with industry will become increasingly more important as a culminating experience. Moreover, students need to be able to apply the technical and managerial theory learned in the classroom to current industry problems and receive feedback from peers, instructors and industry personnel. In addition to providing value to the industries that host projects, students can learn valuable skills that might only be experienced through a project course.

Project courses may increase industry's confidence in higher education's ability to close specific competency gaps. Employers have the opportunity to see potential employees solving problems in a natural work environment. Industry was also able to obtain solutions to complex problems that could not be tackled in day-to-day activities. Additionally, the project course adhered to NAIT accreditation standards. Project courses can be a win-win for all the stakeholders involved. It is recommended that universities continue to collaborate with industry for the ongoing success of all industrial technology students.

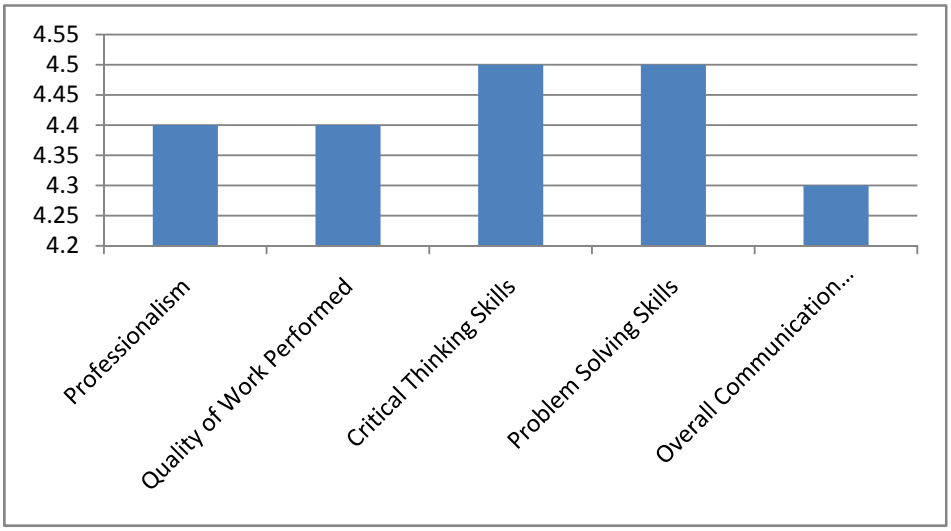

Figure 1. Average Employer Competency Ratings

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