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FROM THE EDITOR

“The More Things Change, the More They Remain the Same”

This week I began my annual fall office “housecleaning.” I was resolved to be thorough and even ruthless in tossing items from the last two decades into the recycling bin. I had developed a mental checklist to aid my decision process, and one criterion was that if something hadn’t been used or even looked at in the past two years, out it went. This high standard lasted until I reached the third shelf where a precariously balanced stack of professional journals resides. The old journals are full of “timely” topics, and most articles advance a bold stance on one issue or another. The research pieces offer discussions and findings that agree with and contradict each other over the years and then change course and contradict and agree with each other all over again.

As I glanced through the various journal topics I experienced feelings of both professional guilt and responsibility. I reflected on how I introduce and develop ideas, topics, methods, and principles with my new trade and industrial (T&I) teachers, and I found myself pondering some questions that all of us as teacher educators might consider. First, in our enthusiasm for particular ideologies, methods, or programs, do we unwittingly encourage teachers to become followers rather than independent users of professional knowledge? Do we teach our teachers to value research, but at the same time to think critically and not become enslaved by its findings?

Promoting a particular way of teaching, although research-based, may be dangerous. It could lead new teachers to believe that there is only one way to teach T&I or technology education, and that good teaching demands compliance with the tenets of a particular ideology or method or program. What happens when the paradigm shifts, and shifts again?

We need to help our teachers balance professional knowledge and use it in creatively resourceful ways. To be successful in the long run, teachers need to develop the confidence and freedom to adapt and combine methods and materials to fit
the situations in which they find themselves. While we encourage our teachers to teach their students critical thinking skills, are we doing the same for them? As I conduct observations of T&I teachers at their schools, I find that good teachers have perfected this concept of balance. As they lay the foundation of knowledge and skills, they allow their creativity to take flight. These teachers adjust, revise, amend, and invent. They are able to evaluate situations and choose to adapt and modify research-based techniques. Their flexibility allows them to shift and adjust to changing times and circumstances in public education.

I don’t think I’ll throw those old journals away just yet. They remind me that it’s important to keep perspective, balance, and even a sense of humor in the pursuit of knowledge. The journals help me keep track of where we have been along the road to professional knowledge. In a strange sense, the old journals are a comfort as they also remind me that “the more things change, the more they remain the same.”

In This Issue

This issue of JITE contains three feature articles related to trade and industrial and technology education. In the first article, Jensen and Burr describe a service-learning experience that was conducted with secondary students in a construction technology course. Questions explored in this case study were whether the service learning project helped to engage student motivation and participation and whether the curriculum objectives were mastered by means of this learning method.

Next, Flowers’s research addresses the issue of the growing demand for higher education faculty in technical education. Flowers used a survey to examine vacancies, hiring criteria, and attitudes toward hiring those who had earned online doctorate degrees in technical education. The sample was found to be significantly less likely (than neutral) to hire an applicant who had earned a doctoral degree in an online program. Survey participants reported a perception of low quality for online doctoral education.

In the third feature article, Hill discusses issues related to the initiative of implementing an engineering design emphasis in technology education programs. His conceptual piece provides
From the Editor

insights into changes that will be experienced by classroom teachers, teacher educators, and support staff if the trend toward engineering design permeates the profession. Other key aspects of possible change Hill addresses are educational philosophy, curriculum, instructional strategies, and collaborative relationships.

In the “At Issue” section, Kraft proposes that the bicycle provides an ideal topic for technology education. Not only does the bicycle have a rich history of development, its study also offers a gateway to the subjects of energy, power, and maintenance. Kraft contends that another benefit of using the bicycle in middle school technology education may be an increased interest among students in riding bicycles, which could lead to life-long behavior changes.

Finally, Herschbach provides a review of Grubb and Lazerson’s book *The Education Gospel: The Economic Power of Schooling*. This book discusses the set of ideas promoting the belief that education raises both personal and public economic wealth and solves numerous social problems.

Following is the Journal’s “Bits and Pieces” section which contains information for submitting articles to the Journal and how to become a member of NAITTE.

JZB
Participation and Learning Relationships: 
A Service-Learning Case Study

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In a traditional classroom setting, students come in, find their seats, and begin to take notes from a lecture. Possibly, for variety, they complete a worksheet, or work on a textbook assignment. Each of these traditional classroom activities is intended to help students learn the course content and in turn help them achieve some desired course grade. In this scenario, grades become the primary motivator for students to learn, and it is grades which spur the students to participate in classroom activities and discussions.

Now imagine a different classroom—a classroom where students enter ready, motivated, and eager to master the days content not because of a fear of poor grades, but because of an internal desire to help others through participation in a class service project. In this classroom, the students understand that they must learn the appropriate skills found in the course content in order to better complete their service objectives, which are also—and not coincidentally—the course learning objectives. Here, students apply their newly learned skills towards the completion of a class service-learning project.

Background

Brewster and Fager (2000) discovered that as students reach the upper grades, student disengagement from classroom learning becomes more frequent and is more pronounced. Using token rewards, such as candy or parties, to encourage students to complete a required assignment in a timely manner is entirely unproductive. However, students whose motivations are

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intrinsically founded are more likely to succeed (Brewster and Fager, 2000).

Much research has been compiled on service-learning, its benefits, and its influence on intrinsic motivation (Giles and Eyler, 1994; Batchelder and Root, 1994; Osborne, Weadick, and Penticuff, in press). Dewey (1938) states that students tend to learn the course content associated with a service-oriented activity when they make a connection with its cause. Other literature on this subject also suggests that the benefits of engaging students in a service-learning activity can induce greater retention of course material because the students begin to see the relevance of their learning as it pertains to real life experiences and issues (Dewey, 1938; Kinsley and McPherson, 1989; Verducci and Pope, 2001).

Service-learning has been around for many years, although it has not always been defined and labeled as such. It was not until the mid 1980s that the term “service-learning” established its roots (Stanton, Giles, and Cruz, 1999). Service-learning is not the same as service. To label a learning activity service-learning, it must be associated with a learning goal or objective that pertains to the curriculum. (Chapin, 1998). As defined by the National and Community Service Trust Act of 1993, service-learning is a teaching strategy by which students learn and develop through active participation in a thoughtfully organized service.

Service-learning is closely associated with experiential learning, hands-on learning, or active learning (Dewey, 1938; Kolb, 1984). Listening to a lecture or a presentation is not necessarily active learning (Chickering and Gamson, 1987). Active learning refers to techniques in which students participate in actions that involve discovering, processing, and applying information (McKinney, 2005). Active learning stems from two basic concepts of learning styles: (1) that learning is by nature an active endeavor and (2) that different people learn in different ways (Meyers and Jones, 1993).

Project-based service-learning emphasizes learning opportunities that are interdisciplinary, student-centered, collaborative, and integrated with real-world issues and practices (Bradford, 2005). Teachers tend to agree that learning
environments that foster academic achievement through hands-on, authentic learning motivate students by engaging them in their own learning process (Brophy 1986).

Service-learning may also involve the “just-in-time” teaching approach, which disseminates information when the learner finds it most relevant and applicable and which takes advantage of that moment when student motivation to learn is at its peak. The “just-in-time” approach also results in overall higher retention rates because application of learned knowledge closely follows knowledge transfer (Berglund, 2004). According to Berglund, a “just-in-time” knowledge-transfer system should mirror the interaction of a student with a tutor by providing real-time assessments, dynamic feedback, and chunked and vetted knowledge.

Service-learning has been used as a method of teaching content in science education, civic education and history, business and marketing education, as well as other areas. However, a review of the literature found no service-learning studies that focused on student engagement or commitment to learning in a high school construction technology classroom setting. Likewise, while the many project opportunities for students make construction technology a natural setting for service-learning, there is an absence of research on how service-learning projects and/or activities promote the course content for construction technology. There is insufficient data available to determine if, in a construction technology classroom environment, a service-learning methodology is effective in engaging student learning.

This qualitative case study of a service-learning experience conducted among secondary students in a construction technology course addresses this lack of research. Data was informally collected during this case study to evaluate whether service-learning projects appear to help motivate and engage students in the learning process and whether students effectively learn the course curriculum and content objectives while participating in class service-learning projects. The study was conducted in an attempt to understand the relationship between students’ commitment to a service-learning project and their commitment to learn the associated course content.
Study Methods

Study Population

The study population was characteristic of similar high schools within the same general area and demographics. The city in which the high school is located has a population of approximately 14,000, and has shown a steady increase in population over the past few years. It is a rural northwestern United States city with a rich agricultural tradition. The socioeconomic face of the city is at the lower end of the middle-class scale in average earnings per year, with an average yearly salary for an adult living and working in the area of roughly $19,000 per year.

The study group consisted of students enrolled in a construction technology class in which the students participated in a service-learning project. Participants consisted of high school students, ages 14-18. While some of the students had elected to take the construction technology course, others were placed in the class by their counselors’ direction. Consequently, the class contained both students who had chosen to take the course as well as those who were assigned to it. The course was offered as an elective to students, and students were permitted to take the course as many times as desired.

The population of the study group consisted of 22 males and 3 females. Of this sample, 7 students were on an individualized educational plan, 6 of the students were considered English language learners, 15 of the students were Caucasian, 9 were Hispanic, and one was Asian. This was reflective of the community’s ethnic make up, the student population for the high school, and of those students who generally enroll in this type of class.

Methods

The case study took place during the beginning two weeks of the second trimester. The unit objectives for this period of time dealt with learning how to safely operate the laboratory machinery. Traditionally, the instructor taught the safe use of the equipment and machinery through lecture and demonstration, which was followed by a safety test to assess the students’ level of understanding.
During the service-learning project, instead of the traditional demonstration/testing method, the instructor used the “just-in-time approach” with the study group. This meant that the students received instruction on the equipment and machinery when they found it necessary and relevant. Students were instructed on the procedures and rules for the use of each machine and/or tool as they needed it to complete their projects. In place of the traditional safety test, the instructor developed rubrics for assessing students’ knowledge of the unit objectives. Rubrics were established for the eight different laboratory machines. By evaluating the rubrics, students were categorized as unsatisfactory, satisfactory, or proficient in their ability to safely use each associated piece of machinery.

The researcher used these rubrics, along with observations, interviews, and student surveys, to assess (a) the students’ level of knowledge of how to safely use the construction technology machinery (b) the differences before and after the service-learning unit in the students’ perceived confidence in the use of the laboratory equipment, (c) the differences before and after the unit in the students’ perceptions of their knowledge of four content areas, and (d) the students’ motivation during the two-week unit and how their motivation affected their confidence levels. The data were collected mostly informally through the rubrics, pre- and post-surveys, interviews between instructor and student, peer evaluations, and instructor observations.

In this study, several methods were used to facilitate a learning atmosphere. The three main approaches were the non-directive approach, the “just-in-time” approach, and the interdisciplinary approach. The non-directive approach gave students the liberty to decide on the how they would spend their time in class, what projects (if any) they wanted to build, and when they would complete the project. By waiting for a student to ask how to use a particular lab tool, the instructor applied the “just-in-time” approach to teach the students how to use the lab machinery or equipment safely. Usually, this occurred at the time a student had need of a particular tool or piece of machinery. An interdisciplinary approach was incorporated because the instructor decided to invite the art class to help paint the toy blocks that the construction technology students were making.
The art class students painted numbers, letters, and symbols on the wooden blocks.

The instructor of the construction technology class also found ways to implement curriculum from other disciplines into the service-learning unit. For example, the construction technology students used math concepts when they needed to measure lengths and when plans for their projects required them to add and subtract fractions.

**Instructor’s Narrative of the Process**

At the beginning of the second trimester, students were welcomed to class and presented with a choice of how to begin the first two weeks of the trimester. Typically, in the first two weeks of the course, students are shown how to safely operate the machinery in the laboratory. I talked to the students about the possibility of doing some kind of project for the community as a way of introducing the course content instead of the traditional method of demonstrating, memorizing, and then testing. This idea, to start off the trimester with a project instead of with the anticipated test and quizzes, was introduced on the first day of class and seemed to grab the attention of the students.

I presented the students with two different choices: They could choose to either begin class with the standard safety test, tool identification test, and demonstrations and lectures on how to run the equipment, or they could choose to begin the course with a service project, which would provide the motivation for the students to learn the curriculum. The students seemed willing and even eager to work on a project instead of the traditional alternative. At this point, I detected a rise in the excitement level in the classroom.

A vote was held to assess the desires of the class. Each student submitted his/her anonymous vote as to how they wanted to begin the trimester. The votes were then tallied and the decision was unanimous in favor of the service project. One student asked, “How soon can we start?”

I told the class, “Let’s start right now.”

I heard comments in the class such as, “I can’t believe we get to start on a project already” and “Hallelujah, no busy work.”
The next step was to choose an appropriate service-learning project that would meet the objectives of the course. In the construction technology class, students are expected to learn how to safely operate machinery, such as the band saw, table saw, radial arm saw, drill press, planer, joiner, and hand tools. Course content also includes learning how to plan, construct, and finish a project while working in a cooperative group setting. I wanted the students to decide on a service-learning project that would incorporate all of these skills and techniques and one that would qualify as a relevant learning experience.

I had the students form groups of three to discuss some possible service projects to do. The groups of students were asked to come up with a list of ideas and/or options of how best they could meet the needs of others in their community while simultaneously accomplishing the class requirements. During this period of brainstorming the students came up with several creative ideas. Some of the ideas included tearing down an old hospital in town, building benches for the school, restoring parts of the rodeo grounds, and making gifts for Christmas.

The class was then presented with all of these different ideas. The students discussed collectively the pros and cons of each idea. The project ideas that did not meet the class objectives, we eliminated from the list. Some of the students felt overwhelmed with the possibility of taking on one of the larger projects. One student commented, “We’ll never finish if we try to do something big, like tear down the old hospital.”

In the end, the students choose to do a service project for the first graders of a local elementary school. The elementary school chosen was located in a lower socio-economic district and was within walking distance of the high school. This class of high school students felt that they could most benefit the first graders of this local elementary school by building a variety of small toys that would be ready to be delivered on the last day of school before the Christmas break. This allowed only two weeks for preparing, designing, manufacturing and assembling, finishing, and delivering the product.

Once the project, the school, and age of the recipients were decided upon, I assigned each group the task of coming up with some possible wooden toy ideas. I asked each group to start
thinking about a practical toy design that we could make for the first graders. When the bell rang for lunch, students were still talking in their groups about what they could make for the elementary students. I was impressed by the class's willingness to serve. Two students stayed after the bell had rung to discuss some options for toy designs. After this first class, I felt that the students were excited and motivated to participate in this project. The next day, many students came to class with pictures of wooden toys that they had looked up on the internet at home. Some students even had some hand-sketched drawings of toy designs (see Figures 1 and 2). The amount of time the students spent out of class, working on ideas for the project, indicated that some of the students were already committed to the idea of the service-learning project.

I had set up a short visit with the elementary students for this second day of the project. I collected the toy designs from the students, asked them to get back into their groups, and to come up with some survey questions that they could ask the

Figure 1
Toy Car Sketch
elementary students during the visit. This visit and survey had a two-fold purpose. The first and most obvious reason was for the high school students to get an understanding of what first-grade children would like for Christmas. The second reason was so that the high school students could make an emotional connection with the first graders—a connection which could help them see the relevance and importance of their service. To inspire this intrinsic attachment was one of my intended motives for the survey and a necessary part of any service-learning project.

Once the students wrote down the questions they were going to ask the younger children, we walked as a class to the elementary school. As the high school students strode toward the elementary school, one student said, “I wish we did this kind of stuff in every class.”

Figure 2

Toy Horse Sketch
Spirits were high with excitement as the high school students entered the elementary school. The first grade teachers had gathered all 90 of their children into one room where the high school students could meet and talk with them. This surprised me because I was under the impression that we were only going to meet with one class of 30 students. I felt a bit nervous at the thought of having 90 toys to make instead of 30. I noticed that the high school students were feeling some of my unease as well. I overheard one of the high school students say to his friend, “You go ahead and give them the interview, I’m just going to hang back here.” I also caught some of the students glancing back and forth to one another as if they were saying “you go first.”

Eventually, the high school students began their interviews. At this visit, the high school students worked in groups of three to survey and interview the first graders on their likes and dislikes. Gradually both the high school students and the first graders began to get to know one another.

As I observed the interview process, I noticed that three of the high school students were still at the door, not participating. When I tried to encourage them to get involved, one student said, “No way, I’ll just wait here until we’re done.” The other two students just shook their heads as a way of expressing their unwillingness to take part.

When I asked the three students why they did not want to participate they all said, in turn, “I don’t know.” These three students might have been uncomfortable with the new situation and surroundings or may have not been interested in the project to begin with. I could not identify the reasons these students chose not to participate in the interview process of the project. (All three students did end up helping with the manufacturing of the toys and were present when the toys were delivered.)

On the walk back from the elementary school the attitudes of the students were subdued and reflective. Most of the students spent the time discussing the answers that the children had given them. Some talked about how many of the first graders wanted to get a simple toy doll or game. One student said, “I am surprised that they didn’t ask for a bike or ‘PlayStation,’ like I would have done at their age. In the group of kids I talked to one wanted a Barbie Doll, two kids asked for a ‘Bratz Doll,’ and the
other one said she wanted a puzzle. I can’t believe that’s all they asked for.”

Another high school student commented to me that he was surprised by what one girl asked for. He said, “She asked for a coat for Christmas.” Even though he could not afford to buy her a coat, he seemed emotionally willing to help that student have a happy Christmas by surprising her with a toy. He told me, “I would love to go to the store and get her a coat if I had the money. But, the next best thing, I guess, would be to make sure she gets a toy from me.”

Another student also told me that the first grade student he talked to wanted her “Dad to come back home for Christmas.” I noticed how the high school students wanted to help these first graders have a great Christmas even though they understood that they couldn’t give them all what they wanted. I realized that the high school students were emotionally concerned and connected to this service project as I heard their comments and felt their enthusiasm for serving the children they had just interviewed.

After we returned to our classroom, we discussed what we had learned. The students seemed to understand the significance of the project. As one student commented to the class as a whole, “We have got to get these toys done on time or we will disappoint a lot of kids.” The students collectively seemed to understand the importance of serving the first grade students and recognized the impact they could have on the elementary students by making each child a toy for Christmas. Even though the first graders had been unaware of the reason for our visit, the high school students felt it necessary to give all of the first graders a toy. Initially, the high school students plan was to select one class to make toys for, but after the visit they wanted to help all 90 students, tripling the anticipated number of toys to build.

Now that the class had a general idea of what the first graders would like to get for Christmas, the designing phase of the process began. While some students were very creative in their toy designs, I felt that with the time constraints and with money being an issue, we had to focus our energies on building the toys from more simple designs. Ultimately, students decided
to design and manufacture toy blocks, trains, rabbits, unicorns, horses, and mini-catapults.

Next, the students manufactured the custom designed products. As the students began this process, I was concerned that we would not get finished with all of the toys by the time they were to be delivered. But, as I overheard the students encouraging their peers with words like “Make sure the bodies get cut out by tomorrow,” “Give me a hand with sanding these blocks,” and “We’re going to make the deadline,” I started to believe that the toys would be finished on time.

In manufacturing the toys, the students found they required specific skills and information to help them complete their projects. Students needed to learn how to safely operate the band saw, table saw, radial arm saw, sander, drill press, planer, surfacer, and various hand tools. Many of the students asked me to supervise them the first time they used each piece of machinery. I wanted the students to ask me for initial help so that I would be able to see if they were working with the equipment and machinery safely. Besides learning how to operate the laboratory tools and equipment, the students needed to know how to correctly use a tape measure and how to add and subtract fractions. The students required these skills in order to successfully accomplish their goals for the service-learning project. In addition, learning these skills fulfilled the unit objectives for that portion of the curriculum.

In the finishing stages of the manufacturing process, the students needed to learn how to correctly prepare the surfaces of the toys that were to receive a non-toxic finish or paint. The students also had to know how to apply the finish to the toys. The toys could be finished in a variety of ways, including polyurethane finish, Danish oil finish, acrylic paints, and water-lock finishes.

Students were assigned to different jobs as demand called for them. For example, when one group had cut out and routed all of the unicorns, horses, and rabbits, students from other groups who were caught up on their jobs, joined in to help with the sanding of those toys. Given the two-week time constraint and the 90 toys that needed to be completed, each student had many opportunities to contribute in many different ways to the project. All of the steps had to be accomplished by the deadline; otherwise
the first graders would not receive their Christmas gifts on time. This deadline motivated students to work diligently and not to procrastinate at any stage of the project.

As I talked with the students I could see how committed they were to working on the projects and getting the toys completed on time. One student expressed this commitment when she said, “The only reason why I came to school today is to work on this project.” Another student commented, “This is the best class in school, because we actually do stuff instead of just sit there listening to boring teachers talk about themselves.”

The end reward for their efforts came with the last step—delivering the toys to the first graders on their last day of school before the Christmas break. The high school students decided to dress up as elves—one student even dressed up as Santa—to present the gifts. The students were eager to deliver the toys. I was impressed with how hard the students had worked on their projects and how they dug in to meet the deadline that they had set for themselves.

At last, we piled up all the toys into one big cart and pushed them over to the elementary school. What a sight we must have been! A group of high school students dressed as elves and one Santa walking down one of the busier city streets pushing a cart full of wooden toys.

As we approached the elementary school the younger students were out at recess playing. When they saw “Santa,” they began screaming and shouting out of excitement and surprise. It was fun to watch the faces of both the younger students who would be receiving the toys and the older students who built them. The high school students presented the toys to the first graders as they came up to sit on “Santa’s” lap and tell him what they wanted for Christmas.

After all the construction technology students’ effort to build the toys and deliver them to the younger students, it was a great reward for the high school students to see the children’s enthusiasm and hear their words of appreciation. I overheard my students say, “This is the best class I’ve ever taken in high school;” “Look at how happy these kids are to get the toys we’ve made!” and “I hope we can do this again every year.” I believe
that this will be an experience that both the younger and older students will remember and reflect upon for a long time to come.

Findings
At the conclusion of the service learning project, the instructor considered the student interviews, personal
observations, the results of the pre-and post surveys, as well as other informal assessment measures in order to determine whether the students had mastered the unit objectives on the safe use of the lab machinery. The instructor also evaluated to what extent the students’ confidence in the use of the machinery had increased during the two-week period and how much knowledge the students indicated they had gained in four content areas. In addition, the instructor sought to appraise the relationship between the students’ motivation and commitment to the project and their stated confidence in their ability to use the machinery.

Student Mastery of Unit Objectives

The instructor formally evaluated the students twice during the two-week service-learning experience by asking the students direct questions concerning the proper and safe processes and procedures for operating the laboratory equipment and machinery. From their responses, the instructor gauged whether or not the students understood how and when a piece of machinery should be used. In addition, the instructor informally assessed the students daily by observing them as they used the equipment to complete the building of their toys.

At the end of the service-learning project, it appeared from these evaluations that 19 out of the 25 students in the class (76%) had learned how to operate the laboratory equipment safely and had satisfactorily mastered the course unit objectives. This was on a par with the results in another construction technology class that the same instructor taught in the traditional lecture/testing format during this same two-week period.

Student Perceptions of Confidence

Two surveys, a pre-instruction survey and a post-instruction survey, were administered to the students in the service-learning class to assess their perceptions of their confidence in the use of the lab equipment. The survey asked the students to evaluate how confident they were in operating the following equipment: band saw, table saw, radial arm saw, planer, joiner, drill press, stationary sander, and scroll saw. The students ranked their responses on a five-point Likert scale with 1 representing “no experience and never been shown how” and 5
representing “very confident, no help needed and feel very safe in the process.”

At the conclusion of the service-learning project, differences in the pre- and post-surveys were analyzed. The compilation of the survey data showed that after the service-learning project, the class’s average confidence level had increased in the use of all eight of the laboratory machines. In verification of the students’ own perceptions of increased confidence, the instructor observed an increase in student aptitude and skill level for each of the eight different pieces of equipment or machinery.

**Student Perceptions of Knowledge of Content**

Additional questions on the pre- and post-surveys asked the students to indicate their perceptions of their knowledge in four content areas: drafting skill, calculating the cost of materials, the process of writing out a plan of procedures, and reading and understanding a working drawing. As shown in Figure 5, in this
portion of the survey, while the students indicated an overall gain in their content area knowledge from pre- to post-survey, the increase was less overall compared to the increase in their confidence in the use of the laboratory machinery.

One reason for the students’ lack of a sense of increased content knowledge could be due to the small amount of time the students spent in active participation concerning these four concepts. Although, the class had opportunity to practice working out a plan of procedure for the service-learning project, the instructor only briefly explained to the class as a whole the other three concepts of drafting a project, calculation of materials, and understanding a working drawing. It may be that not enough time was allowed to sufficiently practice and apply these concepts fully during the time frame of the service-learning project.
Student Motivation and Commitment

To determine the motivation and commitment of the students towards the service-learning project, the instructor observed and talked with the students as they participated in each stage of the project. The determining factors were classroom participation, amount of out-of-class time spent working on the project, students perceived attitudes and feelings towards the project, and student comments concerning the project. A high-level of participation and a willingness to spend extra time outside of the regular class period devoted to the project was labeled commitment as defined by Kanter (1968).

Students were labeled “on task” when they were observed participating throughout an entire class period on their toy-building projects. Through daily observations, the instructor found that 23 out of the 25 students in the class were actively engaged in the entire process of the service-learning project. This calculates to 92% of the class that were on task during this two-week time frame. This percentage of participating students was significantly higher than in the other similar but traditionally taught class. In the class taught by traditional teaching methods, the instructor noted that only 12 of the 22 students stayed on task through the same two-week period. This calculates to approximately 54% of the students consistently participating in class activities on a daily basis, significantly lower than that of the service-learning project class.

Effects of Motivation on Confidence and Content Knowledge

While the students in the service-learning class showed an overall higher level of motivation than did the students in the traditionally taught construction technology class, there was, nevertheless, considerable variation in the levels of commitment of the 25 students enrolled in the service-learning class. From observations and discussions with the students, the instructor judged 13 of the students to be highly committed and 6 to be moderately committed. Four were deemed to have low commitment and 2 to have no commitment to the project.

The instructor then compared the survey data for the groups of students at each of the four commitment levels to determine whether or not there appeared to be a relationship
between the students’ commitment to the project and an increase in the students’ perceptions of confidence on the use of the laboratory machinery and/or the students’ perceptions of a gain in content knowledge. The results of the comparison showed that those students who were most motivated and committed were also those whose perceived confidence and perceived knowledge of content made the greatest increases. (See Figure 6).

At the beginning of the project, the students who were later deemed highly committed to the service-learning project rated themselves with an average of 2.8 in perceived confidence and content knowledge. This same group’s average increased to 4.76 at the end of the two-week project. This translates into a change from “some experience, but need to be shown how with instructors assistance” to “confident, with little assistance needed” in the use of the basic lab machinery. Increases are also noted for the group of students who were labeled as moderately committed as well as those who were judged to have

Figure 6
Pre-and Post-Survey Results Compared by Commitment Levels
low commitment, although the increases for these two groups are not as great as that of the highly motivated students. The two students in the group showing no-commitment to the service-learning project actually scored lower from the pre- to post-survey on their own evaluation of what they learned. Overall, as the levels of commitment decrease from high to no commitment, not only do the students’ perceptions of confidence and learning decrease, but their gains from pre- to post-survey decrease as well.

In summary, out of a classroom of 25 students, 23 showed some level of commitment to the service-learning project, and 19 of these demonstrated to the instructor both their ability to use the machinery safely and their mastery of the course content at or above a satisfactory level. In other words, 82.6% of the students who were labeled “committed” to the service-learning project also achieved a satisfactory rating in the use of the machinery and the application of content skills in this two-week time frame.

Conclusions

This study suggests that service-learning projects or activities motivate the majority of students to participate in class. In addition, it appears that service-learning projects can serve as a tool for engaging some students who would not normally respond to traditional methods of teaching the curriculum for a construction technology course.

The study indicated that learning occurs through the process of service-learning projects or activities. The instructor noted that the students in the study group gained as much, if not more, information and skills pertaining to the safe operation of machinery as other students learned through more traditional teaching methods of demonstrations and lectures. It appears that a service element provides a strong factor in motivating students to learn course content. The students in this study wanted to learn how to use the machinery so that they could complete the project in time to deliver the toys to the first graders at the elementary school.

There seems to be a connection between a student’s level of commitment to a service-learning project and how well he or she learns, understands, and applies the concepts of the course
In this case study, the students’ commitment to the service-learning project had a definite effect on their perceptions of their ability to use the laboratory machinery and on their perceptions of the amount they had learned during the project. As commitment increased so did a student’s belief that he or she had mastered the course content. The students’ perceptions were verified by the instructor’s observations.

The conclusions of this study are based on one instructor’s observations and personal evaluations. The implications of the study derive from these observations as well as experiences in previous years of teaching similar classes. Admittedly, this study was structured on an informal experimental basis. Therefore, the findings and conclusions derived from the study are applicable to this individual case study and are not necessarily valid for a more general student population. It is suggested that more definitive, quantitative studies be carried out with other populations and samples to further explore and investigate this study’s conclusions.

References


Hiring Technical Education Faculty:
Vacancies, Criteria, and Attitudes
Toward Online Doctoral Degrees

James C. Flowers
Holly Baltzer
Ball State University

This report is one of four phases of a broader study designed to provide background information to university departments as they consider offering online doctoral programs in technical education. The four phases encompass a study of the demand for such a program by potential students; a characterization of existing face-to-face doctoral programs in the field; a comparison of models for online doctoral delivery seen in other fields; and the present phase, an assessment of employment needs of universities and their attitudes towards hiring candidates with online doctorates in technical education. This report uses findings from a survey of higher education department chairs and program coordinators to characterize faculty vacancies at the bachelor’s and master’s program levels in post-secondary technical education institutions, the criteria used to hire faculty, and the attitudes toward filling those vacancies with an individual who has earned a doctoral degree through an online method of delivery.

Background

The United States Bureau of Labor Statistics (2006) reported 1.6 million post-secondary teaching jobs in 2004 and predicted this number to increase 27% or more by 2014. Retirements of faculty hired in the 1960s and 1970s to accommodate the post World War II baby boom and increased enrollment due to a growing population of college age students are cited as factors contributing to this demand (Blum, 1990; Castle and Arends, 2000; Magner, 1999; Bureau of Labor Statistics, 2006). Using data from 1997 to 1999, Castle and

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Arends (2000) looked at faculty job listings across disciplines and found “that total openings rose 34% .... [and] the number of applicants per opening decreased by 19%” (p. 8), evidence that an imbalance between supply and demand has been building for some time. They also reported a failure rate of 25% in faculty searches, attributed primarily to competition among universities for a limited pool of candidates. This excess demand for faculty over supply has continued into the current decade.

Magner (1999) suggested that a healthy national economy in the 1990s facilitated the hiring of tenure track faculty as opposed to filling open positions with non-tenure track faculty, which may be more common in leaner economic circumstances. With recent changes in the economy, the trend is shifting toward hiring non-tenure track faculty: “The number of tenure-track positions is declining as institutions seek flexibility in dealing with financial matters and changing student interest” (Bureau of Labor Statistics, 2006, Training, Other Qualifications, and Advancement, ¶12). Entry level, tenure track faculty openings at four-year public colleges and universities are most likely the first to be impacted by state budget cuts, often resulting in hiring freezes or withdrawal of positions (Smallwood, 2002). Thus, the nature of the current economy may temporarily shift the demand somewhat from tenure track to non-tenure track faculty. However as Magner noted, tenure track faculty are generally preferred when finances allow. Yet, this is not likely to offset the overall imbalance between supply and demand for all types of higher education faculty.

Hiring higher education faculty in technical education (defined here to include career and technical education, technology education, and post-secondary technical fields) has been more problematic than in many other fields. The fields of technology education and vocational education were cited by Castle and Arends (2000) as having a lower than average number of applicants per position, with vocational education also showing a much higher than average failure rate (75%) for searches. More recently, Brown (2002) noted a 32% failure rate for faculty searches in technical programs. Post-secondary vocational education teachers rank third highest (127,000 jobs) in the number of faculty jobs reported for 2004 (Bureau of Labor
Statistics, 2006). If the projected rate of increase previously noted is realized, there would be 161,000 post secondary jobs in vocational education in 2014, thus requiring 34,000 new hires by 2014 due to growth alone, not considering replacements of retiring faculty.

These demand projections are cause for even greater concern when comparing them with the supply of new doctorates in technical education. Brown (2002) noted that the number of doctorates granted in “Technical/Industrial Teacher Education” dropped from 186 in 1983/1984 to 98 in 2001/2002, with an estimated 26 to 27 of those graduates available to apply for faculty positions in technical university programs in 2002. Although many of the open positions will be in community colleges and many will not require a doctoral degree, nevertheless the current demand for faculty in this field seems to outweigh the supply, and the imbalance may become more severe if there is a growing emphasis on a doctorate as a necessary criterion for hiring higher education faculty.

In order to meet this growing demand, graduate programs must produce qualified applicants who meet the criteria used by faculty search committees. While search criteria are likely to be specific to both the field and the needs of the institution, there are often common elements, such as degrees/credentials, communication skills, teaching ability, and research potential (Carr & Tsai, 1994; Hettich, Cleland, & Jewett, 1997; and Sudzina, 1991). Brown (2002) reported that, among other search criteria in technical education, the ranking of the doctorate increased from third to first place between 1986/1987 and 2001/2002.

One aspect of the search criterion not mentioned in previous studies is the method of delivery for an applicant’s doctoral degree. Recently, there has been an increase in online degree offerings, including those at the doctoral level (Allen & Seaman, 2005), although technical education seems to be a latecomer to this delivery mode. It has been suggested that one obstacle to the success of online doctoral programs is that those evaluating the credentials of faculty applicants may consider online doctoral degrees substandard compared to face-to-face degrees. In a nationwide study that spanned various fields,
Adams and DeFleur (2005) found that applicants with traditional degrees were preferred by hiring committee chairs over applicants with doctoral degrees from virtual institutions or from degree programs that used mixed method coursework. However, the field of technical teacher education is based on the use of ever-changing technology; therefore in this field, attitudes toward degree programs utilizing newer technology, such as online delivery, may not align with the findings of Adams and DeFleur.

**Methods**

**Sample**

The survey sample included department chairs or program coordinators of bachelor's and master's programs in technical education in the United States. Subjects for this study were located using the following resources: the *Industrial Teacher Education Directory* for 2005-2006 (Schmidt & Custer, 2005); a search of the 2004 directory of the National Association of Industrial Technology (NAIT, 2004); a search at the International Technology Teacher Education Association website; an online search at Petersons.com (Peterson's, n.d.); and an online search at Gradschools.com (2006) for bachelor's and master's level programs in technical education or technical fields. The searches identified a target population of 105 subjects. Verification of programs at the institutions' Websites reduced this to 94 eligible candidates. The chair or coordinator likely to be involved in the hiring practices of the department or program was then identified.

When an institution had more than one program related to technical education with different coordinators listed, the following criteria were put in place to identify equivalent contacts at different institutions: (a) Priority was given to a master's level degree. If both programs were master's level, priority was given to the education-based degree (e.g., MEd over MA or MS) if applicable. (b) If both programs were master's level and both were education based, priority was given to degrees in technology education. These criteria were used because this study is one phase of a larger project intended to characterize the appropriateness of an online doctoral program in technology
education or career and technical education. All duplications were able to be rectified using these two criteria.

Instrumentation

An anonymous, online survey was used to collect data due to its ease for respondents, its low cost, the anonymity it guaranteed to respondents, and its avoidance of data entry errors. The survey contained both closed- and open-ended items geared to determine the demographics of both the individual and the institution; the current and predicted faculty vacancies; the criteria for hiring new faculty; the factors evaluated in tenure decisions; and the respondent’s perception of the institution’s likelihood of hiring an individual with a doctorate that was earned online. Pilot testing of the survey instrument was performed in January of 2006. A dean, two department chairs, and one program coordinator for technical education, from four different universities, completed the survey instrument and provided feedback on its clarity, usability and appropriateness, given the objective of the study. On February 8 and 9 of 2006, following human subjects protocol approval, prospective survey participants received an Email invitation to participate. The survey was available from February 8, 2006 through February 28, 2006. Due to the ranked nature of the data, non-parametric procedures using SPSS software were performed to evaluate the data.

Limitations

The sample in this study was self-selected and therefore may not have been representative of the greater population. Also, this survey was sent only to chairs and coordinators of programs found through the means listed above, and the attitudes of the chair or coordinator may not be representative of the entire department or university. The survey was not sent to any institutions that offered a doctoral degree in technical education because these subjects were utilized in another phase of this research and the investigators did not want overlapping samples. Lastly, hiring practices and criteria change over time; therefore future results may differ from present findings.
Results

Demographics

After two surveys were discarded because the respondents indicated that they did not make hiring decisions for their universities, the overall return rate for this online survey was 30% (28 out of 94). The respondents to the survey had fairly uniform demographics. Most were employed as professors, chairs, or coordinators at colleges or universities. Each respondent made hiring recommendations for his or her institution, usually for a single department that housed multiple programs related to technical education. Most survey participants indicated that they felt it was most appropriate to respond from this department level when answering the survey. Therefore, this survey speaks to the hiring practices of a four-year college or university at the department level, for a department that houses technical education.

The respondents were asked to characterize their institutions as well as themselves. The average department size in this sample had 8.9 full time tenure track faculty and 2.9 full time non-tenure track faculty (n = 28). However, the standard deviations for these questions were large (7.9 and 3.6), indicating the sample contained small, medium, and large departments. The majority of the institutions in this study reportedly require a faculty member to teach either three (13/28) or four (14/28) three-credit hour courses a semester. The mean percentage for the value of the following criteria for tenure evaluations is 54% for teaching, 25% for research, and 21% for service (n = 27).

Twenty-two of 28 departments offered online courses. This accounts for 79% of the institutions surveyed, which is an increase in the percentage of departments in the field offering online classes from the 60.4% found by Ndahi and Ritz’s (2002) study based on the 1999-2000 edition of the Industrial Teacher Education Directory. The average number of online courses offered per department in the current study was 5.0 (n = 28). However, a standard deviation of 6.9 indicates there is much variation within the sample with regards to online offerings. Survey participants were also asked how many classes their
departments planned to begin offering online within the next three years. The mean response to this question was 5.3 (n = 25). Again, the standard deviation was quite large (5.0), indicating a considerable range in the answers to this question. On average, respondents predicted their departments would more than double their online offerings in the next three years.

**Vacancies**

If the reported addition of online courses does not replace face-to-face courses in these programs, the predicted growth from this factor will contribute to a need for more faculty members in technical education. The sample was asked a series of questions regarding the current and anticipated vacancies within their departments. Within these departments, there is on average 1.0 current tenure track vacancy (n = 28), and 0.22 (n = 27) current non-tenure track vacancies. Anticipated vacancies within the next three years were 2.0 (tenure track, n = 28) and 0.7 (non-tenure track, n = 25). This also supports projections of a need for new faculty members. The sample was then asked, “How difficult has it been to attract qualified applicants to the last few vacancies?” The answer choices were presented on a Likert scale ranging from 1—“not difficult” to 5—“extremely difficult.” The sample mean response for this question was 3.5, corresponding to “moderately difficult” (n = 28).

Respondents were asked to indicate in an open-ended item “what specific content areas or teaching specializations will likely be central to the next tenure faculty search?” Most responses indicated technical expertise in certain areas, such as “control/automation/robotics technology,” “engineering technology education,” and “transportation and construction.” This suggests that in this sample there is a greater need for applicants who would teach courses at the bachelor’s level in technical areas (compared to graduate instructors or non-technical areas, such as curriculum).

**Hiring Criteria**

The survey respondents rated the importance of seven criteria for hiring a new tenure-track faculty member. The criteria were ranked using a Likert scale with the following
choices: 1—“very little,” 2—“little,” 3—“moderate,” 4—“much,” and 5—“very much.” The results were compared to the center of this Likert scale (3—“moderate”) using a Wilcoxon Signed Ranks test. Survey respondents ranked all hiring criteria except “ability to bring in external research funding” as more important than moderate, with no significant differences (p > .05) found between them. The criteria “having a doctoral degree or ABD” (All But Dissertation), “ability to teach particular course work,” “ability to communicate effectively,” and “ability to work well with others” were ranked between “much” and “very much” in importance. “Ability to write refereed journal articles and make

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<th>Hiring criterion</th>
<th>Mean</th>
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<th>p</th>
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<tr>
<td>A—“having a doctoral degree, or ABD”</td>
<td>4.68</td>
<td>-4.716</td>
<td>&lt;0.001</td>
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<tr>
<td>B—“ability to teach particular course work”</td>
<td>4.64</td>
<td>-4.689</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>C—“ability to communicate effectively”</td>
<td>4.64</td>
<td>-4.71</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>D—“ability to work well with others”</td>
<td>4.64</td>
<td>-4.66</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>E—“ability to write refereed journal articles and make refereed presentations at conferences”</td>
<td>3.71</td>
<td>-3.47</td>
<td>0.001</td>
</tr>
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<td>F—“ability to provide service to the profession, nation, region, locality, or institution”</td>
<td>3.64</td>
<td>-3.045</td>
<td>0.002</td>
</tr>
<tr>
<td>G—“ability to bring in external research funding”</td>
<td>3.21</td>
<td>-1.734</td>
<td>0.083</td>
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refereed presentations at conferences,” and “ability to provide service to the profession, nation, region, locality, or institution” ranked between “moderate” and “much” in importance. The high importance of the doctorate and the ability to teach specified coursework confirms the rankings of criteria found by Brown (2002). However, Brown’s study did not find communication skills and the ability to work with others to be important, although their importance has been identified by studies in other fields (Hettich, Cleland, & Jewett, 1997; Sudzina, 1991), as well as in the present study.

Attitudes toward Hiring Online Doctorates

Suspecting that the field of technical education might exhibit the same reported reluctance to hire candidates who had earned their degrees online that Adams and DeFleur (2005) found, respondents were asked, “Do you believe your institution would be less likely or more likely to hire an individual to a tenure track position because their doctorate was earned through an online program?” A parallel question was asked regarding a non-tenure track position. Respondents ranked their answers on Likert scales between 1—“much less likely” and 5—“much more likely” with 3 assumed to be neutral. A Wilcoxon Signed Ranks test against neutral (3) was performed to analyze the data. As shown in Table 2, the sample was significantly less likely to hire an individual to either a tenure or non-tenure track position because his or her doctorate was earned online, confirming Adams and DeFleur’s findings.

Table 2
Likelihood of Hiring an Individual with a Doctoral Degree Earned Online—Results from Wilcoxon Signed Ranks Test against Neutral (3)

\[
\begin{array}{|l|c|c|c|}
\hline
\text{Track for new Hire} & \text{Mean} & z & p \\
\hline
\text{Full-time Tenure} & 2.1 & -3.348 & 0.001 \\
\text{Full-Time Non-tenure} & 2.4 & -2.769 & 0.006 \\
\hline
\end{array}
\]
The Likert scale answers to the question concerning hiring a tenure track candidate with an online doctorate were dichotomous, with only a few answers other than 1—“much less likely” or 3 (assumed to be neutral). The respondents were also asked to indicate the main reason for their choices. Among those who answered “1,” the overwhelming sentiment was that online programs are not thought to have the quality of a face-to-face program, and that an online program cannot develop the types of personal skills a professor needs. Two telling quotations are:

- Online programs do not provide for the personal interactions of a classroom environment that enrich one's preparation nor do online programs encourage development of personal/social interaction skills.
- We value the Ph.D. experience that a student receives in a formal Ph.D. program. Research is too important to our new faculty to take a chance on them learning research techniques on line.

As the following responses indicate, among those who answered “3,” the most common sentiment was that the method of delivery for the doctorate was not important, so long as the degree was earned at an accredited institution and was of sufficient quality:

- How the degree was obtained is less important than the credibility of the degree and the granting institution.
- Doesn't matter the delivery...the content is what matters.

In answering the item regarding filling a non-tenure position with a candidate whose degree was earned online, responses were a bit more diverse, but still with a large number of 1—“much less likely” and 3—(assumed to be neutral) responses. The attitudes expressed for a non-tenure hire were very similar to those provided for a tenure hire, with the majority of responses being “same as above” or a comparable statement referring the investigators to the tenure question’s explanation.

Respondents’ Comments

Lastly, the respondents were reminded that the purpose of the survey was to investigate the perceived need for new
Hiring Technical Education Faculty

faculty hires in technical education, and respondents were asked to provide other comments that would help inform the investigators of their opinions. There were very few of these responses and most were in support of an online doctoral program, which is not what the investigators have deemed the majority opinion of the sample. A few examples are:

- Online degrees from accredited programs will serve a real niche demand.
- We want people with solid technical backgrounds and these are often people who aren't in a position to do full-time residential doctoral programs. The key will be to create truly well-devised and rigorous doctoral programs.
- New hires who have experience with distance education (curriculum development or participation) will definitely be more valuable to a department than those who only have traditional classroom experience.
- Will be a growing need.

There was one response that seemed characteristic of the negative feelings found in this study toward hiring an individual with an online doctoral degree:

- ...At one time I personally was interested in an online doctoral degree but the “low-value” placed on this type of degree from our administration has been a deterrent.

Summary and Conclusions

There are job openings in technical education at the post-secondary level. The survey reported an average of one tenure track faculty vacancy per department, with respondents estimating two vacancies per department over the next three years. Given an average department faculty of about nine tenured or tenure track faculty members, two tenure track openings within three years represents an annual department faculty hiring/replacement rate of about 16%. (It should be noted that faculty openings are not synonymous with “a perceived need for additional faculty,” since job openings are dependent on funding, and it is likely that faculty are needed in some programs where there may be insufficient funds to hire new faculty.) There was moderate difficulty reported in attracting qualified applicants. Both the number of vacancies and the difficulty in attracting
applicants provide evidence of a need for the greater production of qualified applicants.

Faculty hiring criteria reported as more-than-moderate in importance included preparation (i.e., “having a doctoral degree, or ABD”) and skills in teaching, communication, working with others, authoring articles and presentations, and providing service. However, the ability to attract external research funding was reported to be of moderate importance, a finding likely linked to the fact that the survey targeted programs at the bachelor’s and master’s, rather than doctoral, levels.

This online survey uncovered a bias against hiring an individual with an online doctoral degree to teach in technical education undergraduate and master’s programs. This confirms the findings of Adams and DeFleur (2005) and extends their findings into the field of technical education. Additionally, it also confirms findings of a concurrent phase of the present study (Flowers & Baltzer, 2006) in which those who have completed a face-to-face doctoral degree were found to be less likely to consider an online doctorate as a valid option. In these studies, the most prominent issue was the perceived lack of quality of online doctoral programs.

Currently there are means of promoting the quality of an online program. The Higher Learning Commission (n.d.) developed accreditation standards specifically for online programs. However, evidence from this study has revealed that this accreditation process will not be enough to ensure that an individual with an online doctoral degree is evaluated equally when applying for a professorship alongside a similar candidate who earned a doctorate face-to-face.

This survey uncovered negative hiring attitudes for candidates with online doctorates. Hiring attitudes that disfavor candidates with online degrees should not change if they are well-founded. However, if they are based on insufficient or incorrect data and can be shown to be inaccurate, measures should be taken to promote change. This may be best accomplished by greater commitment to quality assurances from online degree providers and by providing higher education faculty with accurate information about the rigor of online education. In the meantime, those considering pursuing an online doctoral degree should be
cognizant of the attitudes of prospective employers toward these programs and should evaluate the benefits and drawbacks of online doctorates and their alternatives in relation to the time, effort, and expense of such programs.

Online education is growing (Allen & Seaman, 2005). According to this survey, online offerings in technical education may double in the next three years. As online education grows and more faculty teach online courses, attitudes may change toward online education. Interestingly, two of the respondents who said they would be more likely to hire an individual with an online doctoral degree indicated that they or another member of their faculty earned their doctorate online. This creates the glimmer of hope for those who support online education that, as online offerings expand within the field, the perceived quality and validity of online education may increase.

Previous research on the attitudes of higher education faculty towards distance education tended to consider a faculty member as an online instructor, or a potential online instructor, rather than as someone making hiring decisions. One strategy to alleviate bias in hiring decisions based on an ignorance of distance education may be to address a bias in attitudes toward teaching online. Yick, Patrick and Costin (2005) suggested one mechanism, coined the “bring along effect,” to address negative faculty attitudes toward teaching distance education: “These ‘vicarious observations’ of the hesitant or resistant faculty, where they observed the practices of colleagues who are teaching online, may be key to the process of changing negative attitudes toward distance education” (Discussion and Implications, ¶ 2). As more courses are taught online, more faculty will likely be “brought along” by their colleagues, and in the process the hiring attitudes of their departments toward applicants with online degrees may change.

Overall, this survey found a variety of employment situations within the field of technical education. For example, some positions require teaching three courses per semester while others require four. Those pursuing a professorship in this field should match prospective employers with their credentials, abilities, and goals. There are pockets of support for online education. Therefore, those who do intend to pursue an online
doctoral degree may have opportunities to teach in higher education, though currently these opportunities may be limited.

Acknowledgments
Dr. James Jones, Pilot Testers, Survey Respondents, and the Council on Technology Teacher Education Research Incentive Grant Program

References


Initiatives to integrate engineering design within the field of technology education are increasingly evident (Lewis, 2005; Wicklein, 2006). Alliances between technology education and engineering were prominent in the development of the Standards for Technological Literacy (International Technology Education Association, 2000), and leaders from both disciplines have expressed support for the outcomes described in the Standards (Bybee, 2000; Council of the National Academy of Engineering, 2000; Dugger, Meade, Delany, and Nichols, 2003; Gorham, Newberry, and Bickart, 2003). The National Science Foundation (NSF) has also encouraged and funded opportunities for technology educators and engineers to work collaboratively. The Bridges for Engineering Education projects and more recently the $10 million, 5-year funding for the National Center for Engineering and Technology Education exemplify the commitment of the NSF to support these activities.

The history of technology education is replete with trends and changes in curriculum, technical content, instructional materials and equipment, instructional strategies, and even identity (Lewis, 2004, 1999; Sanders, 2001). The profession has revised its name and made substantial efforts to affect public perceptions of the field. The historical benchmarks in technology education bear labels such as Industrial Arts Curriculum Project, Maryland Plan, Jackson’s Mill, or Technology for All Americans. A movement to embrace engineering design as a focal element in technology education would be another significant event in the ongoing history of technology education and could become another benchmark in shaping the profession.

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Perspectives regarding the role engineering should play within the discipline of technology education vary considerably. These positions range from advocating that technology education take on the role of pre-engineering for high school students to arguments in favor of retaining a broad focus for technology education in which it treats engineering design as simply one of many forms of creative activity. The perspective underlying the position presented here is that technology education should retain a general education role, providing hands-on learning activities for all students and encompassing approaches to design and problem-solving that extend beyond engineering to embrace aesthetics and artistic creativity. Engineering design, however, can provide a focus for the field of technology education that is applicable for students in all grade levels and career pathways.

Implementing an engineering design focus within technology education has significant ramifications. Classroom teachers, teacher educators, and support staff will need additional knowledge and skills to successfully shift the focus of the field toward engineering design. Changes will especially affect the preparation of technology teachers. Curriculum, educational philosophy, instructional strategies, and collaborative relationships are among the facets that will be influenced by this initiative. In each of these areas there are perhaps more questions than answers, and thoughtful discussion and research are needed to guide decision-making. It is essential that the field recognize the key issues so that steps are taken to provide and facilitate necessary professional development.

Curriculum

One theme that has arisen in conversations about an engineering design focus for technology education is the need for additional attention to analysis as a key component of the design process (Wicklein, 2006). Hailey, Erekson, Becker, and Thomas, (2005) identified analysis as the key difference between the approaches taken by technology educators and engineers. Table 1 was presented in their article and provides a side-by-side comparison of two design processes, one for engineering and the other for technology education. The list for technology education has more items and includes activities associated with fabricating...
the designed product, but it fails to adequately address the analytical component included in engineering design. Further examination, however, reveals more substantial differences in the approaches to design taken by these disciplines.

Hailey constructed the list shown in the right-hand column of Table 1 based on the steps described in the *Standards for Technological Literacy* (2000) Standard 8 (C. Hailey, personal communication, February 22, 2006). This material, however, reflects an approach to design that has yet to be widely adopted within the technology education field. Hailey, an engineer, included “identifying criteria” and “specifying constraints” in the phases of the design process, but these steps are not widely practiced within the field of technology education.

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<td>1. Identify the need</td>
<td>1. Defining a problem</td>
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<td>2. Define problem</td>
<td>2. Brainstorming</td>
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<td>4. Identify constraints</td>
<td>4. Identifying criteria</td>
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<tr>
<td>5. Specify evaluation criteria</td>
<td>5. Specifying constraints</td>
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<tr>
<td>7. Engineering Analysis (applications of mathematics &amp; science)</td>
<td>7. Select an approach</td>
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<td>8. Optimization</td>
<td>8. Develop a design proposal</td>
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<td>9. Decision</td>
<td>9. Building a model or prototype</td>
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<td>10. Design specifications</td>
<td>10. Testing &amp; evaluating the design</td>
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<td>11. Communication</td>
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<td>12. Make it – create it</td>
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<td>13. Communicating results</td>
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Table 1: Design Process Comparison

Comment: This explains why I did not rely on Haley's list as presented in Table 1.
The phases of another design process described by Culbertson, Daugherty, Fuerborn, and Loepp (2005) in the Project Probase materials are more typical of those used in the field of technology education (see Table 2). In the Project Probase design process there is no explicit mention of consideration of constraints and criteria. The Project Probase phases consist of (a) identifying and clarifying the problem, (b) brainstorming ideas, (c) selecting a potential solution, (d) modeling and prototyping, (e) testing, (f) evaluating and refining, (g) implementing, and (h) communicating results.

It is important to note that for both technology educators and engineers the design process is iterative with repetition of steps expected. Providing the activities for completing the design process in a numbered list is useful for explaining design activities, but technology educators and engineers seldom go through these steps in a linear fashion.

In comparing design processes typical of technology education, such as that of Project Probase, to those of an engineering design process, the identification of possible solutions without explicit consideration of constraints and criteria as well as the absence of analysis as an activity are noteworthy. Eide et al., in describing the search phase of engineering design activities, specifically stated that “at this point no formal list of

Table 2

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<th>Project Probase Design Process</th>
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<td>(Culbertson, Daugherty, Fuerborn &amp; Loepp, 2005)</td>
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<td>1. Identifying and clarifying the problem</td>
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<td>2. Brainstorming ideas</td>
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<td>3. Selecting a potential solution</td>
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solutions has been developed” (2002, p. 90). Engineers spend time researching relevant facts, identifying constraints, and developing criteria descriptive of optimal solutions before they reach the stage of generating alternative solutions. These stages not only illuminate the initial selection of designs to be considered, but they provide the basis for analyses performed to identify and select an optimal solution. The message here is that designers need to “do their homework” before settling on a design. Developing possible solutions based on familiar materials and processes or technologies that are a part of the designer’s past repertoire of experiences often results in status quo products.

For engineering design to become a focus for technology education, the list of design activities provided by the engineering profession should be adopted. The design process should not progress to identification of specific solutions prior to a thorough investigation of relevant science, patents, similar products, and a careful consideration of constraints and criteria. Technology educators should endeavor to communicate the importance of spending time and energy in researching the context, the related technologies that already exist, and considering the balance of constraints and criteria before locking in on possible solutions. This will pay dividends when selecting a design model or prototype since these early stages provide the basis for the analytical components of engineering design that technology education should also consider incorporating.

Lewis and Zuga (2005) recommended three possible approaches for technology educators to take with regard to the analytical component of engineering design. These options consisted of (a) limiting instruction to the conceptual portion of the engineering design process, (b) addressing the analytical component using worked out engineering design cases, and (c) using a collaborative approach in which technology teachers team with mathematics and science educators as well as with practicing engineers. These recommendations accurately reflect the realities imposed by the limited capabilities of technology educators to address the mathematical analyses required for engineering problem solving.

While it would be ideal if technology education teachers mastered mathematics through the first level of calculus,
calculus-based physics, and chemistry and studied the principles of statics, dynamics, strength of materials, electronics, and fluids, these levels of mathematics would be problematic for many existing members of the profession as well as for the numerous entry-level teachers participating in graduate level alternative certification programs.

A key issue in preparing technology education teachers to adequately address analysis in the design process is the choice of design problems to work with. Conducting research in conjunction with the development of design solutions and using analysis to select a favorable design, along with employing the other design activities implemented by both engineers and technology educators, can be implemented in age appropriate ways. The engineering design process can be applied to problems that require only elementary levels of mathematics. While upper level high school and college level technology education students might research patents, learning activities involving exploration of products on store shelves might be used with elementary or middle school students. Activities related to analysis can be handled in similar fashions, with older students performing relatively complex mathematical calculations while younger students compute averages or perform other manageable tasks. In any case, technology teachers should develop strategies for addressing all of the engineering design elements so that students learn to apply them each time they undertake a problem solving activity.

Implementing an engineering design emphasis in technology education would also require changes in technology teacher education courses. This second element of curricular change would involve integration of optimization and analysis into technology teacher education course content, particularly in conjunction with hands-on assignments and problem solving activities. Technology teacher education courses would need to emphasize that prototypes should not be constructed until design parameters have been developed and analyzed in a systematic way. Technology teacher education students would be expected to master appropriate mathematical computations, and class participants would avoid trial and error approaches to solving problems.
Technology teacher education curriculum materials include a wide array of books, modules, computer software, and other instructional resources. Adapting these materials for use in an engineering-design-focused program would necessitate the specification of constraints in problem solving activities. For example, in a class preparing participants to teach transportation or research and experimentation, it would not be unusual for students to be challenged to design and construct a rocket that achieves the maximum possible altitude using a given propulsion unit and payload capacity. This problem would provide better opportunities to focus on an engineering design perspective if it included specific constraints such as a specified altitude or a downrange target. These constraints would provide opportunities for analysis and design directed toward an optimal solution and would establish a more realistic problem. NASA would have little use for a rocket designed to simply go “as high as possible.”

If engineering design becomes a focus for technology education, changes in curriculum materials would drive changes in the competencies expected of technology teacher educators. They would need the appropriate analytical skills and instructional resources to model and facilitate learning involving engineering design problems. This, in turn, would require some retooling of technology teacher education curriculum and some creative instructional approaches by technology teacher educators. With the sources of assistance available to most university professors, the task could be accomplished, but would require investments of the teacher educators’ time and resources. A systemic change in the profession could not easily occur if technology teacher educators chose not to prepare themselves to contribute to the process.

A third curricular component that infusion of engineering design would bring to the forefront is the development of the social capacity of its learners. In an engineering conference held at the University of Georgia on October 28, 2004, the keynote address was delivered by Dr. Richard Miller, founding President of Olin College. One of the prominent points made in this talk was that the engineering profession was urgently seeking engineers who (a) had good communication skills, (b) could work well in teams, (c) were skilled in social interactions, and (d) had
good business and ethics skills. Miller noted that there was no shortage of programs to prepare engineers to solve analytical problems and identify optimal solutions. What was needed, he stated, were effective methods to infuse development of social skills into the preparation of engineers.

The field of technology education is ideally positioned to collaborate with the discipline of engineering education to develop these desired affective attributes. Delmar Olson (1963) suggested that the purpose of industrial arts was to acquaint students with their technological environment and to aid them in the discovery and development of their own potential. Standards 4 and 6 of the Standards for Technological Literacy (2000) address the cultural, social, economic, and political effects of technology and the role of society in the development and use of technology. Technology education has a long heritage of addressing the issues that the engineering profession lists as its priority needs.

In March of 2004, the 53rd CTTE Yearbook entitled Ethics for Citizenship in a Technological World was published by Glencoe/McGraw-Hill. The key constructs used as organizers for this book include “integrity, responsibility, fairness, caring, initiative, interpersonal skills, and dependability” (Hill, 2004, p. 10). Availability of this book for technology teacher educators to use in conjunction with new curricular materials related to analysis and optimization has positioned the profession to effectively address engineering design in a holistic manner. The ability to deal with affective issues should be a point of emphasis when contrasting the proficiency of technology educators to that of math and science educators for dealing with engineering design in K-12 education. Ethics, communication skills, and teamwork should be prominent within the curricular content of technology teacher education programs.

**Educational Philosophy**

Implementing an engineering design focus in technology education has ramifications for the educational philosophy and conceptual framework guiding teacher preparation. For almost as long as school programs related to technological literacy have existed, there have been philosophical differences concerning whether technology education (industrial arts) programs should...
be pre-vocational or included as a part of general education. Evidence for these differences is still demonstrated by the existence of the Technology Education Division (TED) of the Association for Career and Technical Education (ACTE) and the International Technology Education Association (ITEA).

An important component of any teacher education program is facilitating opportunities for each participant to develop a coherent, philosophical perspective. For those enrolled in technology teacher education this would include thoughtful consideration about the extent to which K-12 technology education should equip students to consider or enter a particular career, to what extent technical content should be shaped by current technologies used in the workplace, whether or not curricular content should be aligned to prepare students for entry or advanced placement within a particular post-secondary degree program, what level of academic rigor should be implemented, and which kinds of students should be targeted for enrollment. All of these issues are associated with significant philosophical positions, and all teachers should be challenged to consider the consequences of related decisions.

Most professionals within the field of technology education would recognize two particular realities pertaining to these discussions. One is the federal funding associated with career and technical education. Federal vocational or career and technical education funds have often been used to support technology education programs taught by educators who viewed their courses as general education, on a par with mathematics, science, English, and history. Another reality most technology educators would have insights into is the stigma associated with career and technical education. Societal influences do an effective job of shaping the psyche, beginning at an early age. In only a few years most children have predictable perceptions about what it means to be a physician as compared to a plumber, a banker as compared to grocery store cashier, or a corporate CEO as compared to a carpenter. Similar perceptions within education might align “academic” teachers with the former and career and technical education teachers with the latter of these occupations. This dynamic can entice technology educators to embrace an
identity with "academic" teachers and the general education sector within school settings.

On the other hand, there is a strong likelihood that incorporating an engineering design emphasis in secondary technology education will cause the field to be perceived by many as an excellent elective course for students who aspire to become engineers. Those within the engineering community have indicated a desire to have greater influence in secondary schools so that more students choose engineering as a major in college. While arguments can be made for the general education value of engineering-design-focused technology education for all students, identifying the field with the work of engineering may move it toward a pre-engineering educational camp.

Both of these realities have philosophical and, to some extent, ethical aspects. The discussion is relevant to the question of introducing an emphasis on engineering design within technology education because engineering brings with it an association with an occupational area of higher status than those of plumbers and carpenters. One of the questions to be considered by the general education technology educator is whether having their discipline associated with a particular career track is more acceptable if the profession is high status. If so, there are related philosophical issues to be considered and discussed within the context of technology teacher education.

Infusing engineering design into technology education could be based on a hybrid philosophical model not unlike the role many technology education programs combined with related trade and industry (T&I) courses have collectively provided. High school technology education courses have sometimes been identified as providing opportunities for students to explore a variety of occupational areas, while more in-depth T&I courses are seen as allowing students to achieve proficiency in specific technical areas. In the absence of an extant high school subject area to develop proficiency in engineering design, technology education might encompass the entire array of courses emphasizing engineering design. Introductory experiences, while retaining an emphasis on engineering design, would be appropriate for all students and retain primarily general education objectives. Additional coursework would focus more
directly on pre-engineering and would be designed for students planning to pursue engineering or a related field of study as a college major.

**Instructional Strategies**

Implementing an engineering design emphasis within technology teacher education would have an impact on its instructional strategies, the equipment and instructional materials used in its coursework, and its co-curricular activities. Technology education has been identified as action-based, and the use of hands-on instructional activities has always appealed to students who prefer learning by doing. Engineering design, on the other hand, while maintaining strong ties to applications of math, science, and technology, largely focuses on analytical processes that lead to optimal solutions. With the extensive array of computer modeling tools now at the disposal of engineers, solutions can often be developed and tested without physical prototypes. Incorporating an engineering design emphasis in technology teacher education will affect the quantity and types of learning activities involving fabrication and machine operations that technology teachers traditionally employ in their classrooms. Instructional time is a finite resource so added attention to analytical activities is likely to reduce opportunities for hands-on fabrication and experimentation.

Another way an infusion of engineering design will affect technology teacher education is in its approach to teaching certain concepts. Engineers, mathematicians, physicists, and chemists approach problem solving from a different perspective than technicians. One example of this is the different methods used to solve DC circuit problems. Both technology educators as well as engineers might ask their students the question, “In a DC circuit, does current flow from positive to negative or from negative to positive?” Instructional strategies in technology education might have their students approach this question from the electron-flow theory prevalent in training for technicians. Engineers, however, typically find the answer using conventional-flow theory as adopted and taught in physics courses. The solution to a DC circuit calculation comes out the same with either theory (as long as one is consistent), but the question to
consider here is to what extent technology teacher education instructional strategies should be aligned with those of the engineering profession.

The method used to solve time and motion problems provides another example of differing instructional approaches. Time and motion problems are typically stated in narrative form such as, “An airplane is traveling 550 mph with a heading of N28°E. The airplane is flying into a 40 mph wind out of due north. What is the resultant velocity and heading?” A technology education solution might involve graphical vector analysis using Bow's notation, a vector scale, a space diagram, and a vector diagram, and the solution would be determined by physically measuring the resultant drawn on a piece of paper. An engineer, however, would likely solve this problem using trigonometry, and while a vector sketch might be used, the solution itself would be determined mathematically. Again, the question for technology teacher educators is which approach to apply as they prepare technology teachers. Should both techniques be employed? Should traditional technology education problem solving strategies give way to those of engineers?

There are additional examples to illustrate ways traditional technology education instructional strategies differ from approaches used in engineering education, but the point is that differences exist. It will be important for technology teacher education programs to encourage each future technology educator to thoughtfully consider choices related to instructional practice. Just because a particular approach is used by engineers, it is not necessarily better for the purposes of technology education. One of the motivations behind some of the NSF Science, Technology, Engineering, and Mathematics (STEM) funding initiatives has been to encourage improvements in engineering education instruction. Certainly, implementing an engineering design emphasis within technology teacher education will result in changes in instructional strategies, whether due to time constraints for presenting multiple approaches, unnecessary redundancy, or desirable outcomes provided by approaches used by engineers.

Most laboratories used by technology teacher education programs have equipment available for use by their students. In
some instances this apparatus is similar to that found in middle school and secondary technology classrooms. In other cases it includes machines and tools acquired during the industrial arts era.Regardless of what is available to support students as they learn to deliver traditional technology education instruction, changes can be expected with a shift to an engineering design emphasis.

For example, the laboratory apparatus used to test the strength of bridges, towers, or other structures fabricated from balsa or similar materials might not serve in a technology education laboratory with an engineering design focus. A typical learning activity is one that challenges students to construct a tower that conforms to specified size and weight constraints and achieves maximum strength when tested to the point of failure with a vertical load. Solutions to the problem typically involve research and experimentation related to trusses, beams, and adhesives. The culmination of the assignment consists of destructive testing of completed towers and generates great excitement on the part of those with the strongest structures.

When an engineering design emphasis is overlaid on the structure problem, the objectives of the activity can change, and the strength analyzing equipment must perform tasks many are not presently capable of. Rather than designing for maximum load, an engineering design problem would likely be directed toward support for some specified load. Calculations would be needed to analyze the available structural materials, and the strength analyzer might need to measure the strength of a single balsa component. Problems arise when the testing device is designed around the traditional technology education activity and is not capable of measuring the small loads of an individual component. Moving technology teacher education toward an emphasis on engineering design will involve changes in the laboratory equipment needed for hands-on activities. In many instances these changes can be accomplished with minimal cost, and in other situations new or different apparatus might be needed. However, all cases require thoughtful consideration of the ramification of bringing an engineering design perspective into the process.
Also to be considered is that engineering educators can provide the field of technology education with useful tools and techniques for solving problems that might not have been a part of technology teachers' previous repertoire. Some of these involve minimal costs, but can significantly affect the procedures technology teacher education programs impart to their students. An example is the use of an engineering design notebook. This tool consists of a bound notebook of cross-section paper, an indexing system, and a process for documenting all aspects of work toward a design solution. Bringing these types of tools and techniques into the array of technology teachers' instructional strategies will enrich the experiences of their students and encourage systematic approaches to problem solving.

Over the past decade immense amounts have been earmarked in many states to purchase updated equipment for use in technology education programs. Many universities have followed this pattern in an effort to provide teacher education students with equipment comparable to that which they will use in their classrooms. In some respects engineering design brings a lessened emphasis on equipment as the focus shifts to mathematical computations and applications of science. The most important equipment may become a good scientific calculator in the hands of every student. Laboratory equipment will still be important, but the emphasis will shift toward the tools and apparatus needed for engineering analysis and optimization.

One of the most important elements of good technology teacher education programs is the co-curricular involvement of students in a Technology Education Collegiate Association (TECA) chapter. This student organization provides tremendous opportunities for leadership development, service, professional learning, and collegiality. Reflecting another aspect of career and technical education influence, TECA is often a seamless component of collegiate teacher preparation programs rather than a recreational or extracurricular activity.

Among the most visible TECA activities are the competitive events conducted at regional conferences and at the annual ITEA conference. “Live” Communication, Problem Solving, Transportation, Live Manufacturing, and Teaching Lesson contests are capped with a Technology Challenge in which
teams from participating universities compete in a quiz-bowl type event. TECA competitions provide an excellent platform for technology teacher educators to show participants the value of co-curricular activities as a part of technology education. As technology teachers, they will have opportunities to involve their own students in the Technology Student Association (TSA) and its corresponding competitive events for middle and high school youth.

Technology teacher educators should consider changes in TECA and TSA competitive events if they are to reflect an engineering design emphasis. The logical starting point would be the TECA competitions since university faculty have significant involvement in planning, hosting, and administering those activities. There might be opportunities to begin by involving engineering students in TECA activities, but this should be thoughtfully considered. Competitive events pitting technology education majors against engineering majors could work against the community building that might otherwise be facilitated between the two disciplines through the event. Teams involving an equitable distribution of technology education and engineering majors would introduce new complexities to the management of these events, but joint activities with TECA and engineering student organizations hold great potential.

**Collaborative Relationships**

Implementing an engineering design focus within technology teacher education would result in changed collaborative relationships. These changes would involve developing new working partnerships within the university and participation in new professional associations. Some of the technology teacher education programs that are moving to adopt an engineering design emphasis have implemented integral involvement of engineering faculty members in their programs. These engineering educators are able to provide the technical expertise to guide development of the content and instructional activities related to engineering design. This collaboration is critical since most technology teacher educators do not yet have expertise to be self-sufficient in this task.
Seeking assistance from engineering faculty can also be complex. Issues of instructional load and cross-unit work responsibilities can create challenges. These concerns can be ameliorated by external funding, and initial assistance can usually be obtained even if additional funding is not available. Moving beyond limited involvement depends on the levels of commitment on the part of the engineering faculty and their academic unit. The technology teacher education faculty will likely still have sole responsibility for direct instruction, but assistance in selecting or developing learning activities and identifying solutions could be sought from those with expertise in engineering. If engineering faculty are not accessible, seeking assistance from engineers in the community could provide an appropriate alternative strategy.

Technology teacher educators have traditionally been involved in professional associations such as the International Technology Education Association (ITEA), the Association for Career and Technical Education (ACTE), or the American Education Research Association (AERA). With the move to emphasize engineering design, some technology teacher educators have joined the American Society for Engineering Education (ASEE). This professional organization now has a K-12 education component along with an initiative emphasizing the importance of exposing students to engineering as a profession. Involvement with ASEE has the potential to both enhance technology teacher education as a profession as well as to detract from it. The ASEE provides resources and activities that can contribute to the professional development of technology educators, but if limited resources result in a technology teacher educator belonging to and participating in a single organization, teacher education professional associations might end up with fewer members. Diligence will be needed to balance these new opportunities for membership in engineering education associations with reduced participation in traditional technology education professional associations.
Technology Teacher Education and the Transition to an Engineering Design Emphasis

Technology teacher education will be affected by moving to an emphasis on engineering design, and many aspects of university-level technology education programs will need to be thoughtfully considered. University faculty will also play a critical role in changes in K-12 technology education, particularly at the high school level. Aside from preparing the next generation of teachers, technology teacher educators hold critical leadership roles in the professional organizations in which teachers participate, and they are often the authors of the textbooks and instructional materials used in school classrooms. They serve on school advisory committees and as consultants. They help to establish standards for certification of teachers and programs. They participate in the development of state curriculum, benchmarks, and learning objectives. If technology education changes to an engineering design emphasis, the focus of these roles will have to change with it.

Technology teacher educators also play a leading role in seeking funding for research projects and in conducting project activities for those which are funded. In the NSF-funded National Center for Engineering and Technology Education, for example, technology education faculty members at nine universities are involved in preparing twenty doctoral students to become the next generation of teacher educators. In any new endeavor, resources beyond the norm are often required. Funded projects will be critical to the successful infusion of engineering design as a focus for technology education, if that is the direction the field chooses to go.

Conclusion

Technology teacher educators have much to consider with regard to integrating an engineering design emphasis in technology education. This change of focus represents a major paradigm shift for the profession and has ramifications for curriculum, philosophy, instructional strategies, and collaborative relationships. Significant commitment will be required on the part of all members of the profession to upgrade analytical
knowledge and skills. Professional development in this area will be particularly critical for teacher educators.

Each member of the technology education profession will have to determine what role they would play and how they would be involved in a move to emphasize engineering design in technology education. Such a change should not be taken lightly or without careful thought. There are reasons why this shift in the focus for the profession should be encouraged and supported, but the movement is not without risk. Venturing into an arena where others have greater expertise about a key portion of the instructional content than those in the profession requires trust and a commitment to change, as well as hard work. Whether the risks will be offset by benefits for constituents and members of the profession remains to be seen, but there is considerable evidence that this trend represents the future of technology education.

References


The Bicycle: Appropriate Technology for Technology Education

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I am always amazed at the end of the spring semester on this college campus to see bicycles abandoned at bicycle racks. Often they are missing components or have flat tires or both. Probably their technologically challenged owners have forgotten them in dreams of some new automobile for which they will be indebted for years to come. Eventually these abandoned bicycles, thrifty wonders of efficiency, will be freed from their racks by campus police and sold to new owners at a university auction. In regards to bicycles and schools, I am also amazed that the bicycle has not been used more in technology education. In other subject areas, such as physics, the bicycle is a favorite among instructors because it serves as such a relevant topic for the study of energy and power.

Shields and Rogers recent editorial in the Journal of Industrial Teacher Education entitled “Incorporating Experimental Technologies in the Middle Level Technology Education Classroom” suggested as curriculum “innovative energy technologies, such as those used in hybrid vehicles” (2005, p.73). From my perspective, a hybrid vehicle seems far removed from the interests of a typical middle school student. Beyond the classroom, why would a middle level student find anything relevant about a hybrid engine? On the other hand, how many middle school students could you find that at least own a bicycle and use it for some form of transportation?

The bicycle evolved during a seventy-year period in the nineteenth century from the hobby horse to the boneshaker to the high wheeler and finally to the safety bicycle. By 1890, the safety

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bicycle, with same size wheels, a chain, and pneumatic tires, provided an independent form of transportation for many Americans and Europeans. During the first half of the twentieth century, the development of the derailleur provided the user with the convenience of multiple gears to enhance both speed and mechanical advantage. Over the last half of the twentieth century the bicycle continued to evolve as transmission and brake systems improved, and lighter weight materials were used. In the beginning, bicycles were made from iron and wood. Today, manufacturers are using titanium, aluminum, chromium-molybdenum steel, and composite materials such as carbon fiber. The beauty of this highly efficient vehicle is that over its evolutionary process, the bicycle has remained low-tech in terms of repair and maintenance, especially when compared to today’s automobile. With a few general shop sockets and wrenches, a repair stand, some specialty tools, and a bit of synthetic oil, you are good to go.

Sadly, in recent years, fewer students are taking advantage of the simple means of transportation a bicycle provides. According to the Bicycle Alliance of Washington State, today “about 13% of American children bike or walk to school, yet more than 30 years ago 66% did.” Moreover, “20-25% of morning traffic is the result of parents driving their children to school” (Safe Routes to School, n.d.). What is wrong with this picture? At the end of the nineteenth century the bicycle was the rage in America because it provided the common man and woman with an independent form of transportation. Don’t today’s middle school students want that same means of independence?

The goal of the New National Safe Routes to School Program is to reverse this trend away from biking and walking. Through a $612 million dollar congressional appropriation, the program offers benefits to all 50 states. “Communities will use this funding to construct new bike lanes, pathways and sidewalks as well as launch Safe Routes education and promotion campaigns in elementary and middle schools” (Bikes Belong Coalition, n.d.).

Not only do bicycles furnish students an independent mode of transportation, bicycle maintenance provides an ideal topic for technology education. Some schools have already
incorporated bicycle technology into their curricula. One of the more interesting examples is the Recycle-a-Bicycle program in New York City. This project takes teens and pre-teens between the ages of 10 and 18 and puts them to work refurbishing used bicycles. The program began in 1994 and was “incorporated into the school's curriculum and offered by the NYC Board of Education as an industrial arts class” (Recycle-A-Bicycle, n.d.). In addition to bicycle maintenance, the participating students learn business concepts, customer service, marketing, and inventory management. As a result of the program, two retail shops have opened, one in Manhattan and one in Brooklyn, where former students of the program are employed.

Another school, Harbor High School in Santa Cruz, California, is piloting a Bike Shop class during the fall of 2006. The goals of the class are to teach bicycle maintenance and repair, mechanical safety check-ups, off-road riding rules, and safe bicycle practices including helmet use and anti-theft skills. Additionally, through a variety of community organizations, instructors will use the bicycle as a vehicle to teach environmental, economic, health, and community participation skills (Bicycle Trip, n.d.).

According to Wicklein and Kachmar, “The appropriate technology movement has at its philosophical heart the desire to capacitate people of all walks of life to create (1) Meaningful Employment, (2) Comprehension of Technology, (3) Self-Reliance, (4) Reduced Environment Impacts” (2001, p. 6). The Recycle-a-Bicycle program in New York and the Harbor High Bike Shop class in Santa Cruz do exactly that. Bicycle technology has minimal impact on the environment. Additionally, students participating in these and similar programs learn all aspects of the technology of the bicycle system and in the process gain self-reliance. Several students have obtained meaningful employment through the New York Recycle-A-Bicycle Program. The results of these programs satisfy all four principles of the appropriate technology movement’s philosophy.

While there are a number of obvious limitations to using bicycles for common transportation—such as cycling during harsh or inclement weather or when carrying a load—biking does offer a partial solution to our transportation problems that is simple,
inexpensive, and immediately available. At the same time, there are few limitations in term of using the bicycle for educational purposes. It is a vehicle for developing technological literacy for a specific technology. Topics that lend themselves to study in a course based on bicycle technology include the history and invention of the bicycle, what makes a good bike in terms of materials and design, repair and maintenance of a bicycle, and safe riding practices. Also easily incorporated are topics in math and science such as calculating mechanical advantage, power, speed, and aerodynamic efficiency.

In a summer workshop covering these and other topics taught recently at the University of Nebraska, bicycle maintenance and repair comprised a good portion of the course. It included teams of students tearing down and reassembling a ten speed bicycle. The goal was not to turn the students into bicycle mechanics, but to give them the confidence to tackle repair problems that might occur with their own two-wheelers. The initial feedback on this course was positive, but what a number of the students wanted more of was the hands-on mechanical know-how.

If more students ride their bicycles to school nationwide, I would expect a rising demand for local purchases and repair of bicycles. In regards to technological literacy, it is comforting to know that even in the present world, complicated technological approaches are not always superior. The bicycle in its simplicity is easy to comprehend, maintain, and repair by the majority of its users. As the students who participated in bicycle technology programs can attest, a bicycle does not require highly trained technicians using sophisticated equipment for maintenance and repair. You can do it yourself!

As we look to others means of transportation beyond the automobile, surely the bicycle should be part of the solution. I would argue that the target student audience to help solve our transportation problems could be middle school students, because a bicycle is likely the most relevant means of transportation in a middle school student’s life. So my challenge goes out to technology educators who want to make a change: When you see students riding to your school on their bikes and parking them in the racks, what will you do to assist and encourage them? Will
these middle school students become lifelong bicyclists, or will they abandon their bicycles and fill their high school parking lots with automobiles?

References


Occasionally a book is published that may not at first attract a great amount of attention, but over time proves to have considerable intellectual influence and eventually causes a retooling of conventional ideas. The Education Gospel: The Economic Power of Schooling by N. Norton Grubb and Marvin Lazerson may be such a work.

Conventional wisdom conceives of vocational education as primarily limited to direct work preparation, provided mainly through secondary or post-secondary programs of less than baccalaureate level. Academic education, on the other hand, is thought of as something quite different, and even the mention that academic coursework is also useful for vocational preparation may raise some heated dissent. But Grubb and Lazerson defy such conventional thinking. The authors observe that virtually all of American education is vocational education. They contend that progressively throughout the twentieth century the economic function of preparing youth and adults for gainful employment slowly worked its way through the system so that today schooling at all levels is dominated by an emphasis on widely defined vocational preparation. The vocational transformation of schooling over the past century has been bolstered by what the authors term the “Education Gospel,” a set of ideas promoting the belief that education raises both personal and public economic wealth and solves a myriad of social problems.

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Vocational and technical educators probably best know Grubb through his work at the National Center for Research in Vocational Education (NCRVE) when it was located at the University of California, Berkeley. During his association with the center from 1988 to 2000, Grubb published numerous studies, monographs, and books addressing work preparation policy issues. His work is insightful, provocative, based on sound research, and comprises a major contribution to the field. In this current volume, Grubb teams with Marvin Lazerson of the University of Pennsylvania. The two first worked together more than thirty years ago when they collaborated on American Education and Vocationalism: A Documentary History, 1870-1970, which remains a useful reference for primary source material. Lazerson’s most recent work has focused on the uses of schooling to further democratic citizenship.

When vocational education first entered secondary schools on a large scale in response to the Smith-Hughes Act of 1917, work preparation was conceived primarily as skills training for local or regional industrial jobs. Instruction tended to be centered on craft-based forms of work and teaching was carried out in shops separate from academic classrooms. In the early twentieth century, work was based on the division of labor and its completion on assembly lines. Today, in contrast, work is no longer regional, but is international in scope, with components produced and functions performed throughout the world. With the final product coming together at central assembly points, work must be carried out in teams, with integrated push-pull and flexible manufacturing systems characterizing production. Information systems reduce time and collapse distance. Computers perform amazing control and processing functions. Compartmentalized knowledge has given way to integrated fields of study that cut across more traditional knowledge groupings and skill sets. More management and information processing skills are required by all, and differences between the academic and the technical have become blurred. More work is intellectual, and what once were manual skill operations are now performed by machines. Consequently, much of what was formally considered good academic preparation has now become necessary vocational preparation.
At the same time, educational opportunity has expanded. Throughout all grade levels, considerably more individuals are enrolled in educational institutions than were a few decades ago. More alternative forms of education are also available, providing a variety of different study options to individuals. The knowledge and information base has expanded, and higher-order, communication, problem solving, and reasoning skills are considered ever more important. The over riding driving force behind these educational changes is economic, and the focus of these changes is the preparation of individuals for entry into a complex, dynamic, and competitive work world. In the words of the authors, "Virtually all educational institutions from the high school on up have become more explicitly vocational, concerned first and foremost with preparation for employment" (p. 13).

In the first section of the book, comprising chapters 1 to 3, the authors present an overview of high school, community college, and university education. They observe that each level of education "has only expanded after occupational goals were added to earlier academic goals; each has become a comprehensive institution incorporating a diversity of purposes and an increasing variety of students" (p. 25). In each of the first three chapters the authors expand on the evolving goals, functions, and programming of the respective institutions and examine the effects of vocationalism on these goals.

In chapter 4, discussion shifts to job training and adult education. The authors provide an overview of the development of programs created to address job preparation for individuals on the social and economic margins of society—dislocated workers, the unemployed, welfare recipients, and the disabled. While the promises inherent in such second-chance programs are remarkable in the eyes of the authors, they believe that the full potential of such programs has yet to be realized.

Chapter 5 examines work preparation in the United States and contrasts U.S. practices with those of other countries. The authors note that one prominent difference is that in the United States there is no "well developed vocational education path through secondary education" mainly because of the emphasis in the U.S. on college education for all. "The United States spends much more than other countries on postsecondary
education relative to K-12 schooling," the authors observe (p. 132). There are links, nevertheless, between educational levels. Often what appears to be academic preparation at one level is actually pre-vocational preparation for the next. Furthermore, the pre-vocational or vocational preparation in the United States tends to be "less pure" and characterized by general instruction in "moral, political and intellectual education." It is indeed, the authors contend, "rare to find public forms of work preparation that are single-minded vocational" (p. 133). As a result, except at the upper levels of specialization, vocational preparation in the United States is less specifically defined than it is in other countries.

Chapters 6 and 7 focus on issues surrounding the placement of work preparation in formal schools and colleges. Why, for example, is it assumed that the best place for vocational preparation is formal institutions separated from actual employment? In these chapters, the authors also examine perplexing issues of status as well as both the private and public benefits of schooling. They explore the effects of vocational programs at various levels of schooling and draw the provocative conclusion that "the question of whether overtly occupational forms of schooling pay off therefore depends on the level of schooling involved. At the lowest level, in high school vocational programs, it is difficult to find any substantial effects of occupational specialization. At the baccalaureate and postgraduate level, these differences become increasingly substantial. In our system of vocationalism, the importance of a particular occupational focus matters the most at higher levels of schooling and the least at the lowest levels" (p. 162). Work by Bishop and Mane (2004; 2005), Gray and Neng-Tang (1992), Mane (1999), and others, however, find contrary results. These studies conclude that there are substantial private and social returns for high school level vocational preparation, particularly in the case of those who train for specific occupations through advanced courses. Although some of the assertions made by Grubb and Lazerson in these chapters may be debatable, the issues they raise probe into areas of policy that are often not thoroughly examined and deserve exploration.
Chapter 8 focuses on another controversial policy issue, the role of vocational education in the perpetuation of inequality. The authors contend that alongside the beneficial outcomes of vocational education lurk potential detrimental effects on individuals and society. These negative results can come about when vocational education diverts attention from more basic academic studies, closes off choices, or directs individuals into low status and low paying jobs. In addition, there exist personal issues of identity, job fulfillment, inequality, opportunity, and questions of long-term social and economic mobility. Under the Education Gospel schooling has become a strong determinant of an individual’s life chances and, in the case of some class and ethnic groups, has grown extremely powerful.

In Chapter 9 the authors discuss the implications of the “Knowledge Revolution” for work preparation in the twenty-first century. Counter to popular public perceptions, today only 30 percent of all jobs require postsecondary education. Nevertheless, changes are at hand, driven as much by the international, global market place as by the explosion of knowledge and technological innovation. In a balanced discussion, the authors examine what is right and what is wrong with American vocationalism. They outline a possible future negative scenario in which there is an undue concentration on narrow skill development. In this adverse event, students search for fast employment access to the detriment of a more balanced education, neglecting the arts, humanities, and general education. The result is workers who hold certification in firm-specific credentials which have little employment transfer value. In this worst-case scenario, unregulated education and training programs proliferate, and, in consequence, due to market competition, education standards decrease. The authors see a particular danger in the possibility that public institutions may be forced to compete and emulate unregulated, poor quality providers of educational services and “abandon all pretense of public responsibility and become dispensers of credential-preparing programs and narrow skills-orientated courses for increasing numbers of semiprofessionals” (p. 259).

The authors contrast this grim outcome to a more promising prospect that reinforces the constructive elements of
our current work preparation system. In this positive scenario, individuals are offered extended schooling opportunities that include both considerable education and adequate training for multiple educational levels and knowledge-based work. The authors stress above all the critical need for clarifying the obligations of collective responsibility. According to the authors, this responsibility centers on a vision of vocational preparation that places human capacity building before limited economic goals. They argue for strengthened, well-rounded, coherent programs that combine technical and academic instruction in order to build broad human competencies. "Powerful" teaching is required, a "kind that can integrate the general and the specific, that can incorporate flexible internships coordinated with classroom content, and that can provide higher-order skills" (pp. 261-262). To achieve this goal, teaching credentials must be broadly defined, barriers to equal opportunity in vocational preparation must be removed, and work itself may need to be restructured.

One does not need to agree with the views of the writers of this provocative work in order to recognize its value. In the United States we have tended to view education in terms of a duality: the academic and the vocational. This thinking is grounded in the Smith-Hughes act of 1917 and much of the subsequent federal legislation. The academic-vocational duality is found in the way that we prepare teachers. It is found in the ways that schools are structured and administered, and it is present in how classes are organized and run. The authors contest this duality by pointing out that in a real sense all education is vocational. This book challenges its readers to think about how we can forge a new concept of vocational preparation, and how we can eliminate barriers to more equitable and fulfilling vocational education. This thought-provoking work succeeds in its design to bring about new and unconventional considerations of work preparation in the United States
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