AC 2008-668: ENGINEERING TECHNOLOGY AS A VEHICLE FOR PUTTING QUALIFIED TECHNOLOGY TEACHERS IN HIGH SCHOOL CLASSROOMS

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Engineering Technology as a Vehicle for Putting Qualified Technology Teachers in High School Classrooms

Abstract

Increasing the presence of engineering and technology in K-12 education has become a high priority for the nation's industrial future. Most middle and high school students and many of their teachers still do not have a positive attitude towards these fields and/or lack an understanding of the role of engineering, as well as the role of engineers and engineering technologists. How do we meet this challenge of bringing knowledge of these fields into K-12 classrooms?

Various professional development programs have been developed and implemented by higher education institutions and educational organizations to help teachers acquire the skills and knowledge necessary to bring these concepts into their classrooms. But the availability of teacher preparation programs has not kept pace.

Technology education, as a discipline, is relatively young, and is an outgrowth of the industrial arts program. Many educators consider the publication of the Jackson's Mill Industrial Arts Curriculum Theory document in 1981 as the starting point of the modern era of technology education.[1] The rapidly increasing number of high school pre-engineering programs across the country has created a growing shortage of teachers qualified to teach such courses. Only recently have some states, such as New Jersey, revised their teacher certification code to authorize a "Teacher of Technology" certification or endorsement, and only one higher education institution in our state has had authorization to provide programs leading to teacher certification in Technology Education. Our university, New Jersey Institute of Technology (NJIT) does not have a teacher preparation program. However, we have established collaboration with a teacher preparation program in a neighboring institution in which our students earn their degree at NJIT, while earning teaching certification from the other institution.

Several alternative programs were examined as possible vehicles for training teachers for the technology education certification. Currently, NJIT undergraduates are able to earn engineering degrees and then acquire teacher certification through the Department of Urban Education of Rutgers University – Newark. It was concluded that this may not be the best approach to increase the number of teachers. We have developed a program specifically for undergraduates who can earn a degree in Engineering Technology, while getting appropriate training in educational background and methods. This paper will describe the development of the program, its rationale, and the educational component of the program that will be putting qualified technology education teachers in high school classrooms.

Introduction

The United States currently has a shortage of qualified workers in the information technology (IT) and science, technology, engineering and mathematics (STEM) fields that will continue at

least into the next decade. As evidenced by the U.S. Government's H1-B visa program, it has become necessary to import skilled practitioners in these fields from other countries to meet the needs of the American industrial base. In South Korea, 38% of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47%, in China, 50%, and in Singapore 67%. In the United States, the corresponding figure is 15%[2]. For the long-term economic health of this country it is important that more students pursue studies in these fields and then join the workforce. The United States is today a net importer of high-technology products. According to a recent survey, 86% of US voters believe that the United States must increase the number of workers with a background in science and mathematics or America's ability to compete in the global economy will be diminished [3]

To achieve an increase in the number of qualified workers, we need to start with the input to the university/industry pipeline, namely high school students. We need to have these students understand the role of technology in our society, and how people in the STEM fields can benefit mankind. However, many K-12 teachers have not been trained to incorporate IT and STEM topics into their programs. Increasing the presence of technology in the K-12 curriculum will require more qualified and better prepared teachers for technology programs as well as for other disciplines in which engineering concepts can be integrated.

Technology education, as a discipline, is relatively young. The rapidly increasing number of high school pre-engineering programs across the country is creating a shortage of teachers qualified to teach such courses. Programs such as the degree program at Michigan Tech[4], or the option to supplement an engineering degree program[5], are two approaches to the production of qualified technology educators that can be emulated. Only recently has our state board of education revised its teacher certification code to authorize a "Teacher of Technology" endorsement. Only one institution in our state is authorized to offer a Technology Education degree, and NJIT is not currently licensed to certify teachers. However, NJIT has formed a partnership with its neighboring university, Rutgers University-Newark, and its Department of Urban Education, that allows our students to earn their engineering, science, or mathematics degrees at NJIT while earning teaching certification from the neighboring university. The partnership agreement allows our students who are majoring in chemistry, physics, engineering, or mathematics to take additional teaching credits and a practicum, and therefore be allowed to go for certification in science or mathematics education. All these approaches have one component in common. They all involve the cooperative effort of a college of engineering and a college/department of education.

This is a group of teachers who can invigorate the curriculum with STEM information - teachers who are certified in technology education. It is interesting that when we discuss technology, whether it is technology education or engineering technology, the question arises as to what does technology really mean. Technology is "know-how that extends human capability." It is more than just knowing; it is knowing and being able to do[6].

Technology education teachers cover a range of courses, including computer assisted design, biotechnology, computer animation, mechanical movement, design technology, and transportation technology. The teacher education programs in this area focus on preparing individuals for careers in public education, whereas the primary mission of industry oriented

technology programs is to prepare technically competent individuals who will be working in business and industry, primarily in management positions[7].

While many of the industrial arts teachers became technology educators, there is a major problem that will occur within the next ten years. The Technology Education Association (TEA) of our state, which is the lead association for Technology Educators, predicts the state will need more than 900 technology teachers by 2015. The group says half of the current tech ed teachers will retire by then, and successful high school programs might have to shut down if new teachers don't sign up to run them. Members of the state TEA approached us in 2006 with the idea of starting a technology education program at our institution. The program could be offered through our partnership with the neighboring university's department of education.

Creation of a Technology Education Program

Our initial approach was to combine courses from several of our engineering disciplines, along with the teacher preparation courses and experiences from our neighboring institution. However, recent changes in our Engineering Technology program allowed us to consider an alternative for the technology part of these students education. Our Engineering Technology program used to be only an upper-two program, awarding a BSET to students who successfully completed a program at a community college. Because there were several counties within our state that did not offer an Engineering Technology associates program, our Engineering Technology program began to offer a four year program. Therefore, the technical part of this proposed new program, Technology Education, could come from courses within the new four-year Engineering Technology Program. The members at our state TEA were in favor of this change – they felt that the engineering technology courses would offer a more hands-on approach than comparable engineering courses.

Certification of technology education programs should be based on the "Standards for Technological Literacy: Content for the Study of Technology"[8]. The program must also include those subjects covered in the technology education part of the PRAXIS Exam[9], an exam required of all candidates for teacher certification/endorsement in our state. Subjects on the PRAXIS Exam include:

- Pedagogical and Professional Studies;
- Information and Communication Technologies;
- Construction Technologies;
- Manufacturing Technologies; and
- Energy/Power/Transportation Technologies.

Students in the Bachelor of Science in Engineering Technology – Technology Education option take 58 credits of General University Requirements, a 28 credit core program in technology, 12 credits of technology electives, and 33 credits of Secondary Education courses. In the Technology core courses, students gain fundamental knowledge and hands-on practice in four areas of technology - Computer Technology, Electrical Engineering Technology, Manufacturing Engineering Technology and Mechanical Engineering Technology. In the Technology

Concentration courses, students will enhance their knowledge in two of the technology areas. Table I details the program.

Table I. Courses relating to the Bachelor of Science in Engineering Technology – Technology Education Option (131 credits)

General University Requirements – GUR (58 Credits)

- HUM 101 – English Comp: Writing, Thinking Speaking
- HUM 102 - English Composition: Writing, Speaking, Thinking II
- MATH 138 – General Calculus I
- MATH 238 – General Calculus II
- MATH 309 – Math Analysis for Tech
- MNET 315 – Industrial Statistics
- Humanities Elective – HUM 211, 212 or HIST 213
- PHIL 334 - Engineering Ethics and Technological Practice
- Elective – Lit/Hist/Phil/STS
- Elective – Hum/Soc Science Capstone Course
- PHY 102/102A – General Physics I and Lab
- PHY 103/103A – General Physics II and Lab
- HSS 202 - Society, Technology, and Environment
- Elective – HSS 211, HUM 212 or HIST 212
- CS 101 – Comp Prog and Prob. Solving
- PE 1xx and 2xx – Physical Education
- MGMT 390 – Principles of Management

Technology Concentration Courses (9 credits)

- Three additional courses in one of the four technology areas

Technology Core Courses (31 credits)

- ET 101 – Introduction to Engineering Tech
- MET 103 – Engineering Graphics & Intro to CAD
- MNET 105 – Applied CAD
- IE 224 – Production Process Design
- IE 473 - Safety Engineering
- MET 303 – Applied Thermodynamics
- ECET 201 – Circuits I
- CPT 310 - Computer Design Fundamentals for Computer Technology
- MET 235 – Statics for Technology
- MNET 300 – Concepts in Machining
- CET 331 – Structural Systems

Secondary Education Requirements (30 credits)

- Social Foundations of Education
- Teaching in Urban Schools
- Cognition, Teaching and Learning
- Issues in Secondary Education
- Methods of Teaching Technology Education (new course)
- Instructional Technology
- Curriculum and Instruction in Secondary Schools
- Junior Practicum - Secondary
- Student Teaching and Seminar

Our state's Core Curriculum Content Standards (CCCS) for Technological Literacy, as specified in Standard 8.2, the Standards for Technological Literacy, Science Standard 5.2 (Science, Technology, and Society), and Science Standard 5.4 (Nature And Process Of Technology) are informed by the ITEA (International Technology Education Association) Standards for Technological Literacy (STL).

Table II relates several of the courses in the next section (including the Technology Core courses, Technology Concentrations courses, and certain General University Requirements) to the five major categories in the ITEA Technology Content Standards. Table III relates the ITEA Standards to the relevant state CCCS.

Table II. Course Relationship to ITEA Technology Content Standards

Course	Nature of Technology	Technology and Society	Design	Abilities for a Technological World	The Designed World
ET 101 – Introduction to Engineering Tech	x	x	x		
MET 103 – Engineering Graphics & Intro to CAD			x	x	x
MNET 105 – Applied CAD			x	x	x
IE 224 – Production Process Design			x	x	
IE 473 - Safety Engineering		x			x
MET 303 – Applied Thermodynamics	x				x
ECET 201 – Circuits I			x		x
CPT 310 - Computer Design Fundamentals for Computer Technology			x		x
MET 235 – Statics for Technology	x				x
MNET 300 – Concepts in Machining	x			x	x
Technology Electives			x		x
PHIL 334 - Engineering Ethics and Technological Practice	x	x			

Table III. Correlation of Standards for Technological Literacy with State of New Jersey Core Curriculum Content Standards

Standards for Technological Literacy (STL)	**New Jersey Core Curriculum Content Standards (NJ-CCCS)**
Nature of Technology	8.2.A. Nature and Impact of Technology 5.4.B. Nature of Technology
Technology and Society	8.2.A. Nature and Impact of Technology 5.4.A. Science and Technology 5.2. Science, Technology, and Society
Design	8.2.B. Design Process and Impact Assessment 5.4.C. Technological Design
Abilities for a Technological World	8.2.B. Design Process and Impact Assessment 5.4.C. Technological Design
The Designed World	8.2.C. Systems in the Designed World

Methods of Teaching Technology Education Course

While the methods course for our students seeking certification in science or mathematics take their methods course at our partner institution, we determined that our colleagues in the Education Department at our partner institution did not have the expertise and experience to teach a methods course in technology education. Thus, we developed our own Methods of Teaching Technology Education course. The development of the course was a collaboration of classroom technology education teachers and university faculty with extensive experience in providing professional development on topics in engineering and technology to K-12 teachers of science, mathematics, and engineering.

This course provides an introduction to the historical and philosophical backgrounds of technology education, including instructional planning and delivery, curriculum design and assessment. Topics include content selection, lesson planning and alignment with standards, assessment and the use of instructional technology in support of different technology education teaching strategies. Attention is given to planning, teaching, safety practices, classroom and laboratory management, and assessing technology education units. Field experiences to observe technology education classes are part of the course. The topics will include:

1. Philosophical background;
2. Content areas of technology education;
3. Curriculum/program design and implementation;
4. Instructional strategies – Effective teaching and learning;
5. Educational measurement and evaluation;
6. Classroom and laboratory management; and
7. Development, implementation, and evaluation of a technology lesson learning activity.

Conclusion

Our application to the state department of education for offering the Technology Education program was approved in January 2008, and we expect our first students to enter in Fall, 2008. There are several outstanding technology education programs that are under a School of Technology or with an Engineering Technology Department[4,5]. What we have presented in this paper is a method of collaboration between a four year engineering technology program and a related teacher education college.

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