Technology Education and the Influences of Research: A United States Perspective, 1985-2005

Technology education has progressed well through its development in the U.S. over the past two decades. Enrollments in grade levels 6-12 have reached an all time high. Major research projects have provided direction for curricular change. The curriculum has moved forward to keep abreast of emerging technologies. Distance learning has assisted teachers in their professional development. With progress, challenges have been encountered in meeting teacher demand and maintaining curricular focus.

The past 20 plus years of curriculum re-design in technology education in the U.S. has resulted from both internal research and best practices of other nations. Today curriculum designers are influenced by federally funded research projects undertaken in the 1960s and then undertaken by individuals, states, foundations, and associations during the 1970s, 1980s, and 1990s, which brought to the forefronts the study of the systems of technology (variously configured as communication, construction, manufacturing, and transportation), *Standards for Technological Literacy* (ITEA, 2000), and current movements that included design (as exemplified by our colleagues from other countries) and engineering processes. Besides these research-based prospects, there have been outside influences to the technology teaching profession from companies who provided technology study modules, textbooks, and computer software.

Moves from shop work to the study of industry and technology began in the U.S. in the 1960s. This reform was stimulated by government-funded research to support the race to space and support national defense. Major curricular changes included the study of industry and the technologies of industry. For example, the American Industry Project (Face & Flug, 1967) focused on the study of the elements of industry (i.e., finance, management, communication, materials, etc.) and the Industrial Arts Curriculum Project (Towers, Lux, & Ray, 1966) studied the systems of industrial technology (i.e., The World of Manufacturing and The World of Construction). These programs had major impacts on the curriculum reform that occurred in secondary schools and universities during the 1970-1980s. Courses such as American Industry and the World of Manufacturing and the World of Construction were high school courses, complete with teaching resources.

DeVore and graduate students at West Virginia University researched technology as a discipline and established a structure for the study of technology (DeVore, 1964). The results were school-based research projects that showed how the study of technology could be undertaken. Graduate assistants worked with teachers at demonstration sites. Their impact was a major influence on technology education curriculum design, which caused technology to be studied through the systems of production, communication, and transportation.

During the late 1970s and early 1980s, the content for the U.S. study of technology was solidified through the *Jackson's Mill Curriculum Theory* which designated that the curriculum for technology education include the study of communication, construction and manufacturing (production), transportation, and the impact these technologies have on individuals, society, and the environment (Snyder & Hales, 1981). In the 1980s, the U.S. study of technology was also influenced by the study of design, which was brought to the U.S. by Ron Todd and others from Great Britain and the Netherlands (Todd, 1985).

National Council for the Accreditation of Teacher Education (NCATE), in conjunction with International Technology Education Association and Council for Technology Teacher Education, established guidelines for the preparation of technology teachers. Early guidelines were based on the study of systems of technology - communication, construction, manufacturing, and transportation (ITEA, 1987). This was the most powerful instrument for change in teacher preparation – gaining national accreditation. Federal vocational funding was also removed from universities' teacher education programs and retained at the state department of education levels during the 1990s. From the early 1970s through the early 1990s, universities provided curriculum development and teacher inservice on integrating technological systems, design, and technology and culture into the curriculum. After vocational funding centralization, limited projects have been undertaken through the contractual method with universities in their states.

These efforts caused name and curricular changes in the U.S. The International Technology Education Association name was born in 1985. Individual states changed their association and school subject names in the years to follow. Teacher licensure requirements were also changed to include courses in the systems of technology and technology and culture.

In the early 1990s some individual U.S. states began to include design in their curriculum, i.e., design and technology. Modular technology, based on the latest technological developments grew steadily in the U.S. Teacher education curriculum expanded to include the systems and new technologies, i.e., automation, biotechnology, digital communications, etc.

In the mid-1990s, the Technology for All Americans Project stimulated research, which resulted in *Standards for Technological Literacy* (ITEA, 2000). The implementation of the standards are receiving mixed acceptance in the first decade of the 21st century. State departments of education and local school systems, driven through university collaboration, are making the biggest implementation changes. National Council on the Accreditation of Teacher Education, in conjunction with International Technology Education Association and Council on Technology Teacher Education, has accreditation standards that direct the preparation of technology teachers. These accreditation guidelines now parallel the *Standards for Technological Literacy* (ITEA, 2000) and include the foundations of teacher preparation – curriculum, instructional strategies, learning environments, students, and professional growth (ITEA, 2003a).

The latest trend to influence the content for the study of technology education in the U.S. has been the engineering process. Some states have included engineering courses in their curriculum formats because of our technological relationship with the profession of engineering. U.S. high school students continue to enroll in drafting and design courses offered through technology education because they feel these courses will aid them as they pursue engineering careers. The technology education profession knew that engineering was much more than drafting, so they planned more appropriate programs.

Since the U.S. has more demand than the number of graduates who are completing engineering programs, the engineering profession has come to the technology education profession to seek assistance in marketing engineering professions. Since some outsiders believed that technology education continues to be shop work, they set about to create an engineering program that is not rooted in the technology education profession. The most prominent example was developed in the late 1980s and is known as *Project Lead the Way* (PLTW) (2005). This program is sponsored in each state by an engineering university. However, PLTW relies on technology education teachers to get trained and implement the engineering courses associated with Project Lead the Way. It will be interesting to watch these programs and relationships mature.

To truly understand the content development for technology education that has occurred in the past twenty years in the U.S., one must also look at the influences that educational vendors have had on shaping the delivery of technology education instruction. One arena to view is that of the textbook publishers. This group has been supportive of the technology education program change movement. The publishers are in business to make a profit, so they pay close attention to curricular trends. They hire professionals who understand curriculum movements and these are usually the curriculum leaders in the U.S. Another group of vendors that has shaped the instructional programs have been those who have developed instructional modules. With new technologies emerging, they have figured ways to education people about these technologies. The companies often hire engineers to design instructional trainers on the new technologies. They have developed self-contained instructional materials and activities that are packed with equipment. Vendors often use what materials are available with little integration of curriculum.

Many schools have developed their middle schools' programs to consist of a number of self-contained modules, which students rotate through (Brusic & LaPorte, 2000). Examples would include modules on bridge building, rockets, electronics, CAD, etc. Other vendors have developed software packages that either support instruction or educational modules. Sim-City™ and Car Builder™ software, as well as, electronic circuit boards are examples of commercially available products. Some in the U.S. profession see these as extensions of the older shop work programs, bringing them to a high-tech realm, while others see them as great public relations ventures for technology education (see Petrina, 1993; Gloeckner & Adamson, 1996; Pullias, 1997; Starkweather, 1997; Rogers, 1998). The major shortcomings are that they usually do not include the social cultural aspects that should be included in a technology education program and that they offer a vendor's perception of the technology education curriculum.

Change in the content for technology education in the U.S. has been in the control of various agents. One of the key groups has been the university faculty who train the teachers for these instructional programs.

Teacher preparation has led and reacted to the above curricular changes. Because of collaboration through educational accreditation agencies, many of these curriculum changes have been brought to reality in teacher preparation. For example, the systems of technology have been transformed into the systems of the designed world as outlined in *Standards for Technological Literacy* (ITEA, 2000). Design and technology and technology and culture have become integral components of teacher preparation. All have been pushed by research, best practice, and *Standards for Technological Literacy* (ITEA, 2000). In addition, distance-learning techniques have added to the preparation of teachers through initial licensure, continued professional development, and master degree completion (Ndahi & Ritz, 2002). This has allowed university programs to have a broader impact on the general university curriculum by positioning technological literacy as an outcome of university general education. Offerings have included science and technology goals, computer literacy skills, and technology and society perspectives within university coursework requirements (Todd & Karsnitz, 1999).

Accreditation is important to programs at leading U.S. universities. If the programs are not judged to be worthy by outside evaluation bodies, the programs do not receive financial support or are discontinued. There are over 200 programs in the U.S. that can prepare technology teachers. However, only 39 are accredited by the National Council for the Accreditation of Teacher Education, in conjunction with ITEA and CTTE (CTTE, 2005). Others are accredited by NCATE through a state partnership program.

The key to accreditation is that the accrediting body establishes the standards that the teacher preparation institution has to meet. Since the 1980s, the Council on Technology Teacher Education has worked to set the standards of judgment. The technical content to be taught and the methods of preparing professional teachers has always been the basis for these standards.

Early standards' technical contents (e.g., *Standards for technology education programs*) (Dugger, Bame, & Pinder, 1985) were based on the curriculum structure that resulted from the Jackson's Mill Curriculum Theory (Snyder & Hales, 1981). After the *Standards for Technological Literacy* (ITEA, 2000) were established, the Council on Technology Teacher Education re-designed the accreditation standards (ITEA, 2003a) to be based on the standards for technological literacy. In both the old and newer standards, research and best practice served as the basis for making teacher preparation judgments.

Teacher preparation programs are re-designing themselves as they prepare for accreditation. The newest knowledge that is emerging in the preparation of teachers is design and technology and although not new, technology and culture. The benchmarks in the *Standards for Technological Literacy* (ITEA, 2000) are self explanatory in the knowledge that teachers of technology education need to master.

Another thread that is being woven into teacher preparation in the U.S. is distributed delivery of instruction through various electronic means - television, web, and CD formats (Ndahi & Ritz, 1999, 2002; Turner & Reed, 2005). Many programs have used these means for the advanced preparation of teachers through the M.S. degree; most notably, Old Dominion University and Ball State University. They have also been found useful for updating teachers to the elements that make-up technological literacy. Few programs are providing distance learning for initial teacher preparation. The two drawbacks are providing for laboratory/technical instruction and the distance the candidates would have to travel to a common site for laboratory instruction to take place (Hobbs, Moon, & Banks, 1997). It is hoped that developments in delivery technologies will improve so that laboratory courses can be taught from a distance.

Because of the universality of technology and culture knowledge and courses needed for the preparation of technology teachers, some faculties have found ways to included some of their courses in the general education (liberal arts) curriculum of their universities (Todd & Karsnitz, 1999). Common courses that can be found are introduction courses and technology and society courses. These offerings get faculty working with others in the university's general education programs and add to the importance of technology education to the campus.

As we get teachers better qualified to deliver technology education in U.S. schools, the school-based programs are also improving. New teachers are taking leadership roles within their state as they redefine the technology education curriculum.

U.S. student programs have taught technology mainly at the secondary level, grades 6-12. Limited work has been undertaken at the elementary level; what has been taught has been exemplary. Many U.S. states have made technology education a requirement in the middle grades (6-8), with few states having a high school mandate. Academic standards have taken the main stage in American education; test taking has been mandated through the federal legislation of *No Child Left Behind* (U.S. Department of Education, 2001).

Middle and high school programs have retained the systems approach to the study of technology in their curriculum frameworks. Vendor prepared modules and software appear to drive much of what has occurred in classrooms and laboratories. State associations have been providing much of the educational classroom materials and the professional development of teachers. State departments of education have been developing frameworks to show how technology courses reinforce the academic core competencies. These have appeared to be subject survival techniques. Engineering as a profession has been explored as content/process for study in some states and through funded projects. Technology education has been valued by school administrators as alternative learning pathways for various student populations. Business and industry has seen technology education as a pathway into the workforce.

Much work had gone into the development of the school-based curriculum for technology education. There were curriculum frameworks, outcome lists for student achievement per course, and instructional materials developed by state departments of education (see Virginia Department of Education, 2005). Much of this work was contracted to universities and their faculties. However, with the redirecting of federal funds that flowed to the universities through the states, the funds have been limited to the technology education specialists at the state levels. Of the funds that have remained, they have been used to update outcome lists, but they have not been used to develop much instructional materials. With the *No Child Left Behind* federal legislation (U.S. Department of Education, 2001), the academic standards have become the ruling force in American schools. State departments of education have been using their limited funding to show how technology education and other workforce education curriculum can be used to better prepare students to master the core academic subjects.

As a result, school systems have been relying on vendors of modules, software, and textbooks for their instructional guidance. State technology education professional associations have taken over in providing the professional development of teachers and are also providing instructional materials for their members (see GITEA, 2005). Seeing the need for the development of curriculum and instructional support for technology education, the International Technology Education Association, through its Center to Advance the Teaching of Technology and Science (CATTS) division, has set up a curriculum and research arm to help move states ahead in implementing technology education. CATTS has developed curriculum materials in conjunction with states and technology education curriculum developers. To become a consortium member and received the ITEA materials for its teachers, states must pay a fee to the association.

In addition to CATTS, the International Technology Education Association has developed outstanding resource materials to assist teachers in implementing technology education. Examples include the Humans Innovating Technology Series (HITS) and Kids Innovating Technology Series (KITS).

Engineering programs are also being sought by school systems to include in their offerings to students. Again, this is a result of relationships with engineering professionals and a way to establish a better image for technology education. For the technology education research community, the federal government, through the National Science Foundation, has supported some of the research for preparing curriculum which will engage learners that want to become engineers (Pearson, 2004).

School administrators support having traditional technology education shop work classes in their schools for their non-academic populations. These administrators believe that weaker versions of technology education can capture the interests of the non-academic students, keep them in school, and possibly provided some skills which will assist them in entering the workplace. Although this is not the major focus of technology literacy programs, these beliefs provide support for some teachers not to change their programs. Employers also support these beliefs. Consequently, change does not occur as technology education professionals would like.

There are a lot of job-training programs in American schools (see the twelve divisions of the Association for Career and Technical Education [ACTE], http://www.acteonline.org/). However, many of these programs, referred to as trade and industrial programs, usually require the student population to leave their high school for half day and be bussed to a career and technical education center. Students are resistant to leave their high school and peers, so many do not choose this type of education. Other schools systems are turning their in-house technology education programs into trade type programs where students earn specialized certificates while in high school. These certificates are set on industrial standards, so teachers believe they are doing the right thing to teach trade specific skills such as computer networking, computer assisted design, and computer operations. Obtaining a certificate often requires a student to be a program completer, which means he or she must complete a sequence of two or more courses in a program (Frederick County Public Schools, 2005).

Because of a lack of leadership, technology education in the U.S. is taking several pathways. Much of this lack of leadership can be blamed on the downsizing of institutions at various levels (Volk, 1997). Many technology education personnel are overworked with other system tasks and cannot provide the leadership to its core missions. For example, one of the major issues facing the U.S. is getting a sufficient supply of teachers to cover the existing programs (Ritz, 1999).

Teacher corps preparation for technology education has not been able to meet U.S. teacher demands. Projections have shown through two five-year studies that the U.S. lacks about 1,000 qualified teachers each year (Weston, 1997). For this reason, technology education is identified as a critical shortage teaching area in most states. A great number of students enter programs as internal university transfer students. These have been the traditional aged college students who go to college as undecided majors and then transfer into technology education. Current technology education majors usually bring their friends into programs. Alternative teacher preparation has grown over the past 15 years. Many second career candidates (military is a large segment) have entered the profession through traditional teacher preparation routes (Ritz, 1999). Some universities have created alternative programs that grant credit for prior training and work experience. Career switchers are another teacher preparation route that has emerged. It is a fast track program where entrants need a B.S. degree for admissions. The career switchers program usually takes a summer for preparation. However, shortages of qualified technology education teachers persist in the U.S. A small percent of the teacher work force in technology education have been female, although 79% of U.S. teachers have been female (Ornstein & Hunkins, 1998).

In an attempt to make all U.S. teachers highly qualified (term from *No Child Left Behind* legislation), tests have become a benchmark within the U.S. educational system. No matter which track technology education candidates take to become a teacher, most states have qualifying tests. States commonly use an academic skills test for admittance such as the Praxis I developed by Educational Testing Services. States vary with their acceptable score. For program completion, candidates must also pass a content knowledge test, usually Praxis II, Technology Education. If a program is designed using the CTTE/NCATE standards, their candidates can easily obtain passing scores on Praxis II. However, if the teacher preparation program does not have a standards-based curriculum, then program completers have problems obtaining passing scores on this instrument. Although Praxis II exists for technology education, the test has not been updated to include the *Standards for Technological Literacy* (ITEA, 2000). It continues to measure knowledge of professional education and the systems of communication, construction, manufacturing, and transportation.

Although the technology education profession has made great strides forward in moving from shop work to technological literacy, threats to technology education exist in American schools. The biggest threat to the vitality of this school subject is to continue to have a qualified pool of teachers (Weston, 1997). Although the shortage of teachers is a known factor, many young people are not choosing teaching as a career. If a qualified teacher does not exist, school administrators are closing programs and converting the facilities to academic classrooms. Federal and state law mandates that students must pass certain academic courses and earn a set number of academic credits to graduate. A large group of U.S. students are disenchanted with their high school academics. However, the federal government is requiring that extra resources be used to engage these students to pass the federal and state endorsed accountability tests. This compounds the teacher shortage problem, because technology is required in most middle schools, grades 6-8. Few U.S. states require technology education at the high school level.

Limits in leadership are another threat to technology education in the U.S. People are not as professionally involved in their careers as in past decades. It is hard to find individuals to run for office in their state and national technology education professional associations. Lack of commitment does not provide strength to counteract threats. People feel safe when they should be preparing to defend their professions.

Technology education has not had the resources to improve its image with the public. Some still consider our subject as shop work. Technology education has the research-based content that needs to be taught to move our society into the future, but the profession does not have the know-how and resources to move us beyond an elective in the schools. Training and investment needs to be made in public relations agendas and actions. Time constraints and resource limits prohibit the U.S. from making further gains for the school subject of technology education.

Due to operating costs and low enrollments, many university teacher preparation programs have been downsized or eliminated (Volk, 1997). During the past three years there have been announcements to hire 45, 60, and 75 technology education and/or industrial technology university faculty. However, the numbers prepared each year hovers around 10 [1]. Where are the replacements going to come from in the future? Without teacher educators, where will the teachers be prepared and who will provide for professional leadership? The number of graduate students spiked in the 1970's but is on a downward trend (Reed, 2001). These are daunting problems facing technology education in the U.S.

Summary

Technology education research and investment have been found throughout the U.S. educational systems. Exemplary technology education programs exist. However, outside threats have persisted due to poor school performance of students in the academic subject areas and the threat to closing programs due to lack of qualified teachers. Leadership gaps and limited public relations efforts have been found to be detrimental to long-term health of technology education in the U.S.

While there is solid evidence to suggest technology education is still in a state of flux after twenty years (Sanders, 2001), there are several very positive trends. First, the *Standards for Technological Literacy* (ITEA, 2000) and *Advancing Excellence in Technological Literacy* (ITEA, 2003b) have had a significant impact on the profession. These materials have been widely accepted by the profession and endorsed by outside organizations. Additionally, these materials are making state curriculums, textbooks, vendor materials, and teacher preparation programs more relevant and rigorous.

Secondly, despite the closing of teacher preparation institutions, most notably at land grant universities, distance learning is helping to reach more students than ever before. Programs at Old Dominion University, Ball State University, and Valley City State University are using various techniques to reach more professionals (Flowers, 2001; Ndahi & Ritz, 1999, 2002; Mugan, Boe, & Edland, 2004; Turner & Reed, 2005).

A third significant trend in the United States is the political climate. Organizations such as the National Academy of Engineering, The National Research Council, and the National Science Foundation have endorsed technology education in various ways. The National Academy of Engineering was a significant supporter for the creation of *Standards for Technological Literacy* (ITEA, 2000) and continues to be a vocal ally. The National Research Council joined the National Academy of Engineering to host several conferences and thoroughly articulated the national implications for technological literacy in *Technically speaking: Why all Americans need to know more about technology* (Pearson & Young, 2002). The National Science Foundation continues to fund projects for secondary engineering programs and science, technology, engineering, and mathematics (STEM) initiatives.

The support is very clear for technological literacy in the United States. We are on the verge of seeing the hard work of the past two decades come to fruition. There is public support (ITEA, 2001 & 2004) and support from national organizations outside the profession. We must maintain our uniform vision, provide leadership, and stay on the course of progress.

[1]Reed, P. A. & Ritz, J. M. (2005). Doctoral program supply and demand. Un-published research paper based on Schmidt, K. (2004) and faculty position postings in professional journals, listservs, and mailings. Norfolk, VA: Old Dominion University, Department of Occupational and Technical Studies

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