愛知教育大学教育実践総合センター紀要
第8号，pp.197〜205（February，2005）

Technology Education: Twenty-five years of progress

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(2004年10月29日受理)

Abstract

The past 25 years has brought significant changes in the field of technology education. Contributing to these changes has been the evolution of a curriculum from the early days of industrial arts that addressed human productive practice to an emerging contemporary technological curriculum shaped by the exponential growth of technology and its impact on the extension of human capabilities, society, and the environment. The recent literature that focuses on the exponential growth of technology and its impact on the extension of human capabilities has a relatively brief history. Therefore, it is the interpretive historical evolution of technology education and the philosophical interpretation of the pervasiveness of technology in American society that have combine to constitute the diverse images of the role technology education has been called upon to play in American schools. The progress towards shifting from an industrial arts focus, to building and educating a technologically literate society as its outcome has shaped the progress of technology education in American schools. This manuscript helps to describe and contextualize the evolution of technology education. From the formative pre-1999 years marked by a standards development effort designed to identify the content for the study of technology, through the progress and organization of curriculum delivery models at the elementary, middle/junior high school, and high school. The general path and development of an articulated curriculum for the field of technology education is illustrated and discussed.

Keyword: Technology Education, Educational Change, Curriculum Organization, Elementary Education, Junior High School Education, High School Education

1. Introduction and Background

Over the past 25 years technology education has experienced a dramatic evolution within educational circles that in many cases bordered on a revolution. To frame this evolution or revolution depending on one's perspective, it is critical to address two fundamental issues that helped shape technology education. First, the historical perspective, this is the lens from which we interpret change and implement its resulting effects. Second is philosophical perspective, this is what Duncan and Biddle (1974) identified as presage variables. Presage variables are all that educators bring to the institutions, programs, and classrooms they serve. Presage variables include such teacher characteristics as prior background, experience, education, and related factors that affect how they view and interpret events or actions that surround them. The factors of historical under pinning and educator presage variables, are critical to how technology education has been conceptualized and implemented.

A Brief History

From a historical perspective it is generally agreed upon that a majority of today's teachers and leaders in technology education were educated and trained in programs that emphasized industrial arts, vocational education, industrial technology, or trade and industrial education. Barlow (1976), Bennett (1937), and Evans (1988) provide evidence that a substantial number of publications and manuscripts have written about the historical evolution of technology education from the early days of manual training through industrial arts education. The recent literature that focuses on the exponential growth of technology and its impact on the extension of human capabilities has a relatively brief history. Therefore, it is the interpretive historical evolution of those involved in technology education and the philosophical interpretation of the pervasiveness of technology in American society that have combined to constitute the diverse images of the role technology education has been called upon to play in American schools to build and educate a technologically literate society.

However, these combinations of factors that help define the image of what technology education is, has been gradual in producing a unified operational definition of technology education. In recent years the efforts of professional, national and leadership organizations like International Technology Education Association, Technical Foundation of America, American Association for the Advancement of Science, National Science Foundation, and the National Aeronautic and Space Administration have been focused on shaping a unified position for the content for the study of technology (ITEA, 2000). Meantime, the lack of an early unified definition aggravated early progress because of a lack of a common language system among those who practice in the field. This gives way to what is akin to a state of paralysis when attempting to communicate to the public and professionals in other fields of study.

Within technology education, the interaction of the factors mentioned previously has spawned lively discourse and critical debate on such topics as what technology should be taught, integrating technology education through math and science education (MST), technology education as the new basic subject in American schools, the position of technology education in our nations schools, and the ever present dilemma of whether technology education is a discipline (Altice and Singletary, 1997, Bensen 1992, Bensen 1995, Gow 1995, Hamm 1992, ITEA, 2000, LaPort & Sanders, 1993 and Wright & Lauda 1993). In view of the early debate that must precede change, the late 1980's and early 1990's bears witness to the struggle to influence and help understand the new direction for what is today technology education. The purpose of this paper is to provide a twenty-five year overview of progress in technology education in the United States while examining the rational that is driving change in the field.

2. The Change Process

The Pre-1999 Years

The movement towards change over that past 25 years has resulted in a number of efforts toward implementing technology education. The winds of change and realization that industrial arts education and its focus on human productive practice had outlived its purpose and the changing technological world cried out for a new curriculum to prepare student for the technological world. In the early years of the 1980's, curriculum innovators among the ranks of teachers and teacher educators experimented with the idea of a technology rich focus that taught students about technology. Ironically in 1949 at The Ohio State University, William Warner and a group of graduate students wrote of a Curriculum to Reflect Technology. Specifically the initial goal was to engage students in an understanding of their technological world and to engage them in the use, management, application of technology across a variety of social and technical contexts. In the mid-1990's the International Technology Education Association joined efforts with the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) to fund the Technology for All Americans project and set a vision for technology education (Dugger,1997, Altice, and Singletary, 1997). The result of the project was a national effort to build, define and reach national consensus on the content for the study of technology across grades K-12 (Smith, 1998, Altice and Dugger, 1998, Laurent, 1997, Dugger, Kinser, Newberry & Singletary,1997).

Standards as the Catalyst for Change

The year 2000 ushered in a new millennium and opportunity for change in technology education. During 2000 the Standards for Technology Literacy: Content for the study of technology (STL) was released and the ensuing effort of professional development, dissemination and adoption was in full swing. During 2000 and 2001 a flurry of activity advancing the new content standards was being fueled by input from The National Academies and respected voices from outside the field (Bybee and Loucks-Horsley, 2000, Bybee, 2000, Colaianne, 2000, and Wulf, 2000). The effort of the entire field of technology education yielded a set of educational standards that would guide the field. Several important mileposts were achieved during this time. The newly developed standards formed a basis and language system of understanding about the study of technology that could now be shared among and between practitioners and all other educational constituents.

Advancing Excellence in Technology Education

As the effort to promote, educate, and implement the new standards, phase two and three of the vision for technology education was taking shape. Standards to define and promote professional development, program, and student assessment were being developed. Addenda to the technological literacy standards series are currently being developed and disseminated. Figure 1 shows the progression, coherence, and vision for a full series of public documents to define, measure, assess, teach, and develop curriculum for technology education

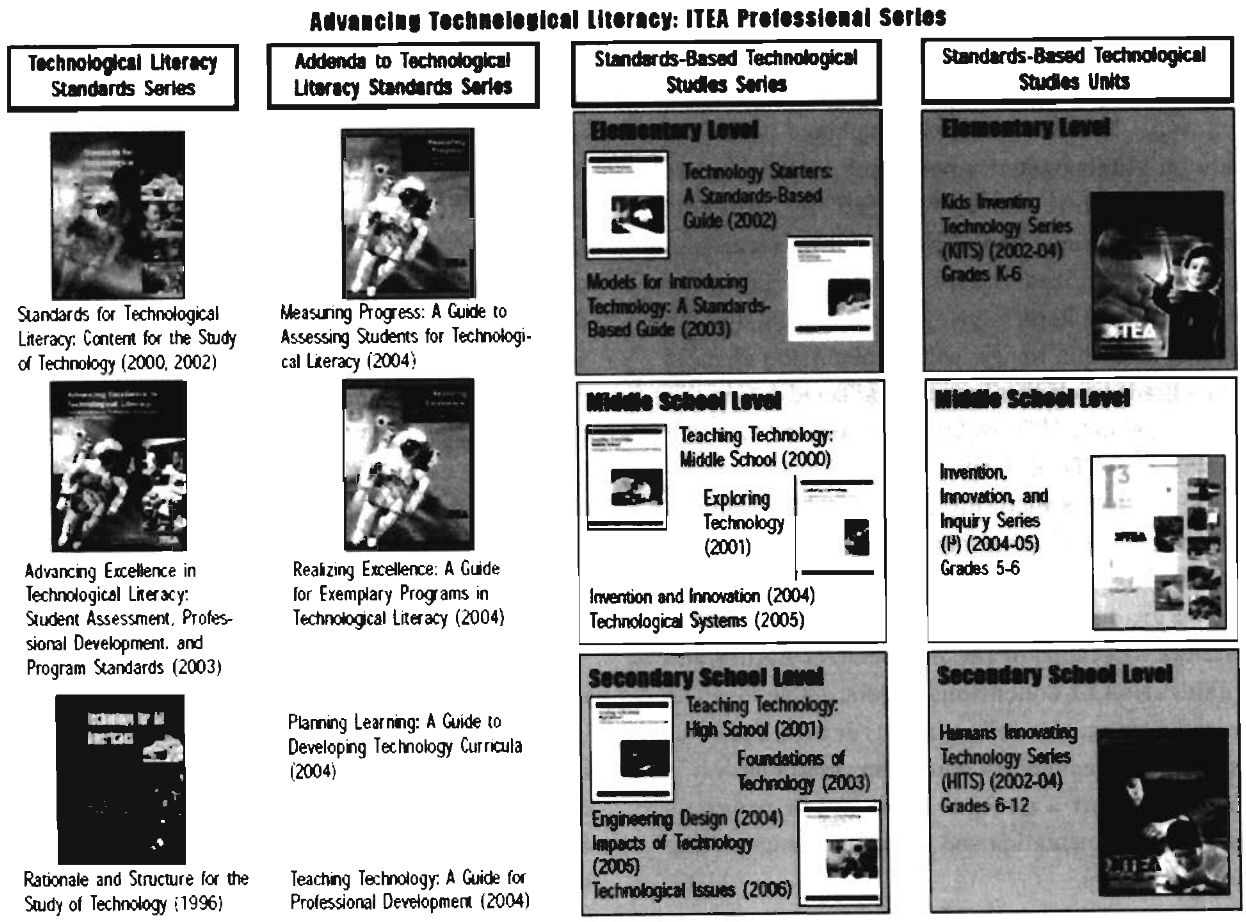

Figure 1 Advancing Technological Literacy Professional Series.

across an articulated continuum.

3. Organization of Progress Across Grade Levels

Contemporary Technology Education

The diverse discussions that have permeated the technology education literature have had a positive influence on how technology education is organized and delivered in our nation's schools. However, if uniformity or a unified curriculum is sought, disappointment is not far. Unlike the historical roots of industrial arts, which were fairly well defined, technologies of today are complex integrated systems that interact with varied disciplines and subjects which have important consequences when implemented in classroom settings. Therefore, when local or state controlled schools and school districts consider implementing technology education programs, multiple questions arise that have direct implications for how a program is developed and implemented. While the standards project has helped to define the content for the study of technology, curricular and instructional approaches are varied.

Two major factors that exert substantial influence on how technology education is implemented can be identified. The first factor takes into account what currently exists in the way of industrial arts or trade and vocational education in an institution or within an educational structure and the rational and structure for change (Dugger, 1997). At issue is the role that technology education will or does assume within an existing structure. At question is, whether technology education should it be established independently of what exists, or should technology education be part of a planned and standards-based educational course of study organized in a articulated continuum? A point we will return to later.

The second factor addresses questions of what technologies should be taught and valued. Subsumed within this concern is when, and at what grade level certain technologies should be taught, and at what level of technological capability and competence is achieved. These two factors, combined with local state and independent governance of schools and school districts have resulted in differing conceptualizations and implementation strategies across the United States. The Standards for Technological Literacy have served as a catalyst for change, thus this review will highlight the changes across grade levels that have been affected during this 25 year period, 1979 to 2004 (Bybee and Loucks-Horsley, 2000, ITEA, 2000).

Therefore, the following sections will provide an overview of how technology education has evolved and is delivered as an educational program within and across grade levels in many states and school districts. Because of the independent nature and organization of educational agencies across the United States, the following structure does not represent all technology education programs, yet it does represent a general overview of progress towards implementation and systemic change during the last 25 years.

Elementary Technology Education

In most local educational agencies, elementary education is defined as grade pre-K through 6. While exceptions exist, other models range from K through 5 or K through 8. For purposes of discussion, elementary education will include grades K through 5 with grades 6 through 8 reserved for the middle or junior high school grades.

Elementary classrooms are traditionally self contained instructional environments with a single teacher who is responsible for delivering a majority of the grade level curriculum he or she teaches. Often the curriculum has state mandated content with minimal instructional time requirements for each subject, each school day. What typically emerges is a structured instructional day focused around traditional basic content areas of language arts, social studies, reading, and mathematics. The remainder of the elementary curriculum is built around science, art, music, and physical education. These subjects are not commonly taught each day but rather rotated in during the weekly schedule. For example, of the five instructional days that constitute a week, science may be taught during three of the five available instructional days.

At this point, you ask, why are we examining an elementary instructional day? It is the structure of content and instructional time coupled with the liberal arts, generalist trained teacher that limits the introduction of technology education into the elementary curriculum. This creates a dilemma and tension between instructional content and time. This tension manifests itself in two dimensions. First, the professional preparation of the teacher to be able to design and deliver a technology curriculum. Second, working within the time constraints imposed by the rest of the curriculum. Teachers who are interested and capable of including technology education in their elementary curriculum often do not have sufficient time in the instructional day. Teachers who desire to include technology education in their instruction often do not have the necessary background to design effective instruction in technology.

Most agree that technology education at the elementary level is best introduced within an integrated curriculum. A major outcome desired of elementary technology education is the development of a technological conscience. This is achieved by designing into an integrated curriculum, problems of social and human interest. These instructional situations give students experiences in creating, implementing, and evaluating technological solutions. The universal objective of this integrated elementary technology curriculum is to foster the understanding of the relationship between technology, society, design, the designed world and understanding the implications of its application towards the solution of simple problems. This is often best accomplished in an elementary school curriculum through a process of mutual exchange between human and physical resources with other disciplines being taught.

With the pervasiveness of technology in American culture, technology education can not be ignored and must be addressed as a fundamental part of the elementary education experience. However, the challenges then become apparent. Elementary-pre-service teacher education and curriculum design need to be at the forefront of this dialogue. Teachers from a predominantly liberal educational background must be provided with the opportunity to learn how to integrate technological concepts and content into their instruction across all disciplines. Towards progress in this direction, the establishment of a Technology Education for Children Council within the

ITE has been working to implement elementary level technology education. Another example of progress is states such as California have moved to develop curriculum standards and integrated performance activities for the elementary level, yet little has been accomplished towards full implementation. In American elementary classrooms in general, implementing the study of technology on a wide scale has yet to be accomplished and much effort is required to make technology education an integral part of the general education curriculum. Therefore, until the time and resources are available for current and prospective elementary teachers to be formally trained to integrate technology education concepts into their instruction, technology education at the elementary level will be reserved for students who are fortunate enough to have a teacher willing to develop innovative strategies to include the study of technology in their daily instruction.

With the growing movement throughout education to seek ways to integrate programs in order to make them more meaningful, useful, and better understood, the use of technology education as a foundational content area of study at the elementary level to achieve these goals has exceptional promise. From a program development perspective, technology education in the elementary grades also has the potential to form a foundation to future articulated programs.

Middle Grade Technology Education

In many schools technology education is mandated as a course of study at a particular grade level. The middle grades of grade six, seven and eight have often been selected because of the introductory, integrated, and enrichment nature of the middle grade curriculum. Pragmatically, introductory or exploration in technology education at the middle grades level has often replaced traditional industrial arts and pre-vocational exploratory courses of woods, metal and drafting. Often the case is simply that technology education at this level is gender neutral, politically more acceptable, and appealing to parents and administrators than courses previously offered.

In the middle grades technology education is designed to assume a more critical role of providing a smooth articulated link between the elementary "awareness" of technology and the authentic application of technological concepts. The content of introductory technology education programs at the middle grades is often organized around universal themes that are flexible and integrated with instruction in other disciplines.

These themes often include but are not limited to the study of:

- Technological method
- Common tool usage
- Common equipment usage
- Basic technological systems and process technology
- Extended human capabilities
- Materials and process
- Terminology
- Environmental concerns
- Social values and impacts
- Scientific principles
- Economics
- Design technology
- Research and development
- Ethics

The themes mentioned above are sometimes carried throughout the introductory curricular content areas of communication technology, manufacturing technology, transportation technology, construction technology, design technology, and bio-technology.

What has emerged in the United States is a powerful and dynamic technology education program that is flexible, easily adapted to unique school settings, and capitalizes on some unique characteristics of middle grade learners. Primarily middle grade learners are active and inquisitive. Students in middle grades can be characterized as wanting to know a little bit about everything, yet not wanting to know very much about anything. The key element in this energetic mix of student motivation and engaging technology education classrooms is capitalizing on the motivation of the learner to inquire and participate. Thus, the hallmark of the middle grade technology education program is the standards-based hands-on nature of the learning tasks.

A second and even more powerful element is the instructional delivery system employed in many middle grade technology education programs. Unlike the teacher centered classroom of elementary grades, the middle grade technology education learning environment is most often student centered. Directly, this means that the roles of student and teacher take on new dimensions. The student is placed in a position of controlling his or her learning while the teacher frequently assumes the role of guide or coach.

Students often learn in teams, working cooperatively to design or solve learning tasks related to technology. This unique learning environment places the demands of higher levels of cognition on the student. Simply stated, the student must thoroughly use all his or her available knowledge to complete the learning tasks. This shifts the demands of learning from the teacher to the student and requires the student to cognitively integrate knowledge from all disciplines to apply and create new knowledge.

Middle grade technology education programs in the United States have been the keystone of the technology education component of the educational continuum. Students who have experienced little in the way of technological study at the elementary level easily transition into introductory technology education courses in the middle grades. Students who have experienced elementary technology education are challenged and enriched by the dynamic breadth of technological experiences. The cardinal components of a broad based technologically focused curriculum, coupled with an active, hands-on learning environment centered on an innovative instructional delivery system tailored for the middle grade learner has propelled introductory technology education programs at the middle grade level into a position of common place in American education.

Technology Education in the High School and Beyond

While technology education at the middle grade level has experienced wide spread growth and development, technology education at the high school level is in a state of transition. This transition is not much different than the transition being experienced by all Americans as society moves from a predominantly industrial manufacturing economy to one driven by information and knowledge lead by technological innovation.

As in society, high schools are experiencing some fundamental changes that form the under pinning that impact how technology education programs are designed and implemented. The first of these fundamental changes is the movement from learning facts or declarative knowledge to emphasizing concept learning leading towards application and critical analysis. A second fundamental change has placed emphasis on process learning in which the procedures used to arrive at answers are valued more than the correctness or incorrect nature of the answers presented by students. The third and most profound force being asserted across all secondary school curriculums is the emphasis placed on curriculum integration and links to higher educational paths. This has important implications to the integration of subjects across all disciplines. Equal importance must be placed on curriculum integration within technology education fields. The emphasis on within and across curricular integration represents a significant opportunity for technology education and technology education teachers to assume leadership roles.

Progress of Delivery Models and Organization in American High Schools

From its historical roots, high school technology education programs are working to transition from industrial arts and pre-vocational programs, to programs that are more in line with societal demands for students to be more technologically capable and able to evaluate, interpret, and adapt to changes outside the classroom. A second position is that many high schools are working to realign their curriculum to include a new technology education component that will meet the aforementioned demands. With these common principles as guides, various models have emerged. An early model for change was charted by a select group of 21 leaders in Industrial Arts education documented by Snyder and Hales (n.d.) referred to as the Jackson's Mill Project. From this project, curricular efforts evolved that essentially moved industrial arts from a pre-vocational skills development position to a position of studying technology and industry from a human productive activity perspective. Illinois (Illinois State Board of Education, 1989) later developed both middle grade and high school industrial technology education programs that emphasized comparable curricular organizers set out by the Jackson's Mill Project in the content areas of communication, energy utilization, production and transportation technologies. Within this model, the high school curriculum offered the four content areas as separate courses that emphasized resources, technical processes, industrial applications, and technological impacts. These courses were designed and offered to 9th and 10th grade students so that conceptually the content would articulate and build from the middle grade technology curriculum. Eleventh and 12th grade students were offered advanced technical studies in these areas as well as vocationally oriented studies.

Similarly, Indiana (Indiana Industrial Technology

Education Program Guide, 1985) implemented an articulated 6th through 12th grade technology program that consisted of an 18 course offering. The 6th through 8th grade program was a broad based program focused on a combination of traditional and technology oriented learning modules in an Introduction to Industrial Technology program. The curricular content employed a non-traditional delivery method focused on the learner as discussed earlier in the middle grade section. The high school plan was designed comparable to the Illinois plan and offered four introductory and 13 advanced study courses distributed between communication, construction, manufacturing, and transportation technology.

While these two examples are not exhaustive representations of technology programs in American schools, they do represent elements and structure commonly encountered in a significant number of high schools as illustrated in Figure 2. Figure 2 shows the curricular structure from introductory level courses similar to the curriculum organizers suggested by the new Standards for Technological Literacy: Content for the study of technology. However, as a result of aggressive integration and team building efforts, unique organizational models have emerged. At the introductory and advanced level, technology courses are often part of academic academies. These academies are rigorous academic

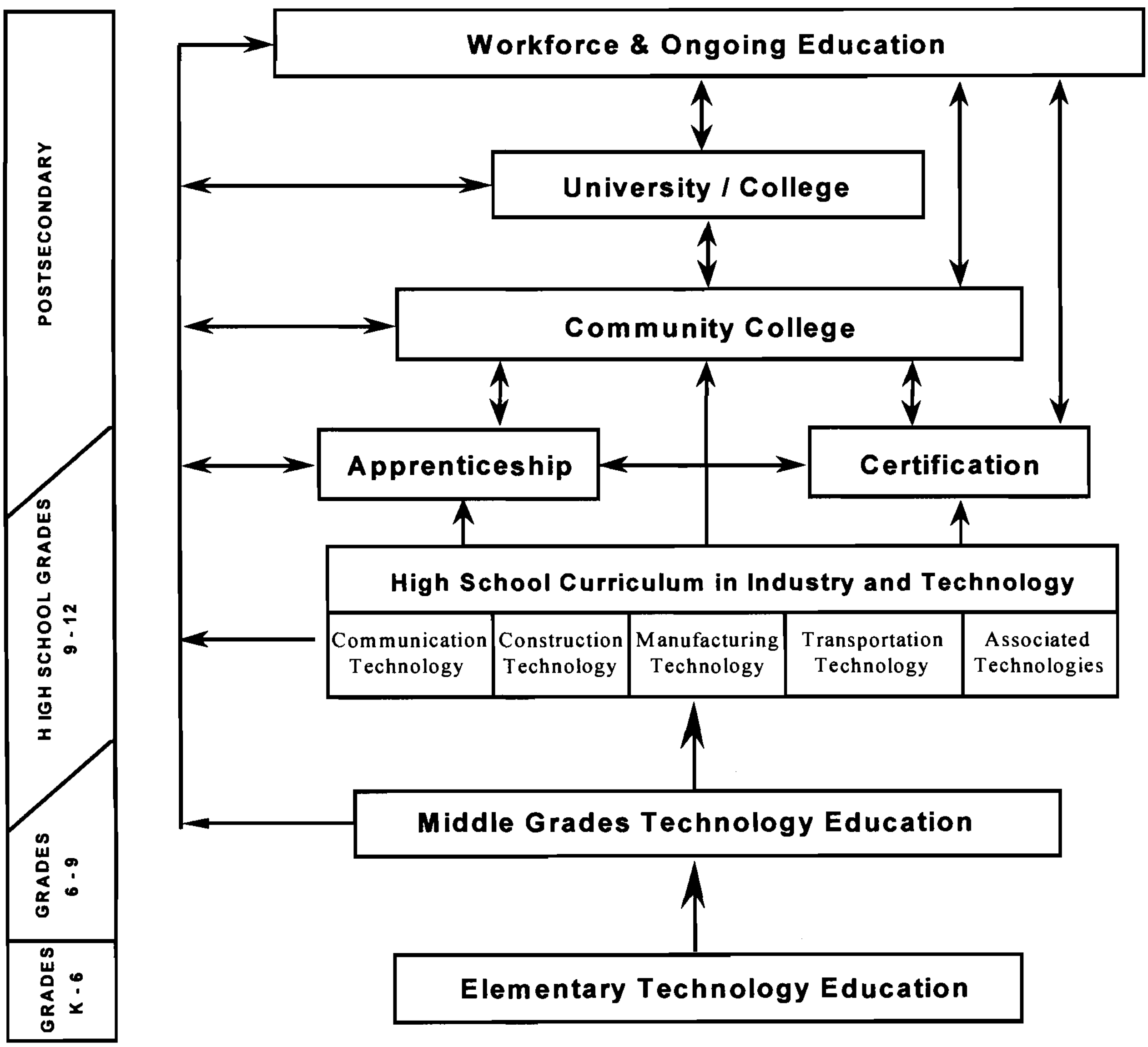

Figure 2 General Organization of Technology Education in the United States.
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and technologically focused programs that are offered within a comprehensive high school. The academy is made up of instructional teams comprised of academic and technology teachers who design, plan and implement an integrated curriculum focused on a technological oriented curricular field.

For example, a communications academy could be organized around one or more communications technologies that included design, drafting, electronics, graphic arts photography, computers, broadcasting, and telecommunications. The curriculum for these content areas is planned in conjunction with core academic teachers from mathematics, science, English, and social science. The academic and technology teachers that make up an academy team work directly with the high school counselors to select a cohort of students who apply for admission to the academy and agree to adhere to the rigors of the curriculum. This cohort of teachers, counselors, and students then remain together for two to three years until graduation.

The academy structure requires a cooperative effort among teachers, school administrators, parents, community colleges, local businesses, and industry. Students often take advanced study courses at local community colleges or regional occupational programs and fulfill internship or work place learning requirements during their senior year at local businesses. This cooperative effort reduces duplication of instructional services and integrates students into an articulated continuum designed for life long learning beyond high school. The combination of higher education elements and work place learning represents a powerful new direction for technology programs.

In high school structures that do not employ an academy model, the introductory level courses may serve as the foundations for advanced study in technology. Advanced instruction is often provided by regional occupational centers or programs conducted either on high school campuses or at centralized occupational centers. These programs serve both work force bound students and matriculating students bound for certification and degree programs at community colleges and universities. Articulation agreements with local community colleges further streamline and facilitate advanced professional study in industrial technology or technology education at the university level.

4. Conclusions

Technology education in the United States has made significant progress during the past 25 years. Many states have adopted or are in the process of adopting organizational structures that define a technology education continuum that is standards based reflective of STL. Common to each of the examples discussed is the need for cooperation and communication between the agencies responsible for delivering a standards based technology curriculum. A technology curriculum that operates in isolation either from the roots of elementary technology education or from the many career paths or branches available to students is destined to wither if not connected or articulated to other programs. However, becoming active and investigating the many options available in designing and implementing a standards based articulated technology education program will invigorate and promote growth both professionally and academically for students and teachers alike.

Technology education and the state of advanced technical preparation in the United States is truly in the midst of profound change. This change is positive and will help set the course for the direction of technical education in the 21st century. At the forefront is the need to set program design goals that are consistent with content standards and articulated career path options that offer students educational opportunities that extend from elementary technology education through to university professional preparation and beyond.

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