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From the editor

About a year and a half ago, Tom Erekson approached me with the idea for a “special issue” of the JTE that might explore curriculum theory and application in technology education. The idea sounded like a good one, and the JTE Editorial Board approved the proposal in Spring of 1991. The result is this special issue of the *Journal of Technology Education* with all articles relating to one theme: “Curriculum Change in Technology Education: Differing Theoretical Perspectives.” I believe this issue of the JTE provides the most comprehensive discussion of technology education curriculum assembled to date in a single publication.

These articles should be of interest to every professional in the field. Others seeking a better understanding of technology education will also find this issue of the JTE worthwhile.

I'd like to thank Tom Erekson for his early organizational efforts, each of the authors for meeting rigorous deadlines, and Dennis Herschbach for his assistance as publication deadlines drew near. In addition, I offer a special note of thanks to the reviewers who diligently reviewed *all* of the manuscripts as a group... a time-consuming, but necessary task.

This issue of the JTE is “special” for another reason as well; it is available *electronically*. Anyone in the world who has access to either Bitnet or Internet will now be able to download the *Journal of Technology Education*. Free access to the JTE ensures the potential for a vast new audience of readers worldwide! This pioneering effort puts the JTE among a very select group of professional journals to be distributed electronically (Strangelove and Kovacs [1991] identified only 7 peer-reviewed electronic journals). Given our field's mission to educate broadly about our technological world, it seems most fitting for us to be among the first to “go electronic” with our distribution. Refer to the *Miscellany* section at the end of the JTE for details on electronic access.

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Reference

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Introduction to Special Theme Issue

Curriculum Change in Technology Education Differing Theoretical Perspectives

Dennis R. Herschbach

Professions periodically undergo name changes. The name "technology education" is rapidly replacing "industrial arts," and there seems to be little doubt that by the end of the decade the transformation will be complete. There is less certainty, however, concerning what is technology education. Is it industrial arts renamed? Does it reflect new instructional content or methods? Will a new student population be served? Most proponents of technology education argue for a significant restructuring of the former industrial arts. However, except for the wide use of general industrial categories for curriculum organizers, such as transportation, manufacturing, construction, and communication, there is little professional agreement on specific curriculum components. This is partly due to the complexity of technology. It defies easy definition. This is also partly due to reform itself. The intellectual disarray which often accompanies reform movements characterizes technology education.

Curriculum theory provides one way to guide educational change. Although curriculum development is an inexact process because many of the decisions are largely value judgments, there are, nevertheless, ways to go about it which produce consistent results. Among curriculum theorists there is general agreement that there are five basic curriculum design patterns. Each is supported by an underlying rationale, and each produces a curriculum design with distinct characteristics. A curriculum design pattern provides a logically coherent way to organize instruction.

While different theorists may use different terminology, the five basic curriculum design patterns are a) academic rationalist (separate subjects); b)

Dennis Herschbach is Associate Professor in the Department of Industrial, Technological and Occupational Education, University of Maryland, College Park, MD.

technical/utilitarian (competencies); c) intellectual processes; d) personal relevance; and e) social reconstruction. Each design pattern is supported by a rational which guides the selection and ordering of content.

The five articles in this special issue examine curriculum change in technology education through one of the different theoretical perspectives. In the first article, Erekson outlines the characteristics of the academic rationalist design pattern, and argues that technology education can clearly fit within this perspective. While acknowledging the lack of a clearly defined "discipline" of technology, the author suggests that a new discipline is emerging, and that the method through which technological problems are solved may be one source of curriculum content. The second article discusses from a historical perspective the competencies, or what is more recently termed the technical/utilitarian design pattern. This pattern has been applied widely to industrial arts. It is suggested that before a similar application can be made to technology education there are key issues that must be addressed.

In the third article, Johnson outlines the characteristics of the intellectual processes design pattern, a newly emerged perspective. The author presents a rationale for this design pattern and identifies the sources of content and organizing concepts. In the fourth article, Petrina observes that while the personal relevance design pattern is compatible with most statements about the purpose of technology education, curriculum plans generally do not emphasize this perspective. After examining the development and characteristics of the personal relevance pattern, the author identifies some of the issues that must be resolved before wider application can be achieved. In the final article, Zuga explores the social reconstruction perspective. What is meant by social reconstruction is examined, and ideas are presented for organizing a social reconstruction curriculum. The author observes that this perspective will challenge technology educators to take a stand on many of the social issues that surround the creation and use of technology.

Each of these design patterns has been applied to industrial arts education in varying degree. The extent to which they influence the development of technology education remains to be seen. Nevertheless, as the reconceptualization of industrial arts continues, technology education will have to draw from one or more of these design patterns if it is going to develop a coherent rationale for the selection of instructional content. The profession must continue to engage in a dialogue which explores the full curricular implications of the different theoretical perspectives. The articles in this issue are presented as a contribution to this dialogue. °

Articles

Technology Education from the Academic Rationalist Theoretical Perspective

Thomas Erekson

The purpose for this article is to explore technology education from the perspective of the academic rationalist. Such an exploration is intended to provide information for technology educators who are grappling with education reform since it appears that the reforms of the 1980s are based on academic rationalism curriculum theory. This exploration includes consideration of the theoretical perspective, rationale, source of content, organizational structure, perceived advantages, and unresolved issues.

Academic rationalism conceptualizes curriculum as distinct subjects or disciplines. This perspective is the most widely used curriculum design pattern and it originates from the seven liberal arts of the classical curriculum (Herschbach, 1989). Academic rationalism is described by Hirst and Peters (1974) as follows:

> Academic rationalism, among the several curriculum orientations, is the one with the longest history. This orientation emphasizes the schools' responsibility to enable the young to share the intellectual fruits of those who have gone on before, including not only the concepts, generalizations, and methods of the academic disciplines but also those works of art that have withstood the test of time. For those who embrace this curriculum orientation, becoming educated means becoming initiated into the modes of thought these disciplines represent or becoming informed about the content of those disciplines (pp. 198-199).

Thus, the major purpose undergirding academic rationalism is to transmit the knowledge and aesthetics of one generation to the next. This is accomplished through education which is organized within recognized academic disciplines.

Tom Erekson is Dean, College of Technology, Bowling Green State University, Bowling Green, OH.

Theoretical Perspective - Technology as a Discipline

Bruner (1960) proposed that curriculum organization and design be based on the structure of the academic disciplines. McNeil (1981) described Bruner's perspective as follows:

> He [Bruner] proposed that the curriculum of a subject should be determined by the most fundamental understanding that can be achieved of the underlying principles that give structure to a discipline. The basis for his argument was economy. Such learning permits generalizations, makes knowledge usable in contexts other than that in which it is learned, and facilitates memory by allowing the learner to relate what would otherwise be easily forgotten, unconnected facts. (pp. 56-57)

Academic disciplines organize subjects around conceptions of knowledge. McNeil (1981) suggests that “the irreducible element of curriculum is knowledge” and that the “nucleus of knowledge and the chief content or subject matter of instruction are found in academic subjects that are primarily intellectual” (p. 53). Schwab (1974) contends that the “knowledge of any given time rests not on the facts but on selected facts — and the selection of the conceptual principles of inquiry” (p. 165). McNeil (1981) also indicates that recognized scholars in a field or discipline are the ones who select the goals and the content of the curriculum.

Given the theoretical perspective of organizing subjects around conceptions of knowledge, the academic rationalist perspective of technology education will emanate from a characterization of technology as knowledge, which provides the boundaries or framework for a discipline. This perspective is supported by the technology education study group, a group of twenty-five leaders who developed the document entitled, *A Conceptual Framework for Technology Education*. In the conceptual framework document (Savage and Sterry, 1990), the following definition of technology is provided: “Technology is a body of knowledge and the application of resources to produce outcomes in response to human needs and wants (p.7).” In effect, this definition embraces academic rationalism by characterizing technology as “a body of knowledge.” Historically, this body of knowledge has been viewed in the profession as the knowledge of practice, or praxiology if you will. Praxiology was used as a part of the philosophical foundation in the rationale for the Industrial Arts Curriculum Project. Lux and Ray (1968) provided the following description: “This body of knowledge is termed ‘theory of practice,’ ‘knowledge of practice,’ or ‘praxiology.’ It encompasses man's (sic) ways of doing which bring about what is valued, or ought to be, through action.” (p. 7)

Skolimowski (1972), citing work by the Polish philosopher Kotarbinski, described praxiology as the theory of efficient action. He contends that “it is through constructing praxiological models that we accomplish progress in technology” (p. 46). Of course, praxiology analyzes action from the perspective of efficiency and Skolimowski refers to praxiology as a “normative discipline.”

Several technology educators have endorsed the academic rationalist perspective of technology and view technology as a discipline. While this perspective has created some controversy, the most notable justification for this perspective was made in DeVore's 1964 monograph “Technology: An Intellectual Discipline.” DeVore makes the case for viewing technology as a discipline based on the five criteria put forth by Shermis (1962) in an article published in the *Phi Delta Kappan*. These five points were presented by DeVore as follows:

> An intellectual discipline:
>
> 1. has a recognizable and significant tradition, an identifiable history.
> 2. has an organized body of knowledge which has structure with unity among the parts. The knowledge has:
>   a. been objectively determined by verifiable and agreed upon methods,
>   b. stood the test of time thereby evidencing durability,
>   c. been found to be cumulative in nature, and
>   d. deals in concepts and ideas from a theoretical base.
> 3. is related to man's (sic) activities and aspirations and becomes essential to man by addressing itself to the solution of problems of paramount significance to man and his (sic) society,
> 4. identifies as a part of its tradition and history a considerable achievement in both eminent men (sic) and their ideas, and
> 5. relates to the future man (sic) by providing the stimulation and inspiration for man (sic) to further his (sic) ideas and to reach his (sic) goals. (p. 10)

In the monograph, DeVore describes how technology meets these criteria and, therefore, is an intellectual discipline.

Curriculum Rationale

From a theoretical perspective, academic rationalists believe that the curriculum should develop the mind with objective knowledge that can be tested through empirical evidence and reasoning (McNeil, 1981). Hirst (1974) purports that the development of the mind, from a rational perspective, is achieved by mastering the fundamental structure of knowledge, logical relations, meaning, and criteria for assessing and evaluating truth.

However, academic rationalists do not limit their perspective only to the transmission of existing knowledge to future generations. Academic rationalism includes the perspective that knowledge can be created and the systems for disciplined inquiry are an integral part of the theoretical rationale. This is described by McNeil (1981) as follows:

> . . . most curriculum theorists today reject this fixed view of knowledge and instead hold that knowledge can be constructed. The creation of knowledge -- valid statements, conclusions, or truths -- occurs by following the inquiry systems of particular disciplines or cognitive forms. The acquiring of disciplinary forms for creating knowledge constitutes the most valid aspect of the modern academic curriculum; the recitation of given conclusions apart from the methods

> and theories by which they are established is less defensible in a period characterized by both expansion and revision of knowledge -- new truths departing from older principles. (p. 55)

Thus, the curriculum rationale from the academic rationalist perspective is to develop a structured organizing pattern which transmits knowledge and involves students in the creation of new knowledge. This rationale is embraced by technology educators who organize curriculum such that students are immersed in *doing* technology, or in learning through performing like technologists. This perspective is supported by Bruner who suggested active involvement as though a specialist in the discipline as a vehicle for learning the discipline. According to Bruner (1960) "the school boy (sic) learning physics is a physicist, and it is easier for him (sic) to learn physics behaving like a physicist than doing something else" (p. 31). Likewise, those who would advocate that technology is a discipline would suggest that the student learn the discipline by behaving like a technologist. This approach is intended to facilitate the acquisition of technological knowledge and knowledge of practice, or "to gain knowledge in 'doing' technology not just 'knowing' about technology" (Todd, 1990). After all, technological knowledge is being created and changing at an ever accelerating pace.

This curriculum rationale, based on a perspective of technology as a discipline, is further supported by the identification of a method of inquiry, the "technological method," in the Conceptual Framework document (Savage & Sterry, 1990). The identification of the method of disciplined inquiry whereby technology is created is critical to the academic rationalist perspective of technology education. The technological method, analogous to the scientific method, is an approach to problem-solving and is described by Todd (1990) as follows:

> By attending to human needs and wants 1) problems and opportunities 2) can be addressed by applying resources 3) and technological knowledge 4) through technological processes 5). The result of this effort can be evaluated 6) to assess the solutions and impacts 7) resulting from these general technological activities (p. 3).
>
> Todd's description of the technological method is consistent with the description provided in *A Conceptual Framework for Technology Education* (Savage & Sterry, 1990).

Source of Content

From the academic rationalist perspective the content reservoir for technology education should be based on a taxonomy of technology. While there is no uniform agreement on a taxonomy, the most widely agreed upon taxonomy emanates from the Jackson's Mill project (Hales & Snyder, 1982). This approach identifies the domains of knowledge and the interaction with the human adaptive systems. The curriculum taxonomy that has evolved from Jackson's Mill focuses content on four adaptive systems; manufacturing, communication, construction, and transportation. Each of these adaptive systems has been categorized in their unique curriculum taxonomies in various state and local curriculum guides.

The discipline of technology should not be limited to only these industrial-related technologies as the source of content. There are several other areas of technological knowledge that are equally important for study. For example, the bio-related technologies provide an array of possibilities for inclusion and study in Technology. To this end, the Conceptual Framework document identified four sources of content for Technology Education; communication, transportation, production, and bio-related technology (Savage & Sterry, 1990). These sources of content were not identified to become the end all, rather they were identified to be representative of technologies that could be included in the curriculum. It was further realized that new technological areas would likely emerge in future years and decades which would be appropriate for study.

An academic rationalist could also derive a curriculum taxonomy based on an analysis of the technological method. In effect, this approach would be to structure curriculum content to develop knowledge of the technological method and its components. Under this arrangement students would learn how specialists in technology discover knowledge (McNeil, 1981). Thus, the content becomes the taxonomy of the technological method.

Organizational Structure

According to Schwab (1974) the structures of modern disciplines are very diverse and complex. This complexity suggests that there is no one best organizational structure for all disciplines. Rather, there are diverse structures depending on the discipline as described by Schwab (1974):

> The diversity of modern structures means that we must look, not for a simple theory of learning leading to a one best learning-teaching structure for our schools, but for a complex theory leading to a number of different structures, each appropriate or “best” for a given discipline or group of disciplines (p. 163).

There is no doubt that technology is a complex, diverse discipline, and there has been no “one best” structure identified. Examples of diverse organizational structures are provided in state curriculum guides for technology education. State guides include structures such as Bio-related Technology, Physical Technology, and Communication Technology (State of Ohio; Savage, 1990); Production Technology, Communication Technology, Transportation Technology, and Energy Utilization Technology (State of Illinois; Illinois State Board of Education, 1989); Invention and Innovation, Enterprise, Control Technology, Information Processing, Energy, Materials and Processes, Technical Design and Presentation, and so forth (State of New Jersey; Commission, 1987); Technological Systems, Communication Technology, Power/Transportation Technology, Manufacturing/Construction Technology (State of Pennsylvania; Pennsylvania, 1988).

McNeil (1981) discusses the concept of “structure in the disciplines” which has been utilized as a basis for an organizing pattern and identifying curriculum content. He identified three kinds of structure:

1. Organizational structure -- definitions of how one discipline differs in a fundamental way from another. A discipline's organizational structure also indicates the borders of inquiry for that discipline.
2. Substantive structure -- the kinds of questions to ask in inquiry, the data needed, and ideas (concepts, principles, theories) to use in interpreting data.
3. Syntactical structure -- the manner in which those in the respective disciplines gather data, test assertions, and generalize findings. The particular method used in performing such tasks makes up the syntax of a discipline. (McNeil, 1981, p. 57).

The structure of technology education, given McNeil's perspectives of structure, would follow the proposals in the Conceptual Framework document (Savage & Sterry, 1990; Todd, 1990). The conceptual framework provides the following:

1. Organizational structure -- content organizers of production, communication, transportation, and bio-related technologies with an emphasis on “doing” technology.
2. Substantive structure -- problems and opportunities that come in response to human needs and wants, and the social and environmental impacts often provide the basis for inquiry.
3. Syntactical structure -- the identification of the technological method, and its use, provide a syntax for the discipline of technology.

Perceived Advantages

In making the case for identifying technology as a discipline, DeVore (1964) states the major advantage as follows:

> There is only one suitable reason [for identifying technology as an intellectual discipline]. A subject area so identified meets certain stringent criteria established by others and takes its place as an area of study essential to an understanding of man (sic) and his (sic) world. By becoming an intellectual discipline an area becomes accepted as a necessary and contributing study in the education of all youth (p. 5).

By embracing academic rationalism, technology educators have the opportunity to become an equal area in the curriculum with the associated respect. In addition, much of the educational reform movement is founded in academic rationalism. For example, the Holmes Group recommendations for the reform of teacher preparation is discipline- based (Erekson, 1988). Those technology teacher education programs that have perceived technology as a discipline have, in effect, endorsed academic rationalism, and have found it much easier to develop redesign proposals in concert with the tenets of the Holmes Group.

Where technology education is perceived as a discipline it has gained respect and an equal place in the academic curriculum. This is exemplified in the proposed revised requirements for high school graduation in the State of Maryland (Maryland State Department of Education, 1991). The previous standards required a one semester course in the "practical arts" which could be met through a course in technology education or a course in areas such as home economics, vocational education, or computer education. The proposed new standards eliminate the practical arts requirement, however, the Maryland State Department of Education has added a new requirement in technology education. In effect, students may be required to take a one year course in technology education to graduate from high school. Thus, technology education has moved from one of the practical arts to a subject equivalent to science, social studies, math, and language arts. By advocating, academic rationalism, that technology education is a new discipline, perception and policy have changed.

Unresolved Issues

There are two major issues that need to be resolved in order for technology education to be congruent with the tenets of academic rationalism. First, the academic rationalist conceptualization of technology education requires that the curriculum be organized into distinct, separate subjects. Technology is dynamic, diverse, and inherently interdisciplinary. As such, it is difficult to identify the unique boundaries of the discipline.

The second issue to resolve concerns the identification of the scholars of technology. Academic rationalism is founded on the premise of recognized disciplines which organize curriculum around conceptions of knowledge. These disciplines and conceptions of knowledge are identified and developed over time by a body of scholars. Who are the scholars for the discipline of technology? Are they engineering faculty? anthropologists? historians? technology teacher educators? Furthermore, if the profession can identify a group of technology scholars, do these scholars identify themselves with the discipline of technology?

Conclusion

According to McNeil (1981) the separate subject, academic rationalist, perspective will remain the prevailing conception of curriculum in the future. If technology education desires equal status in the curriculum with the classical subjects, technology educators will need to embrace academic rationalism and advocate the perspective of technology as a new intellectual discipline. Some might suggest that it will be almost an impossible task to establish technology as a new intellectual discipline. However, there are newer disciplines which are gaining acceptance in the academic arena. Examples are described by McNeil (1981) as follows:

> Newer disciplines claim to be more relevant than the older ones. Psychology, for instance, is challenging literature for the honor of interpreting human nature. Anthropology begs admission on the grounds that it can do a better job of helping pupils gain a valid world view than can history, a field known for reflecting parochial interests. (p. 69)

It is possible to establish a new intellectual discipline. Technology has the potential to become an intellectual discipline and, like psychology and anthropology as cited above, technology can claim to be more relevant than many of the older disciplines. However, to establish technology as an intellectual discipline, it will require the identification of a body of scholars of technology -- individuals who view themselves as scholars of technology. It will also require time, perhaps decades, for technology to gain acceptance as an intellectual discipline among the academicians. However, as is the case in Maryland, technology education can gain equal status with the academic subjects.

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Technology and Efficiency: Competencies as Content

Dennis R. Herschbach

Curriculum proposals and counter proposals characterize technology education. Some proposals enjoy widespread attention, others attract only momentary notice. Considerable incongruity, moreover, sometimes exists between stated objectives and the methods proposed to achieve them (Clark, 1989). One source of uncertainty is the lack of clearly articulated curriculum designs. A curriculum design pattern provides a logical way to organize instruction. However, as Eagan (1978) observes, uncertainty over how the curriculum should be organized leads to uncertainty about content.

Industrial arts historically has drawn heavily from the competency, or what is more recently termed the technical/utilitarian design pattern (Herschbach, 1989; Zuga, 1989). The technical/utilitarian pattern undergirds much of what is being termed technology education, although a considerable lack of clarity may accompany its application. The purpose of this paper is to examine the use of the technical/utilitarian design pattern and its application to technology education. However, competencies, the older, but shorter term will be used throughout this article.

Comparison With Other Design Traditions

Curriculum theorists generally agree that there are variations of five basic curriculum design patterns, used singly or in combination: a) academic rationalism; b) competencies (technical/utilitarian); c) intellectual processes; d) social reconstruction; and e) personal relevance (Eisner, 1979; Eisner and Vallance, 1974; Orlansky and Smith, 1978; Saylor, et al., 1981; Schubert, 1986; Smith, Stanley and Shores, 1959). There are important differences between each design pattern.

In general, the *competency* pattern is characterized by the application of what is commonly termed an “ends-means model,” popularized by Robert Tyler in the 1950s. Objectives, the ends of instruction, are first identified. The content of instruction is selected to address the objectives, and the various instructional elements, the means, are then designed to assist students in attaining the objectives. This is a characteristic also shared with the *academic rationalist* design pattern.

Dennis Herschbach is an Associate Professor in the Department of Industrial, Technological and Occupational Education, University of Maryland, College Park, MD.

In contrast, the *social reconstruction* and the *personal relevance* patterns place less emphasis on predetermined content. The term "curriculum development" is used in the broad sense, referring to both identifying the content and developing the accompanying instructional materials, student activities, evaluation items, and so on. This is because the selection of content is thought to be influenced in part by what is known about the learner and individual differences in background, ability, interest, and learning style. There is less concern for learning particular knowledge, so little distinction is made between the what (content) and how (delivery system) of instruction. What students are expected to learn is a product of the instructional activities, and may vary between learners. This is because it is thought that instructional content cannot be fully specified until student characteristics and interests are taken into account (Egan, 1978).

The *process* pattern can fit into either of these general groups, depending on the particular objectives of instruction. This is because there is no set way of organizing content. Thus, the process design can be integrated into an academic rationalists or competency pattern, or it can complement the social reconstruction and personal relevance designs.

Technical instruction when organized within the framework of a competency design has other distinguishing characteristics. One of the most notable features is that it is *performance*, rather than subject oriented. This is the difference between technical instruction and instruction in formal subjects, such as biology, physics or economics. This is a difference that sets the competency pattern off from the academic rationalist design. Although formal subject matter from the disciplines is used, the technical activity is the basis for determining what formal subject matter to select. The subject matter selected for instruction relates directly to the technical activity. The link between instruction and the use of skills is direct, and functional.

Efficiency is a concept fundamental to the design of instruction based on the competency pattern: Instruction is efficient to the degree that course objectives are mastered. Instructional efficiency is achieved through the teaching methods, activities and instructional materials designed to guide learning. This is commonly referred to as the instructional "delivery system." Of course, the delivery system is designed to accommodate student background, learning differences between students, and available resources. When instruction is rationally designed, incorporating sound principles of learning, greater instructional efficiency results.

Instruction based on the competency pattern tends to be characterized by lists of objectives; ordered instructional sequences which relate to the objectives; highly organized instructional systems; and measures of performance which assess the outcomes specified in the objectives. The content of instruction is identified through one of many analytical procedures used to identify technical skills, including manipulative, process or conceptual. The relationship between all of the instructional components is direct and functional (Molnar and Zahorik, 1977).

Historical Overview

The systematic design of technical instruction based on competencies has a rich tradition. Charles Allen's influential work *The Instructor, the Man and the Job*, published in 1919, demonstrated the usefulness of organizing instruction into logical units which could be standardized among different training locations. The effectiveness of instruction was no longer based solely on the ability of the individual instructor, but was also due to the quality of the design itself, which served to guide the instructor and provided the basis for planning, conducting and evaluating instruction. Subsequent work by W. W. Charters (1923), Robert Selvidge (1923; 1926), Selvidge and Fryklund (1930) and others helped to develop a framework for the systematic analysis of instructional content and the design of instructional materials.

These early efforts were applied during World War II to the training of military personnel and production workers. The effectiveness of deliberately planned and systematically organized training was clearly demonstrated. Following the war, government groups and private industry, convinced that quality and productivity could be improved through systematic training, invested in research and development. This work established the foundation for contemporary instructional design practice. Theoretical constructs were formulated along with practical procedures which helped to guide instructional development and implementation. There was a direct impact on public education as new ideas found a place within the educational literature. The military and industry, for example, originally funded much of the work carried out by influential researchers such as Miller (1962), Mager (1962), Gagne (1965) and Butler (1972). The results of their work were applied to the design of public instruction.

The scope of activity also expanded significantly. At least five lines of research which impacted on instructional design were pursued:

1. attention was focused on the need to clearly specify objectives in observable and measurable terms;
2. measurement and evaluation concepts were advanced, making it possible not only to directly measure learning outcomes but also to assess the efficiency of the various instructional components;
3. learning theory was merged with instructional design theory;
4. advances were made in the use of instructional materials and educational technology; and
5. instructional system models were formulated.

By the 1970s sufficient theory and practice existed to build well- conceived, efficient, integrated systems of instruction. Instructional development evolved into a large enterprise serving government and military groups, private industry, public education and related professions.

The 1980s have seen additional instructional system refinement, particularly in the application of learning theory and the use of educational technology. Computer technology especially is a current focus. Present models for the design of technical instruction build from a rich body of knowledge, and draw concepts and practices from a diverse stream of influence, including industrial psychology, skills analysis, programmed learning, measurement and evaluation, media design and learning theory. There also has been a convergence of practice. In theory and substance the instructional design models used in vocational and technical instruction differ little from those applied to industrial training and to other subject fields which emphasize improving practice. Essentially, a rational, problem-solving approach is applied to the design of instruction.

Industrial arts educators have made extensive use of the competency design pattern (Herschbach, 1989; Zuga, 1989). However, its application has been less specific and tied less directly to training for specific jobs. The instructional models are less elaborate than those applied to industrial or military training, yet the same basic conceptual framework is used; and although the underlying efficiency rationale often may be masked by broad educational and social objectives, the attainment of specific learning outcomes is the intended final instructional result. Differences are in the specificity of instruction, rather than in the overall design pattern. Industrial arts educators have been less concerned with the development of high levels of technical skills and with in-depth skill development in selected technical areas.

Knowingly or not, technology educators also use the competency pattern, particularly in those programs which center on technical specialties (Zuga, 1989). As an outgrowth of industrial arts, some of the same industrial design practices are followed in technology education. The unit shop continues to be widely used (Smith, 1989; Virginia Polytechnic Institute and State University, 1982). The tendency, however, is to align program design more closely with the work of Tyler rather than with the elaborate models currently used in industrial or military training.

Tyler: Formulating a Model

There have been many characterizations of the instructional design process. The most fundamental and influential has been the work of Ralph W. Tyler, set forth in *Basic Principles of Curriculum and Instruction* (1949). To understand Tyler's work is to understand the basic concepts behind the design of technical instruction structured around competencies.

Tyler advanced a fundamental, but simple, idea that profoundly influenced the course of instructional design; namely, that decisions about the ends of instruction, the objectives, should be made first and that all other decisions should follow. He reasoned that it was first necessary to have clearly in mind what is to be taught before actually proceeding with designing instruction. “Objectives,” said Tyler, “become the criteria by which materials are selected, content is outlined, instructional procedures are developed and tests and examinations are prepared” (1949, p. 3). Although this may now seem like a common sense idea, it has served as the foundation for considerable subsequent instructional design work. With the publication in 1962 of Mager's book *Preparing Instructional Objectives*, the idea of first formulating objectives became popularized.

As previously discussed, instructional systems characterized by the use of objectives are based on what is commonly termed an “ends-means model” of instructional design. As the name suggests, decisions about the objectives--the ends of instruction--are separate from, and made prior to, decisions about the means--the instructional activities, materials and so on designed to facilitate learning. The various instructional elements are designed to assist students in attaining the objectives.

The ends-means model provides a way to directly relate instruction with outcomes. All of the instructional components used are developed from, and support, the attainment of the objectives. Tyler (1949) realized the complexity of the learning act, but he reasoned that if the related instructional components were focused on the attainment of the wanted behavior, there was a high probability that the desired outcomes would be realized. *Efficient* instruction would result.

While Tyler's early work has been reformulated, extended and improved since the publication of this influential volume in 1949, the basic instructional design tasks remain the same. The instructions designer must identify:

1. What is the purpose of instruction?
2. What educational experiences should be provided in order to attain the purpose?
3. How can instruction be effectively organized?
4. How can instruction be best evaluated?

While retaining the basic rationale and substance of the Tyler model, Taba (1962) developed seven explicit steps:

1. Diagnosing of needs
2. Formulation of objectives
3. Selection of content
4. Organizing of content
5. Selection of learning experiences
6. Organization of learning experiences
7. Determination of what and how to evaluate

Selvidge: Influencing the Field

One effort to develop a program of study for industrial arts based on competencies centers around the work of R.W. Selvidge at the University of Missouri. Selvidge's model fits within the Tyler framework, and it has continued to influence instructional design.

Although he was mainly concerned with trade and industrial training rather than industrial arts education, the analysis approach advocated by Selvidge was sanctioned in the 1930s by the American Vocational Association as being appropriate for industrial arts. The aim was to bring elements of manual training, manual arts and vocational education together. Many industrial arts educators adopted the analysis approach to the selection of content material. Several variations of this approach were widely used, and job and trade analysis are still the dominant method of selecting course content material for technical instruction (Herschbach, 1984).

Analysis, as developed by Selvidge, was an adaptation and alteration of elements from both manual training and manual arts. It incorporated the shop project as an essential aspect of instruction, as well as industrial processes, material and related information. Content was selected by an analysis of a trade or occupation for materials that would achieve the instructional objectives of the course. Instruction was broken down into units entailing operations and jobs. The content selected tended to be heavy on the manipulative side, and this was viewed as being appropriate for pre-vocational or vocational development.

While there is variation among advocates, the basic method and sequence are as follows:

The first step is to determine the objectives of the program of studies; these comprise "the information skills, attitudes, interests, habits of work we expect the boy to have when he has completed his period of training" (Selvidge and Fryklund, 1930, p. 36).

Secondly, an analysis of the subject field should be made in order to arrive at the main divisions of the field. For instance, "a course for automotive mechanics might logically be organized into such divisions as engine, power transmissions, chassis, electrical and body repair; these main divisions are then further analyzed" (Giachino and Gallington, 1954, p. 68).

The next step is the selection from the analysis of those items that are appropriate for the length of the course, student ability, course level, available equipment, and the general objectives. The total course content material comprises a list of: "things you should be able to do" (operative skills), "things you should know" (information necessary for successful performance of the skills), and "what you should be" (attitudes and habits necessary for successful performance).

Lastly, the course content material should be formulated into a course of study, with teaching materials organized and arranged for instructional use. Instructional sheets are often used for this purpose. Practice work, production and individual projects are used.

Selvidge developed a procedure through which technical instruction could be systematically designed by the classroom teacher. Much as Charles Allen (1919) had done before him, Selvidge provided a way by which instruction could be standardized and instructional quality resulted from the design process itself. Efficiency was to be the outcome. Selvidge's wide success, however, provoked opposition. Some considered that instruction was too vocational to be appropriate for industrial arts. Particularly vocal was William E. Warner (Evans, 1988).

Warner: Reflecting Industrial Categories

Warner's deep opposition to Selvidge was no doubted rooted in his own instructional plan. Warner largely discounted the analytical method as developed by Selvidge for identifying instructional content. Instead, instruction would take place within the "Laboratory of Industries" through selected industrial categories, such as metalworking, ceramics, and communication. Exploratory, vocational, consumer, artistic and developmental objectives would be stressed (Warner, 1936). Developments along Warner's ideas took the form of segments, or categories, of industry, such as graphic arts, metals, and woods, as representative areas of instruction. Later, largely through the work of his graduate students, the general categories of power, transportation, communication, construction and manufacturing were stressed (Warner, 1948). The Industrial Arts Curriculum Project (IACP) included only two, construction and manufacturing (Journal of Industrial Arts, 1969). More recently, the Jackson's Mills group has suggested communication, construction, manufacturing and transportation (Hales and Snyder, 1982).

However, Warner was unable to develop a practical way to derive specific instructional content from the larger instructional categories. He was never explicit about the relationship between objectives and course content. In other words, how did objectives translate directly into what students were to learn? As Taba (1962) observes, this is always difficult to do because focus is lacking. The categories are general organizers, "but set no guideposts to what should be emphasized, and what not" (p. 304). Consequently, in much of Warner's work there was inconsistency between the curriculum rationale and the content selected (Bruner et al., 1941). Moreover, it was not uncommon for practitioners to apply Taylor's concepts to the selection of instructional content while still retaining the more global organizers characterizing Warner's work. This practice continues today.

Gordon Wilber: Finding the Middle Ground

Gordon Wilber's (1948) work is significant in that he occupied the middle ground between two extremes: Selvidge and Warner. Basically using Tyler's approach to the design of instruction, Wilber proposed that content selection start from a set of general objectives, followed by specific behavioral objectives. Lessons, projects and activities would next be developed to effect the desired behavioral changes. Subject matter was considered as being two types: manipulative, involving the use of tools and materials, and resulting in projects; and related material.

Although Wilber's program is an amalgamation of the two approaches by Selvidge and Warner, it was couched in sounder pedagogical terms. Like Tyler, Wilber's model included a clear progression from goals to content and learning activities, culminating in evaluation. By following the ends-means model proposed by Tyler, there was a logical way to bridge the gap between the general curriculum organizers proposed by Warner and others and specific instructional content. At the same time, by focusing on general objectives, Wilber avoided the close resemblance to vocational instruction which so often characterized the programs patterned after Selvidge.

Attesting to Wilber's influence, a curriculum development model based on behavioral changes was adopted by the American Vocational Association in 1953. Throughout the 1970s the American Industrial Arts Association supplied guidelines for incorporating behavioral outcomes into instructional programs. Through the work of Mager (1962), Popham and Baker (1970) and others, “competency- based” instruction became popularized. Few areas of study in public education were immune to its influence in the 1970s, and the Tyler model exerts a pervasive influence today. “The power and impact of the Tyler model cannot be overstated,” Molnar and Zahorik (1977) observe. “Virtually every person who has ever been in a teacher education program has been introduced to this model. It has been synonymous with curriculum work at all levels” (p. 3).

Subject areas, such as science instruction, mathematics, and English tend to draw course content from the disciplines, rather than work activity, and they are based on the academic rationalist design pattern. This sets them off from technical subjects such as technology education and vocational instruction. Nevertheless, the “delivery system” (the objectives, course material, activities, and evaluation items) reflects the ends-means model. Moreover, efficiency is the underlying objective of both (Herschbach, 1989). When educators talk about basic skills testing, greater accountability, or a more rigorous curriculum, they are talking about greater efficiency. In general, American education for at least the past three decades can be characterized by an efficiency thrust.

The Challenge

All forms of public technical education use the competency design pattern. Its application, however, is less sophisticated than is found in military and industrial applications. It is more akin to the work of Tyler and Wilber than to the elaborate design models currently in use. It is applied in a more abbreviated form. As technology educators ponder the curriculum challenges of the future, to what extent can the competency pattern serve to guide curriculum development?

The efficiency rationale is, and will continue to be a major goal of American education. Financial constraints, the alarm over low student achievement levels, the competition of a global economy, political ideology, these and other factors which shape the public's perception of education, will continue to drive the objective of efficiency. At least since Selvidge's day, industrial arts educators (and presently technology education supporters) have adhered to the efficiency rationale, even if unknowingly. The concept of technological rationality is inherent in technical instruction (Molnar and Zahorik, 1977). Perhaps for this reason, the competency design will continue to have wide appeal.

However, if the competencies design is to serve as a major organizing pattern for technology education it is essential to address at least three major issues.

First, theorist must clarify the *educational* function of technology education so that there is a direct relationship between the ends and means of instruction. Conceptual inconsistency has been a characteristic mark of the movement (Herschbach, 1989; Clark, 1989; Zuga, 1989). However, as Egan (1978) notes, “If one lacks a clear sense of the purpose of education then one is deprived of an essential means of specifying what the curriculum should contain” (p. 69).

Whether or not the efficiency rationale should be the major underlying rationale of technology education, and whether the competency design should be a major organizing framework is open to debate. Other objectives, which are largely the outcome of other design patterns, certainly merit consideration.

Second, the relationship of technology education to the separate subjects design pattern must be clarified. As previously discussed, the competencies and academic rationalists design patterns both share the common rationale of efficiency, and both make use of Tyler's ends-means model. The two patterns are used in combination, but depending on how they are used results in distinctly different curricula.

The supposition that technology is a discipline (separate subject), reducible to discrete units of instruction similar to that found in the teaching of mathematics, English or physics, is open to question. As Frey (1989) suggests, “technology is grounded in ‘praxis,’ rather than abstract concepts, or ‘theoria’

(p. 25). And while technology can be characterized as object, process, knowledge, and volition, these characteristics manifest themselves through human *activity* (Frey, 1989). However, to the extent that technology is conceived as an intellectual discipline to be studied rather than activity to be engaged in, there is less room for the application of the competency design pattern.

Third, and perhaps most important, the content of technology education must be conceived in broader terms than is usually achieved by the application of the competency design to curriculum development. Use of the competency design pattern often results in narrowly prescribed instructional content, such as that found in the work of Selvidge. Application of the Tyler model to curriculum development can result in a static instructional design (Smith, Stanley and Shores, 1957; Molnar and Zahorik, 1977). These limitations, however, can be overcome. To do so means defining competencies in broad terms. Competencies are more than the ability to manipulate tools, use material and apply mechanical processes. Problem solving, critical thinking skills, ordered ways of working — these are competencies that can also be identified. The analytical methods formerly applied to identify job tasks and tool operations can be equally applied to the identification of broader conceptual learning and general educational outcomes. Gordon Wilber demonstrated this. Particularly appealing is the idea of effecting a synthesis with the process design pattern.

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A Framework for Technology Education Curricula Which Emphasizes Intellectual Processes

Scott D. Johnson

As the field of technology education evolves, its unique mission to provide relevant and experiential learning opportunities for students is becoming clear. Through well developed curricula, technology education programs are able to reinforce academic content, enhance higher order thinking skills, and promote active involvement with technology (Johnson, 1991). The development of curricula which addresses such goals is both difficult and complex.

A variety of curriculum perspectives exist which greatly influence the direction and results of curriculum development efforts (Eisner & Vallance, 1974; Miller & Seller, 1985; Zuga, 1989). These perspectives include academic rationalist, technical/utilitarian, intellectual processes, social reconstruction, and personal relevance. While curricula developed through each curriculum perspective vary in their contribution toward a well-rounded education, this article is based on the assumption that the development of intellectual processes should be the primary goal of education. Therefore, the purpose of this article is to establish a rationale for technology education curricula which emphasizes the development of intellectual processes and lay the foundation for an intellectual processes curriculum framework.

The Importance of Intellectual Skills in the Future

There is little doubt that the development of intellectual processes is critical in this age of advancing technology. Tremendous changes have occurred and will continue to occur in the workplace. Equipment and processes are becoming more sophisticated. This sophistication has resulted in fundamental changes in the skills needed by workers. Increased levels of skills are required to maintain the complex equipment. There has been a switch from concrete (hands-on) tasks to abstract (minds-on) tasks which require mental skills such as symbolic and abstract thinking (Grubb, 1984). Management strategies have also changed in recent years. Just-in-time manufacturing,

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Scott D. Johnson is Assistant Professor and Chair, Technology Education Division, Department of Vocational and Technical Education, University of Illinois at Urbana-Champaign, Champaign, IL. The preparation of this article was supported in part by the National Center for Research in Vocational Education, under a grant from the Office of Vocational and Adult Education, U. S. Department of Education. This article has not been reviewed by the National Center and is not an official publication of the Center.

participative management techniques, statistical process control, and an increased emphasis on teamwork are just a few examples of the changing nature of the workplace.

As a result of the advances in technology and the organizational changes to the industrial infrastructure, job expectations for workers have changed. Rather than simply performing repetitive tasks, workers are now expected to be skilled in many jobs. While technical skills are still needed, they are not enough. Workers need to have a broader understanding of their role in the organization, be able to work in teams, and possess higher levels of communication and computational skills. Consequently, business and industry needs a workforce that possesses a broad general education with heavy emphasis on math and science. While these changes suggest the need for a greater emphasis on academic skills, the most important job skills may be the ability to think creatively, solve problems, and make decisions. In actuality, the workforce must have the ability to learn in order to keep pace with the constantly changing world.

While technological and organizational changes are impacting the workforce, similar challenges face the general public. The impacts of technology on our society, culture, environment, and political systems need to be analyzed and evaluated by citizens. Without well developed intellectual skills and an understanding of technology, it is doubtful that the general public will be willing nor able to make critical decisions regarding technological issues.

Given the fact that the skills needed by the workforce are changing and the increased need for all citizens to have high level thinking skills, are students being provided with the opportunity to acquire those skills? The answer to that question is a disappointing NO! These skills are not being taught in the majority of the schools; students are left to discover them on their own. School curricula has traditionally been developed based on behavioral psychology foundations and traditional task analysis methods which lead to a focus on rote learning and physical and basic skill development.

Because contemporary curriculum needs to emphasize understanding rather than rote memorization and heighten higher level cognitive skills in addition to physical and basic skills, curriculum development is more complex than it has been in the past. Part of the difficulty in developing curriculum that emphasizes intellectual processes is the fact that these processes occur only in the mind and are therefore not directly observable to the curriculum developer. In addition, good thinkers and problem solvers do not know how they think and solve problems because intellectual processes become so automated that they occur instinctively (Ericsson & Simon, 1984). Because the intellectual processes are not directly observable, teachers often neglect these processes in their instruction.

Zuga (1985) acknowledges that there have been few attempts to design and operationalize an intellectual processes curriculum; partly because of the lack of a coherent framework. However, recent research in cognitive psychology has provided conceptions and techniques for identifying intellectual processes. Findings from these studies can provide an initial framework for the development and implementation of an intellectual processes curriculum.

The Content of an Intellectual Processes Curriculum

Before laying the groundwork for an intellectual processes curriculum, conceptual and operational definitions of intellectual processes are needed. Intellectual processes are those mental operations which enable one to acquire new knowledge, apply that knowledge in both familiar and unique situations, and control the mental processing that is required for knowledge acquisition and use.

There are many paradigms which attempt to describe intellectual processes. In this article, the framework provided by Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, and Suthor (1988) will be used to depict intellectual processes. Through a synthesis of recent research, Marzano et al. identified five, nondisparate dimensions of thinking; (a) thinking processes, (b) core thinking skills, (c) critical and creative thinking, (d) metacognition, and (e) the relationship of content to thinking. These five dimensions become the focus of an intellectual processes curriculum.

Thinking Processes

Thinking processes are complex mental operations which result from a combination of specific thinking skills. Marzano et al. (1988) identify eight thinking processes which are used during knowledge acquisition and use. The first three processes (i.e., concept formation, principle formation, and comprehension) are used primarily to acquire new knowledge. The next four processes (i.e., problem solving, decision making, inquiry, and composition) are used primarily during the application of knowledge. The final process, oral discourse, is used during both knowledge acquisition and knowledge application.

Core Thinking Skills

Core thinking skills are the specific mental operations that are used in combination to achieve a particular goal (Marzano et al., 1988). It is the unique combination of these core thinking skills which define the broader thinking processes identified above. Marzano et al. have generated a list of 21 core thinking skills which they have grouped into eight broad categories. The following list of thinking skills is not all inclusive, however, it does provide a way of organizing the specific skills which students must learn in order to become good thinkers (see Figure 1).

Focusing Skills
1. Defining problems
2. Setting goals

Information Gathering Skills
3. Observing
4. Formulating questions

Analyzing Skills
11. Identifying attributes and components
12. Identifying relationships and patterns
13. Identifying main ideas
14. Identifying errors

Generating Skills

Remembering Skills
  5. Encoding
  6. Recalling

Organizing Skills
  7. Comparing
  8. Classifying
  9. Ordering
  10. Representing

  15. Inferring
  16. Predicting
  17. Elaborating

Integrating Skills
  18. Summarizing
  19. Restructuring

Evaluating Skills
  20. Establishing criteria
  21. Verifying

Figure 1. Core Thinking Skills (Marzano et al., 1988, pg. 69).

Critical and Creative Thinking

While many people equate critical and creative thinking with thinking processes, Marzano et al. (1988) suggest that they are unique aspects of all thinking irrespective of the type of process used. People can engage in varying degrees of creative and critical thinking while solving problems, making decisions, and conducting research. For example, when attempting to design a more efficient alternative energy collector, one student may develop a very creative solution while another student contemplates a typical design. Problem solvers may also differ greatly in the degree of critical thought used to reflect on the process needed to solve the problem.

Metacognition

Metacognition refers to one's awareness about their own thinking processes while performing specific tasks. Often called ‘strategic thinking,’ metacognition involves the planning that takes place before engaging in a thinking activity, regulation of one's thinking during the activity, and evaluation of the appropriateness of one's thinking performance upon the completion of the activity.

Relationship of Content Knowledge to Intellectual Processes

A curriculum which focuses on the development of intellectual processes cannot be developed in isolation. Attempting to teach thinking skills without something to think about is like teaching computer-aided design principles without access to a computer; the theories and procedures can be talked about, but the necessary skills can never be fully developed.

Early attempts to create instructional programs to develop intellectual processes were unsuccessful because they focused solely on the thinking skills essential for problem solving and neglected the importance of domain knowledge (Newell & Simon, 1972). Recent cognitive research clearly establishes the link between content knowledge and intellectual processes. The classic study by Chase and Simon (1973) found that the superior performance of chess masters could be attributed more to their ability to recognize board layout patterns from past experiences than to their hypothesized superior mental capability. In fact, Chase and Simon found that when the chess masters were confronted with unconventional chess layouts, the experts performed much like novices. A recent study by Chi, Feltovich, and Glaser (1984) also provides support for the importance of teaching intellectual processes within a context of a domain of knowledge. In a study of the thought processes of experts and novices in physics, Chi et al. found that the two groups approached mechanics problems very differently. The better performance by the experts was attributed to their deeper understanding of physics principles. Without this deep understanding of the domain, the novices' intellectual processes proved to be inadequate for solving similar problems.

The Structure of an Intellectual Processes Curriculum

Given the importance of intellectual processes in this world of constant change, what kind of curriculum design can ensure that the processes are developed in students? The following discussion provides an initial framework for curricula which emphasize the development of intellectual processes.

Goals of an Intellectual Processes Curriculum

Curricula which emphasize intellectual processes seek to develop the capacity for general and complex thinking skills. While not exhaustive, the following list identifies several key goals for a technology education curriculum which is designed to emphasize intellectual processes:

1. Students should acquire a repertoire of cognitive and metacognitive skills and strategies that can be used when engaged in technological activity such as problem solving, decision making, and inquiry.
2. Through explicit emphasis on intellectual processes, students should gain an awareness of the nature of thinking and their mental capability to control attitudes, dispositions, and development.
3. Through the numerous experiential activities found in technology education curricula, students should be able to use thinking skills and strategies with increasing independence and responsibility.
4. Because technology itself is interdisciplinary, students should attain high levels of knowledge in a variety of subject areas including technology, mathematics, science, social studies, and composition.
5. Because learning occurs best when related to experience and transfers to situations similar to the conditions of learning, students should be provided with activities that closely represent real world situations and contexts.

An Instructional Model for an Intellectual Processes Curriculum

A variety of existing instructional models are appropriate for an intellectual processes curriculum. Possibly the most promising model of instruction for enhancing student intellectual processes is called cognitive apprenticeship (Collins, Brown, & Newman, 1989). Cognitive apprenticeship uses many of the instructional strategies of traditional apprenticeship but emphasizes cognitive skills rather than physical skills. Traditional apprenticeship contains three primary components; (a) modeling, (b) coaching, and (c) fading. In traditional apprenticeship programs, the master craftsman models expert behavior by demonstrating to the apprentice how to do a task while explaining what is being done and why it is done that way. By observing the master perform, the apprentice learns the correct actions and procedures and then attempts to copy them on a similar task. The master then coaches the apprentice through the task by providing hints and corrective feedback if needed. As the apprentice becomes more skilled, the master gives the apprentice more and more control over the task by 'fading' into the background. Another important aspect of apprenticeship includes the emphasis on 'real world' activities which are appropriately sequenced by the master to fit the apprentice's current level of ability.

Cognitive apprenticeship uses the same modeling, coaching, fading paradigm to enhance students' cognitive abilities. During the modeling phase of cognitive apprenticeship, the instructor shows students how to complete a task or solve a problem while verbalizing the activity. However, in contrast to typical school instruction, the activity is modeled within the context of real world situations. For example, if a lesson deals with the concept of recycling, an activity for students should be designed around a real problem such as the development of a community recycling program. As an introduction to this lesson, the instructor should work through a similar problem with the class to model the thinking processes to be used. By modeling the desired intellectual processes, students will discover that there are many ways to solve problems, that experts make mistakes, and that seemingly simple problems are very complex in the real world.

Following the modeling of the desired processes, instructors need to become coaches. This involves observing students while they carry out a task, analyzing their performance, and providing hints and assistance if needed. Finally, as the students' cognitive skills become more accomplished they will be able to perform with less and less instructor intervention. This fading aspect of cognitive apprenticeship results in the gradual transfer of responsibility for learning from teacher to student.

In addition to the three primary components, the cognitive apprenticeship model includes several other defining characteristics. These characteristics include increasing complexity and diversity in lesson sequences and providing a learning environment which promotes intrinsic motivation, cooperation, and competition (Collins et al., 1989). For example, the student space simulation activity at McCullough High School in The Woodlands, Texas began as an activity in one class and quickly expanded into a project which involved virtually every program in the school. This project also generated considerable interest and cooperation among students and teachers due to its real world relevance (McHaney & Bernhardt, 1989).

Instructional Principles for Developing Intellectual Processes

Five broad, general principles emanate from the cognitive research literature which emphasize the development of intellectual processes (Thomas, Johnson, Cooke, DiCola, Jehng, & Kvistad, 1988). Those principles include making thinking and learning easier, building on what students already know, facilitating information processing, facilitating ‘deep thinking,’ and making thinking processes explicit. The following list identifies the instructional principles which are used to enhance intellectual processes. See Thomas et al. (1988) for more detailed descriptions of these principles.

Principle 1: Help Students Organize Their Knowledge. Research shows that experts are able to process large amounts of information when solving problems while novices often get ‘mentally bogged down’ when confronted with lots of information. Instruction to improve intellectual processes must reduce the overload on student's working memory in order to enhance their ability to learn and solve problems. One way to reduce the ‘load’ on working memory is through the use of an external memory. Use of an external memory enables problem solvers to keep track of where they are in the process of solving a problem, thereby easing the load on working memory (Larkin, 1988). External memories can be as simple as a bill of materials for a project or as complicated as a diagram of an electronic device or complex social system. Concept mapping is another form of external memory that helps students organize new information (Novak, Gowin, & Johansen, 1983).

Principle 2: Build on What Students Already Know. Learning theories state that the ability to gain and use new knowledge is greatly affected by the knowledge students bring to a learning situation. Students use their existing knowledge to interpret and understand what is presented each day. If a student does not come to class with the appropriate prerequisite knowledge, the student will have difficulty understanding and remembering the new content. In essence, prerequisite knowledge serves as an ‘anchor’ to hold new information in memory. Without an appropriate anchor in the student's memory, the new information will simply ‘float away.’ As a result, in order for learning to take place, teachers must be sure that students have the prerequisite knowledge needed to learn. Two instructional techniques which address this principle are advanced organizers and analogies.

Principle 3: Facilitate Information Processing. Cognitive science research has consistently indicated that the way something is learned influences later use of that knowledge. New knowledge is ‘indexed’ in the mind when it is learned so that it can be easily found and retrieved when needed (Phye & Andre, 1986; Reiser, 1986). Indexing of information in memory is analogous to using a card catalogue to ‘index’ books in a library. With such an indexing system, specific books can be identified and located easily. Consequently, instruction must ensure that new information is indexed in ways that make it accessible at a later time. Strategies which facilitate information processing include supporting instruction through written, verbal, and graphic materials, providing outlines and organizing schemas for new content, and using real world scenarios for examples and activities which match student interests and experiences.

Principle 4: Facilitate ‘Deep Thinking.’ Any instructional method that causes students to consciously work harder at learning will help them achieve the instructional outcomes. Thinking hard increases the clarity of new information and aids understanding and recall. One of the best ways to get students to think is to have them elaborate on the material. In general, elaboration means that students think about the meaning of the material, identify relationships to other information, connect new information to what is already familiar, and generate expectations, predictions, and questions about the material. Techniques such as cooperative learning, peer tutoring, and paired problem solving can be used to get students to think.

Principle 5: Make Thinking Processes Explicit. There appears to be a growing consensus among researchers and teachers that it is beneficial to explicitly and directly teach students both the concept of metacognition and the use of metacognitive processes. When using direct instruction, teachers should explicitly teach strategies and skills by explaining not only what the strategy is, but also how, when, where, and why the strategy should be employed. Problem solving, decision making, planning, evaluating, and reflecting are all skills that can be reinforced in technology education classrooms. The direct teaching of these skills will improve student's overall performance by teaching them how to learn better rather than teaching them to perform isolated skills. In essence, the approach can be described by the old adage ‘Give people fish and they are fed for a day, but teach them to fish and they are fed for a lifetime.’

The Role of the Teacher

For an intellectual processes curriculum to be effective, the instructor must view teaching as a cooperative learning venture between student and instructor. The instructor's role is not to transmit information to the student, rather, the instructor should serve as a facilitator for learning. This involves creating and managing meaningful learning experiences and stimulating student thinking through questions and probes. Above all else, the instructor must be knowledgeable about and pay close attention to student reasoning and thinking processes.

An excellent example of the role of the teacher in an intellectual processes curriculum has been developed for teaching mathematical problem solving (Schoenfeld, 1983). In this approach, Schoenfeld teaches a set of problem solving strategies for solving mathematical problems to his students. His teaching involves showing students how he, as a mathematician, solves problems. However, unlike most teachers, he does not work the problems out in advance in order to show the students a smooth and successful solution. He even encourages his students to bring problems to class for him to solve. By being confronted with unfamiliar problems, Schoenfeld is forced to solve them as a mathematician would; by using a variety of strategies and by making errors. Through this technique, the students have the opportunity to see that there are many ways to solve mathematics problems and that even expert mathematicians make mistakes.

Schoenfeld does not stop his problem solving activity when an answer has been found because mathematicians in the ‘real world’ continue looking for alternative solutions, easier methods to solve the problem, and then attempt to generalize the solution to other problems.

Because technology education content is often taught through a problem solving method, Schoenfeld's instructional approach can be easily adapted to the technology education classroom. Technology teachers need to act like technologists in their classrooms. They need to solve unfamiliar technological problems for students and not be afraid to make errors or have difficulties finding solutions. By serving as a role model, technology teachers can show students how to collect and use information to solve technological problems and help them realize that not all problems have straight forward and simple solutions.

Evaluation of an Intellectual Processes Curriculum

Evaluating student attainment of the desired intellectual processes is the weakest component of this curricular approach. Evaluation for this type of curriculum must focus on the acquisition of complex intellectual skills. However, because students' intellectual processes are not directly observable, it is difficult to determine when students have reached the desired level of performance. Current approaches to evaluation through written examinations are not adequate for testing the attainment of intellectual processes. Instructors are left with evaluation methods which rely on their intuitive skills to subjectively assess student intellectual abilities. Clearly, considerable research in this area is needed.

Constraints to an Intellectual Processes Curriculum

While there are many reasons for developing an intellectual processes curriculum there are also several obstacles which must be faced by curriculum designers (Miller & Seller, 1985). First, the intellectual processes curriculum can be criticized for its narrowness. An intellectual processes curriculum focuses primarily on left-brain oriented logical thinking and problem solving while ignoring the more intuitive, right-brain thinking. However, a well planned curriculum which incorporates learning experiences with ill-structured, design-oriented problems may help avoid this constraint.

A second constraint faced by an intellectual processes curriculum involves a perception that many of the learning experiences can be characterized as ‘playing school, scientist, or engineer.’ To counteract this potential constraint, students need to see the relevance of the activities and be allowed to act on the issues so problem solving is integrated at a deeper, more holistic level.

Third, intellectual processes curricula can be criticized for its apparent neglect of content knowledge. On the surface an intellectual processes curriculum can appear to focus solely on thinking. However, as indicated earlier, an intellectual processes curriculum cannot be effective unless it includes a substantial amount of emphasis on content knowledge. As a result, this constraint can be resolved by developing high quality curricula.

Summary

Building on the assumption that the most important skill for the future is the ability to think, an initial framework for an intellectual processes curriculum theory has been described. While it is acknowledged that the curricular framework is incomplete, it is hoped that a critical examination and elaboration of the framework will be undertaken by technology educators. Many of the exemplary programs described in recent issues of *The Technology Teacher* (McHaney & Bernhardt, 1988; Thode, 1989a; Thode, 1989b) and *TIES* magazine (Craig, 1990; Neuman, 1991; Todd & Hutchinson, 1991) contain aspects of the proposed intellectual processes curriculum and should serve as a testing ground for further refinements of this initial framework.

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Curriculum Change in Technology Education: A Theoretical Perspective on Personal Relevance Curriculum Designs

Stephen Petrina

Personal relevance curriculum designs are compatible with most mission and philosophical statements for technology education; yet, there are few, if any curriculum plans that emphasize this design. The experience-based nature of technology education suggests a certain affinity with personal relevance. Practice and theory within the profession has influenced and has been influenced by personal relevance designs and their inherent humanistic theories. While this interaction is apparent through any historical survey of the profession and evident in contemporary literature, the nature of personal relevance designs have been only partially examined. Within the profession, there is little information in the way of adequate description and implementation of personal relevance or other humanistic curriculum designs (Herschbach, 1989; Horton, 1985; McCrory, 1987; Moss, 1987; Zuga, 1989).

The purpose of this article is to provide insight into personal relevance curriculum designs through a discussion of a theoretical perspective on their nature, underlying rationale and application to a study of technology, source of content, organizational structure, and use in technology education. Most of the discussions are limited to a micro-curriculum as opposed to a macro level. However, inferences can be drawn to include both. The focus of the discussions is on middle, junior, and senior high levels of schooling. Personal relevance designs are grounded in humanistic theory; consequently, it was necessary to summarize and generalize a number of humanistic views, beliefs and convictions.

Personal Relevance Curriculum Designs

Steve Petrina is a doctoral student in the Department of Industrial, Technological, and Occupational Education, University of Maryland, College Park, MD.

Advocates of personal relevance curriculum designs maintain that education should and does play an integral role in a student's life and has a major influence on a student's self-concept, psyche, outlook on life, and world view. Emphases of personal relevance curriculum designs are on personal growth, integrity, autonomy, and unique meaning. Personal growth is viewed as the process of developing into a self-actualizing, autonomous, authentic, healthy, happy human being. The development of body and intellect are of equal importance. Education within this context means holistic growth toward personal and humane goals; an integration of the cognitive, creative, aesthetic, moral, and vocational dimensions of being human. The development of people who can transcend contemporary constraints is central to this design (Eisner, 1979; Klein, 1986; Kolesnik, 1975; Maslow, 1968; McNeil, 1981).

Students are free to develop, or are active in helping define their own curricula based on their personal problems, developmental levels, goals, interests, curiosities, capabilities, and needs. The following concepts are considered essential to the composition of a personal relevance curriculum design (McNeil, 1981):

1. Participation - There is consent, power sharing, negotiation, and joint responsibility by coparticipants. It is essentially nonauthoritarian and not unilateral.
2. Integration - There is interaction, interpenetration, and integration of thinking, feeling, and action.
3. Relevance - The subject matter is related to the basic needs and lives of the participants and is significant to them, both emotionally and intellectually.
4. Self - The self is a legitimate object of learning.
5. Goal - The social goal or purpose is to develop the whole person within a human society (p. 9).

These curricular concepts guide the development of learning experiences and their character is dependent on teacher-student-community interaction, deliberation, and discourse. Participants have educational autonomy and democratically bring their curricula into focus.

Curriculum planning then, does not follow traditional Mager, Skinner or Tyler models. Behavioral objectives do not enter into the curriculum. Ends and means are not predetermined, but are bound to resources and context. Within a personal relevance design, the content and modes of inquiry, modes of expression, and goals are matters of personal choice or democratic process. Teaching techniques that encourage both planning and spontaneity, expression, insight, and reflective thought are integral to overall curricular unity, comprehensiveness, diversity, and consonance. The educational process is defined within unique contexts. Humanists advocate freedom of curriculum development through an emphasis on personal relevance as a challenge to traditional subject-centered models. A discussion of the rationale for personal relevance designs to help clarify the basis of the preceding concepts and postulates follows.

Underlying Curriculum Rationale and its Application to a Study of Technology

Generally speaking, personal relevance curriculum designs reflect pedagogical ideas of child-centered, and progressive educators, and have evolved to their current conceptualization within the humanistic education movement. With the humanistic education movement came a reinterpretation of student-centered education and an articulation of existential and hermeneutic philosophies, and third force and gestalt psychologies. Conceptions of the learner, knowledge, society, and the learning process have been shaped by these theories, and share a connectedness with schools of reconceptualized curriculum thought and experientialist curricular orientations (Klohr, 1980; Schubert, 1986).

The underlying rationale for personal relevance designs is supported by theories in humanistic psychologies and philosophies, and interactional sociologies. Considering humanistic theories and their related educational thought, humanists ask: ‘what do subject-centered curricula do for personal relevance, freedom, individuality, and humane goals?’ They suggest that

1. given the nature of mass culture and modern society, individuality, personal freedom, and humane goals are prohibitively constrained,
2. the school has a responsibility to emphasize the development of individuality, personal freedom, and humane goals,
3. the authoritarian and technocratic control that has pervaded the educational system constrains individuality, personal freedom, and humane goals,
4. prevalent, traditional, subject-centered curricula are inherently authoritarian and fail miserably in promoting individuality, personal freedom, and humane goals,
5. presuppositions and assumptions underlying traditional education need to be examined and challenged; and, individuals within a democratic society deserve better,
6. considering inherent problems of prevalent educational theory and curricula, humanistic theories are considerable within the context of a democratic society,
7. a restructuring of the schools is necessary to encourage individuality, personal freedom, and humane goals, and
8. curricula based on personal relevance should be considered as viable alternatives to traditional curricula (Holt, 1970; Kolesnik 1975; McNeil, 1981; Rust, 1975; Sloan, 1984).

This underlying rationale for personal relevance curriculum designs and its supporting theories are the bases of justification for curricular decisions concerning the content and style of the educational process.

Application to a Study of Technology

The preceding rationale can be applied to include a study of technology. Technology, in all of its manifestations and consequences, has been and continues to be a matter of critical concern to humanists (Dewey, 1900; Mumford, 1934; Rugg, 1958; Wirth, 1989). The humanization of technology, often reflective of the thought of Mumford, is intrinsic to the humanistic movement. Humanists advocate confronting the nature of technology through holistic, contextual and critical inquiry. Consciousness, insight, and knowledge related to the interaction of self, technology, culture, and society is essential to personal development. Inquiry into technology is integral to personal relevance curricula for the following, and other reasons:

1. technology is central to human experience and individual life worlds (Ihde, 1990),
2. the ubiquity and mediacy of technology shape our perceptions of the world and self (Ormiston, 1990),
3. human values, freedom and choice interact with technology on a personal level (Ihde, 1983),
4. personal livelihood is dependent on technology (Rapp, 1989; Wirth, 1987),
5. technology is a fundamental area of culture and human endeavor, and is inextricably interwoven with history, culture, and society; also, it is integrative in nature (Kranzberg, 1986),
6. technology is necessary for human existence (Huning, 1985),
7. technology is problematic and paradoxical for individuals and society (Rapp, 1989),
8. the artificial world is ambient; increasingly, technology is habitat (Ormiston, 1990), and
9. technology must be humanized and its direction subjected to limitations and determined democratically by society. There is tension between personal and social choice (Davis, 1981).

Humanists would also suggest that traditional, subject-centered education is permeated with technology; yet as a topic of educational inquiry, it is traditionally precluded to anything but passing glances or delivered at an impersonal level.

Source of Content

In personal relevance curriculum designs, content, as a body of established truths is not a source for the initiation of learning experiences. Humanists generally subscribe to a Deweyan instrumental view of disciplinary content. Disciplinary content has an instrumental function as a means of illuminating a student's life world. It is an instrument in the development of self-concept and incidental to the learning process.

Because of its inertness, separation from process and lack of personal meaning, humanists reject disciplinary content as knowledge on philosophical grounds. They maintain that knowledge is dynamic and in need of subjective validity and a personal, practical dimension. Substance of thought, or the content of knowledge is of major importance to humanists. A source of content in a personal relevance curriculum design lies in the immediate concerns of the student's interaction with his/her environment.

This is not to say that content is ignored in a personal relevance curriculum design. A major challenge within any curriculum design is the determination of what is practical and essential to the welfare of the student, community, and society. No humanist would deny the importance of reading, writing, and communication, or other essential subjects and skills. They suggest that through deliberation and dialogue, the student, teacher, and the community interact as a source of essential content.

Humanists also recognize ecological, cultural and historical perspective as essential to the development of identity and social purpose. To a humanist, a critical perspective on the relationships of self to values, the community, the environment, cultural milleau, and historical continuum is essential to personal growth. The development of perception of patterns of human existence within history and culture is essential. But, humanists also suggest that equally essential is the realization that these perspectives and perceptions can be faulty and have the potential to constrain. Knowledge as personal, practical, and focused on the human condition is a significant concern. Humanists respond to the dilemma of knowledge by emphasizing inquiry, the nurturant potential of learning environments, and intrinsic motivation factors of relevance and choice. The problem in curriculum, as humanists view it, is not one of content, but one of style (Brown, 1978; Clark, 1990; Eash, 1971; Greene, 1971; Junell, 1979; Frymier, 1972; Kolesnik, 1975; McNeil, 1981; Pilder, 1969).

Organizational Structure

Advocates claim that a great strength of personal relevance designs is their emphasis on unity and integration. Within curricula based on these designs, the integration of emotions, thoughts, actions, and goals with the social setting and environment are emphasized. Methods such as nondirective teaching, synectics, seminars, awareness training, social inquiry, cooperative and individual projects, and discovery encourage self-expression and personal meaning. Gestalt techniques facilitate interaction and insight. Phenomenological and hermeneutic techniques help to bring experiences and personal narrative to levels of understanding. Organization is established through personal problems and interests. Units are used to encourage the development of unified and comprehensive experiences (Joyce & Weil, 1980; Kolesnik, 1975; McNeil, 1981).

Because of their holistic and integrating nature, and potential for unifying students with the learning environment, units are often used to provide organizational structure. Units within personal relevance designs are more attuned to the progressive interpretation than their more popular subject-centered readings. They are experience-based or based on the development of learning experiences that focus on significant themes in the students' relationship with their environment. Experience-based units help students recognize the relationships between their own experiences and broader problems and patterns in life. They integrate the knowing, feeling, and doing aspects of experience and learning. They integrate a student's thought, emotions and actions, with purpose, the means-ends continuum, and the environment. Units often present themselves as both project and problem, and students draw on diverse types of inquiry, knowledge and other resources to assist in their resolution. The organization provided is on the learner's psychological level as opposed to an expert's logical level (Burton, 1952; Ogletree, Gebauer & Ujlaki, 1980).

The determination of the nature and types of units used is bound to student and teacher negotiation. Cooperative units are developed to reach students on personal levels and broadly conceived to accommodate individuality. Curricula for a high school group could be organized within units such as: self-expression and modern culture; personal values and science, technology, and the military in the 20th century; work and economic amenity; social reform and personal agenda; technological change and humanistic imperatives; personal freedom and emancipation; energy, environment, and personal consumption; old materials, censorship, and new art; communicable disease, research and modern medicine; choice of apparel, fashion and style; or political efficacy and personal destiny. Junior high units are also focused on significant aspects of students' lives, and made accessible to their maturity level.

The organization of elements within units is a matter of individual and group interest, motivation, and resources. Emphasis is on connecting abstract concepts to real and personal themes inherent in the students' lives. Outcomes are dependent on the degree to which relevance, unity, integration, and personal insight are developed. The challenge is to unify variety and diversity toward common goals.

Application to Technology Education

A review of literature leaves one to conclude that applications of personal relevance curriculum designs are nonexistent within technology education (or their existence has not been communicated through literature). Nonetheless, there are descriptions of programs, units, and other endeavors that are integrated in their curricular designs and suggestive of holistic and integrative approaches to studying technology. An example of the shape that personal relevance curricula might take has been provided.

The following examples of units are suggestive of holistic inquiry into technology. Maley (1973) presented units to support a study of technology, and structured them within an integrated curriculum design. His proposed units are experienced-based, and provide for student choice within a framework of societal needs. Other units within technology education that provide for student choice within structured frameworks include Maley (1989) and Pytlik (1981). In social studies, American history, the history of technology, and Science, Technology & Society (STS), there are examples of subject-centered units that are thematically based on technology, and suggest varying degrees of flexibility for student choice and freedom within a traditional setting (Barnes, 1982; Bensen & Eaves, 1985; Sinclair & Smulyan, 1990; Wagner, 1990).

There exists a wealth of exhibits, books, and articles that provide insight into the nature of technology. Museum exhibits and accompanying texts provide evidence of technology as both a social force and social product (Hindle & Lubar, 1988; Stratton, 1990). Introductions to technology, contextual readings of the history of technology, and thematic studies provide evidence of the interrelationships of technology to other endeavors in life (DeVore, 1980; Hughes, 1983; Volk, 1990). Surveys such as these begin to suggest the shape and avenues of inquiry that students might pursue within arrangements of units. There are a variety of resources within technology education, STS, the philosophy and history of technology, and other areas of inquiry from which teachers can draw. Insight into the holistic, contextual and integrative nature of technology, and accompanying modes of inquiry is necessary for teachers, but a solid grounding in humanistic theories and techniques is essential.

The shape that a personal relevance curriculum might take can be illustrated through a summary of a unit titled ‘Prescription for conservation, health, and personal transportation: the bicycle!’ This example would be appropriate for a junior high technology education class. Unity, integration, consonance, and relevance are addressed through thematic use of a common product in which most students within the junior high grades are sincerely interested. The technology of bicycles is advantageous in its historical significance, social effects, and multi-cultural utility; and, its relationships to physics, engineering, physiology, economics, geography, safety and health, sport and leisure, urban design, industry, and environmental policy. Through their simplicity and performance, bicycles challenge students to apply techniques related to design, invention, experimentation, maintenance, and repair. Bicycles can inspire the formation of clubs, affiliation with cycling organizations, and planned bike tours. Most importantly, the centrality of bicycles to youth can be used to develop self-concept through insight into personal relationships with technology.

Following initial planning and coordination of problem and project areas, students begin to develop experiences that take advantage of the relationships of the bicycle to aspects of everyday life. Experiences develop through the use of a variety of resources found in laboratory, library, classroom, and community facilities. For instance, a group of students might: design and conduct a survey to determine the extent of bicycle use in their community, and report the results as compared to national and international trends; determine the needs of a cycling society and initiate a local or national letter-writing program to shape transportation policy; design cities of the future which accommodate a variety of modes of transportation; design and construct bicycle trailers with concern for specific speed and payload factors; survey and map geographic regions for potential bikeways; investigate the bicycle use of teen-agers in developing countries; design and conduct experiments that focus on physiological demands of cycling; print posters to promote bicycle use; or design a sculpture, and write songs or plays that express feelings toward human-powered transportation. Individual expression of emotion and ideas through artistic, technical, and practical capabilities in the form of paintings, sculptures, poems, songs, stories, engineering drawings, reports, models, objects of utility, and discussions is encouraged. Involvement in these modes of expression, and the use of personal and social families of teaching models, including gestalt and phenomenological techniques, encourage students to develop and own concepts of themselves and their relationship to their environment.

Conclusion

Current educational thought and evolving world views can be recognized as support for humanistic goals. Perspectives on learning suggest the importance of context, environment, and other life-shaping forces, and tend to strengthen other major tenets of humanistic theories. There is renewed interest in process, integration, and experience. Learning how to learn has become synonymous with education. Self-directed, original, creative, and critical-thinking people seem to be the new societal need. Ecology, conservation, balance, and the humanization of technology are of considerable global concern. Evidence of failed spending and programmatic educational efforts of the 1980s provide grounds for innovation. It has been suggested the paradigm shaping authoritarian, technocratic curricula has become dysfunctional (Eisner, 1979; Wirth, 1989). Within this context, an education that humanists envision may be a suitable alternative to predominant subject-centered orientations.

However, without complete restructuring of the schools, the demands of personal relevance curricula may prohibit them from being anything more than alternatives. Likewise, without total commitment from teachers, administrators, and the community, meaning readjustment of an entrenched educational paradigm, it is unlikely that personal relevance designs will be accepted as anything more than aberrant. Nonetheless, the rationale underlying these curriculum designs is considerable.

Given their historical roots, personal relevance curriculum designs should not seem aberrant to technology educators. Still, technology educators have not embraced personal relevance designs and curricular proposals have been characteristically based on subject-centered, hybrid and often incompatible designs. At least some humanistic techniques have been assimilated into technology education classrooms; but, within technical or subject-centered designs, their nature and vitality may be distorted.

The subject-centered orientation of technology education curricula is comprehensible within its context. Technology education was conceptualized during an era of national emphases on academic standards and testing, and shaped by a dominant educational paradigm. Articulation of a humanistic mission and philosophy for technology education, and the design of curricula that are consistent with this mission would mean transcendence of the prevailing socio-political climate. Technology educators will have to position themselves within schools of reconceptualized curriculum thought and critical praxis. Dialogue and inquiry within the profession will have to be extended to include a concern for phenomenological, hermeneutical and other non-positivistic ways of interpreting the human experience of creating, using, and in general, living with technology.

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Social Reconstruction Curriculum and Technology Education

Karen F. Zuga

> . . . to shape the experiences of the young so that instead of reproducing current habits, better habits shall be formed, and thus the future adult society be an improvement on their own. (Dewey, 1916, p. 79)

In the first half of the century, during the depths of the Great Depression, Progressive educators set out to reform education by calling for a social reconstruction curriculum orientation. In this paper I will explore social reconstruction with regard to schools, curriculum, and technology education. In the first half of the paper I will explore what was meant by social reconstruction, the way in which it was implemented in experimental schools, and the legacy of social reconstruction. In the second half of the paper I will discuss the role of processes in technology education curriculum, provide ideas for organizing a social reconstruction curriculum orientation in technology education, and list examples of what a social reconstruction curriculum orientation in technology education is not.

Social Reconstruction

In response to social conditions of the day, Progressive educators during the early half of the century were advocating a restructuring of education in this country. Many of the Progressives believed that, due to school practices, schools and society were caught in a dualistic relationship which separated the school from mainstream society and created an isolation of the schools. They believed that what happened under the auspices of the schools was not real or reflective of the problems in society (Bode, 1933; Counts, 1932; Cremin, 1977; Dewey, 1916; Dewey and Childs, 1933). Furthermore, the Progressives argued that the artificial environment of the schools was miseducative in that the youth of the country were not prepared to see and understand the values and issues which would confront them as they became adults (Dewey and Childs, 1933). As a result of these beliefs, some Progressives proposed that the schools create a new social order (Counts, 1932).

Karen Zuga is Associate Professor, Department of Educational Studies, The Ohio State University, Columbus, OH.

Definition

Creating a new environment in the schools, ‘reconstructing’ the existing environment, was the Progressive agenda, but how that was to be accomplished was not universally agreed upon (Cremin, 1976). As with any other idea, a range of opinions were held with Counts proffering, perhaps, the most radical opinion. Counts (1932) envisioned a restructuring of American society and economy as he said, ‘The times are literally crying for a new vision of American destiny. The teaching profession, or at least its progressive elements, should eagerly grasp the opportunity which the fates have placed in their hands.’ (p. 50) Others were less radical in their suggestions for reform, but did believe that social reconstruction was the central aim of a good education and was necessary in schools, if not, society at large.

Citing that many members of society were far too concerned with individual needs, that the fervent nationalism of the times inhibited international cooperation, and that the economic depression was signalling problems with the existing society and economic structure (Dewey and Childs, 1933) mainstream Progressives believed that the schools could be structured in a new way, and, in turn, encourage students as future citizens to reconstruct society. The focus of mainstream Progressives was on the restructuring of schools; an effort which many hoped would lead to eventual changes in society. For schools and students, mainstream Progressive educators had several goals which included: orienting students and helping them commit to the life in which they would participate; helping students to develop intellectual, esthetic, or practical interests; setting up an environment which would lead to a deeper understanding of a democratic way of life; and reconstructing the procedures of the school through experimentalism (Hullfish, 1933). Mainstream Progressive educators differed with Counts in that they saw a future for the existing democracy. About the social reconstruction of the mainstream Progressives, Dewey and Childs (1933) said:

> Our continued democracy of life will depend upon our own power of character and intelligence in using the resources at hand for a society which is not so much planned as planning --- a society in which the constructive use of experimental method is completely naturalized. In such a national life, society itself would be a function of education, and the actual educative effect of all institutions would be in harmony with the professed aims of the special educational institution. (Dewey and Childs, 1933, p. 65)

Interestingly, the Progressives based their interpretation of social reconstruction in experimentalism, science, and technology. Experimentalism and faith in science and technology are fundamental to the philosophy of pragmatism. As a leading pragmatic philosopher, Dewey conceived of pragmatism as a uniquely American philosophy which dealt with the concepts of the instrumentalism of technology and the experimentalism of science as inquiry (Hickman, 1990; Smith, 1980). It is no wonder, then, that Dewey advocated experimentation in schools for both the students via the curriculum and for administrators as they determined the structure of schools. Moreover, Dewey and Childs (1933) spoke of the use of instrumentalism as a technology of education which would influence society: 'An identity, an equation, exists between the urgent social need of the present and that of education. Society, in order to solve its own problems and remedy its own ills, needs to employ science and technology for social instead of merely private ends.' (p.64) Make no mistake about it, though, the purpose of the use of science and technology was to be a social purpose, not an individual purpose and not a business purpose. Individual and business values and actions were clearly criticized by the Progressives who linked these values and actions to the evident ills within society during the first half of the century (Bode, 1933; Counts, 1932; Dewey and Childs, 1933).

Implementation

A number of experimental or laboratory schools were set up during the Progressive Era in education. It is from these schools that examples of what social reconstruction would look like in education can be drawn. Bode (1933) explains social reconstruction as a 'continuous reconstruction of experience' (p. 19) in daily school practice with the following examples:

> This reconstruction of experience, if it is to have any significance, must take the form of actual living and doing. Consequently the school must be transformed into a place where pupils go, not primarily to acquire knowledge, but to carry on a way of life. That is, the school is to be regarded as, first of all, an ideal community in which pupils get practice in cooperation, in self-government, and in the application of intelligence to difficulties or problems as they may arise. In such a community there is no antecedent compartmentalization of values.

There are a number of important points here about social reconstruction. Social reconstruction involves active participation through 'doing.' However, this is not mindless drill, skill development, or even the completion of personally chosen projects, because the Progressives clearly intended a social purpose to all activity. They viewed the school as a community in which values and habits useful in the greater community would be instilled through practice. This was not to be an activity such as job training or skill development which fit students into preconceived notions of what adults believed they should become. That is why there was an emphasis on self-government by students and that is why Bode (1933, pp. 19-20) continued: 'Shopwork, for example, is not dominated by the idea of personal profit, but becomes a medium for the expression of esthetic values and social aims. The quest for knowledge is not ruled by the standards of research, but is brought into immediate relation with human ends. Judgements of conduct are not based upon abstract rules, but on considerations of group welfare.' The message is clearly one of social purpose as the guiding force for the reconstruction of experience within the school. Social purpose also guided the selection of content and activities which formed the curriculum. The social purpose is documented in an overview of the science and technology curriculum at The Ohio State University Elementary School and Kindergarten in 1935: ‘In evaluating our results, we asked ourselves thoughtfully: ‘Does the educational experience we are setting up provide for real participation by each student in each of these functions of living?’’ (Publications Committee, 1935, p. 121) The curriculum of the laboratory school included a core of study about the preparation of materials which was specified to take place in the science, all of the arts, and the home economics laboratories. Industry, distribution, and control were some of the topics to be studied in this core.

The Ohio State University laboratory school was organized about the concept of social reconstruction and was often cited as an exemplar of social reconstruction curriculum in action. The secondary school operated on the same guiding principles. The effectiveness of the secondary program was documented, uniquely, by the first graduating class who took it upon themselves to write and publish a book about their perceptions of the social reconstruction program they had followed (Class of 1938, 1938). In their extensive work the students explained how they created their school environment with teachers who served as friends and advisors. In the early years, much of the work that was done under the auspices of industrial arts involved modifying their own school environment by refurbishing the school building.

In the experimental schools of the Progressive Era social reconstruction curriculum involved student self government, the evolution of a community consciousness on the part of students, and group project work which focussed on the school, local, national, and international communities.

The Legacy

Very little evidence of the social reconstruction curriculum remains today. Vestiges of practices initiated in the experimental schools can be seen in efforts to operate student councils, attempts to provide students some free choice in projects, and endeavors to maintain school laboratories in technology and consumer science education. What happened?

Dewey and Childs 1933 critique of the failure to adopt social reconstruction educational practices during that era has an all too familiar ring today:

> Why, even when the social concepts were retained in theory, were they treated in a way which left them mainly only a nominal force, their transforming effect on practice being evaded? Why were they so often used merely to justify and to supply a terminology for traditional practices? The reason which lies on the surface is that an abstract and formal conception of society was substituted for the earlier formal concept of the individual. General ideas like the transmission and critical remaking of social values, reconstruction of experience, receive acceptance in words, but are often merely plastered on to existing practices, being used to provide a new vocabulary for old practices and a new means for justifying them. (p. 33)

Essentially, Dewey and Childs are critiquing the failure to move from the academic rationalist curriculum of the Greek tradition and the personal needs curriculum of the Herbartian tradition. Educators are still struggling with these, and other curriculum orientations today. Technology education has not escaped this struggle.

Cremin (1976 & 1977), with the benefit of hindsight offers an additional explanation of the lack of implementation in schools of the Progressives' idea of social reconstruction. He believes that Dewey failed to resolve the dualism between the school and society that he fought to overcome because he failed to account for the many institutions in society which provide education. Media, family, church, and industry are just some of the institutions which provide education that Cremin cites. Cremin argues that a contemporary conception of schooling must account for the influence of these institutions and their modes of education.

Phenomenologists and critical scientists provide other reasons for the lack of enduring social reconstruction curriculum reform. Vandenberg (1971), in a phenomenological analysis, views the reform efforts of the twentieth century as a Hegelian dialectic in which social reconstruction was an alternative view promulgated as a result of child-centered beliefs and was recombined with life-adjustment ideas in the post World War II period. More recently, Gonzalez (1982), critiquing from a Marxist perspective, charges that the Progressives ‘never challenged the tenets of capitalist production’ (p. 103).

These and many more interpretations can be offered in order to explain the absence of social reconstruction curriculum today. Dewey and Childs (1933), however, remain eerily accurate in their sense of educational ills both in their time and today as they wrote:

> Actually pupils have been protected from family, industry, business, as they exist to-day. Just as schools have been led by actual conditions to be non-sectarian in religion, and thus have been forced to evade important questions about the bearings of contemporary science and historical knowledge upon traditional religious beliefs, so they have tended to become colorless, because [sic] neutral, in most of the vital social issues of the day. The practical result is an indiscriminate complacency about actual conditions. The evil goes much deeper than the production of a split between theory and practice and the creating of a corresponding unreality in theory. Our educational undertakings are left without unified direction and without the ardor and enthusiasm that are generated when educational activities are organically connected with dominant social purpose and conviction. Lacking direction by definite social ideals, these undertakings become the victim of special pressure groups, the subject of contending special interests, the sport of passing intellectual fashions, the toys of dominant personalities who impress for a time their special opinions, the passive tools of antiquated traditions. They supply students with technical instrumentalities for realizing such purposes as outside conditions breed in them. They accomplish little in forming the basic desires and purposes which determine social activities. (pp. 34-35)

In other words, at best, schools are insulated from society and serve to preserve the status quo and, at worst, schools are subject to the whims of fads and special interest groups. If administrators and teachers do not take a stand on the issues, students will not be able to take a stand. We, as educators have not taken a stand. As technology educators most of us promote a sterile conception of a discipline based subject matter, rather than grappling with the many social issues and problems which result from our use (as a society) of technology.

Creating a Social Reconstruction Curriculum for Technology Education

Technology educators have relied upon technical processes as a means of generating curriculum content. This is true for traditional programs as well as contemporary programs. Teaching about technical processes is essential in a ‘hands on’ program. A social reconstruction curriculum orientation would be ‘hands on.’ It is the way in which the technical processes are organized that distinguishes the curriculum orientation. In this section I will discuss the prominent role of technical processes in technology education curriculum, examples of a social reconstruction orientation in technology education, and what is not a social reconstruction curriculum orientation in technology education.

Processes as Traditional Curriculum Content

There are many ways in which to identify and define appropriate content for technology education. To this time, technology educators have concentrated primarily on categorizing processes either via the traditional content of industrial arts or through contemporary proposals for industrial technology education and technology education. For example, industrial arts educators started with a material such as wood or a process such as drawing and using a form of task analysis categorized the processes students needed to know in order to transform the material or create an acceptable drawing (Silvius & Bohn, 1976; Silvius & Curry, 1967; Wilber, 1948). The approach used in the Maryland Plan appears to eschew a focus on processes while students select content. However, processes eventually are taught as they are required by the individual student's project (Maley, 1973). In the same manner, industrial technology educators started with an inputs-processes-outputs model of manufacturing or constructing and categorized a wider array of processes needed to manufacture and construct (Towers, Lux, & Ray, 1966). The industrial technology education curriculum was more inclusive in that it incorporated the processes involved in managing the businesses of manufacturing and construction. Contemporary technology education curriculum follows the same route as industrial technology curriculum by using an inputs-processes-outputs model for generating curriculum (Snyder & Hales, 1981). Some variation exists with the British models of design and technology curriculum in that problem solving becomes the focus of the curriculum and problem solving processes in addition to technical processes are used to organize curriculum (Barlex & Kimbell, 1986; Kimbell, 1982; Williamson & Sharpe, 1988).

It is clear that technology educators teach about processes. The differences in the curriculum orientations (when and how the processes are taught) are rooted in teachers' beliefs about education and students. These beliefs cause the teacher to select and organize the processes in a variety of ways. The differences lie in the way in which the teacher chooses to slice the pie of the current content universe of technical processes.

Organizing Technology Education with a Social Reconstruction Orientation

In order to implement a social reconstruction curriculum orientation in technology education social problems which have particular relevance to technology are chosen and become the means for organizing technical processes. Technical processes are taught only as the need to know them in order to solve the social problem arises. For example, pressing social problems such as designing and constructing low cost housing for the homeless, refurbishing low cost housing, or retrofitting housing with energy saving devices becomes the thrust of a social reconstruction curriculum in a construction class. Students may never get a chance to try all of the processes, such as installing shingles on a roof or wiring, needed in order to build a contemporary home. The teacher is more concerned about the social problem and creating a community with students and society and is less concerned about 'covering the content.' Only the technical processes needed to construct the alternative form of housing are taught to those students who need to know the technical processes. The teacher also trusts that the greater social goal is of more value than specific content. The teacher believes that the experience of solving a problem such as creating low cost shelter for the homeless will instill in students habits and enthusiasm for seeking out the knowledge and skills needed to take on additional problems which will involve other knowledge and skills. The teacher also believes that by example and practice with selected processes that attitudes of safety and pride in quality will transfer to new processes. In this way the teacher hopes to help a student to be not dependent upon instruction in order to function as an adult in society, but to be willing to experiment and to try new ideas and skills.

We are not lacking in pressing social problems which relate to technology. Each content area of technology education can be used as a vehicle for attacking social concerns. Some examples include:

Transportation.

1. Designing and creating less polluting power systems for vehicles
2. Designing and creating prototype alternative transportation systems for the community and presenting those designs to city council

Manufacturing.

1. Investigating the effects of local manufacturing firms policies on the local environment and either honoring the firms or approaching the firms with suggestions for improvement
2. Investigating and attempting to develop biodegradable polymers
3. Creating a manufacturing business which makes a product identified as valuable to a select market such as senior citizens or low socio-economic

status (SES) citizens in the local community and marketing that product to them on a cost recovery basis

Communication.

1. Creating and testing personal emergency communication devices for handicapped people
2. Examining advertising claims by doing product testing and reporting the results to the local community

Construction.

1. Conducting an energy audit on the school building and making recommendations to the school board for retrofitting energy saving devices
2. Conducting energy audits and correcting the deficiencies on students' homes, homes of the elderly, and homes of low SES citizens

The list of examples is bounded only by the imagination of the students and teachers who, in partnership, implement a social reconstruction curriculum orientation in technology education.

What A Social Reconstruction Curriculum Orientation Is Not

Another way of illustrating something is to discuss what it is not. I choose to discuss what a social reconstruction orientation to curriculum is not by using illustrations drawn from contemporary technology education practices.

It is not having the teacher choose course content or the social problems. It is not isolating students in glitzy cubicles in front of computer screens which feed a standardized curriculum to all students during their rotation through a modular curriculum. It is not having all students complete the same project. It is not having students solve unrelated problems created by teachers in order to address course content or to keep the students active. It is not failing to challenge students to be critical of their school and culture (of which industry is a part). It is not teaching technological processes in an uncritical manner. It is not permitting individual students to make projects solely to satisfy individual needs. It is not teaching students how to follow directions all of the time. It is not determining what content a child needs to know in the future in order to be a successful adult, thereby limiting the potential of the child. It is not lacking the commitment to take a stand, one which will not be universally agreed upon, on issues, all issues. It is not discouraging students from taking a stand on issues.

Whatever technology education activities are conducted in a social reconstruction curriculum orientation, there is a social purpose to the activity. That social purpose should be left to the choice of the students, because the students are to be encouraged to take on the responsibility of recreating society.

Summary

Several purposes of education have been prominent in this country since the beginning of public education. Social reconstruction is one of the unique categories of purpose which has helped to shape educators' thinking about curriculum. Social reconstruction curriculum tries to involve students in school and community life in order to help them to become adults who can reconstruct and improve society.

Many technology educators have tried activities with students which were motivated by a social reconstruction perspective, but few have implemented a complete program. In fact, there are few examples of any program which is singular in curriculum orientation.

There is a greater problem with the social reconstruction curriculum orientation. This is the focus on social problems and the inescapable problem of having the choice of the social problem reveal a value orientation. The Progressives were well aware of this underlying tension which involves taking a stand on the issues confronting today's society. It is much easier to remain in the isolated school environment than to declare one's political orientation in an effort to attempt to remedy social problems, for it is in the way in which one chooses to solve the problem that one's political ideology is revealed.

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Book Reviews

The History and Influence of Technology

Hughes, Thomas P. (1989). *American genesis: A century of invention and technological enthusiasm, 1870 - 1970.* New York: Penguin Books, $10.95 (paperback), 529 pp. (ISBN 0-14-00-9741-4).

Marcus, Alan I., Howard P. Segal (1989). *Technology in America: A brief history.* New York: Harcourt, Brace Jovanovich, Publishers, $14.95 (paperback), 380 pp. (ISBN 0-15- 589762-4).

McGinn, Robert E. (1991). *Science, technology, and society.* Englewood Cliffs, NJ: Prentice Hall, $19.40 (paperback), 302 pp., (ISBN 0-13-794736-4).

Pacey, Arnold (1990). *Technology in world civilization.* Cambridge, MA: The MIT Press, $9.95 (paperback), 238 pp. (ISBN 0-262-66072-5).

Pursell, Carroll W. Jr., Ed. (1990). *Technology in America: A history of individuals and ideas.* Cambridge, MA: MIT Press, 2nd ed., $11.95 (paperback), 319 pp. (ISBN 0-262-66049-0).

Reviewed by Dennis W. Cheek

These five books, all available in paperback, are part of a growing and intersecting corpus of scholarship that will enlighten technology educators at all levels - elementary through post-doctoral studies. Two books provide a very broad base from which to consider the other contributions, which focus on the history of technology in America. The five volumes as a set, make a wonderful resource library for any technology teacher seeking to understand technology within the contexts of American history and global interdependence.

McGinn's contribution to the well-known and highly acclaimed Prentice Hall Foundations of Modern Sociology Series, is the best introductory sociol-

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Dennis W. Cheek is Book Review Editor for the Journal of Technology Education and Coordinator of Curriculum Development, New York Science, Technology and Society Education Project at the New York State Education Department.

ogy of science and technology textbook in English. The author is department chair of the Values, Technology, Science and Society (VTSS) Program at Stanford University. The nature, contexts, and relationships between science and technology are briefly explained. Modern theories of science and technology in society are presented to form a context for topics in the remainder of the book. The final two sections consider the influence of science and technology on modern society and the impact of modern society on science and technology. An appendix briefly introduces the reader to the growing STS movement.

The sociological approach of McGinn is nicely complimented by Pacey's historical tour de force which looks at technology over a thousand year period of world civilization. A singular contribution is his emphasis upon the adaption of technology to particular cultures and peoples. Pacey presents many examples of the diffusion and transformation of technology from Asia and Africa to Europe and cases where the diffusion occurred in the reverse direction. His informed criticism of naive technology transfer from industrialized to nonindustrialized nations is well-founded.

What then of technology in America? The reviewer knows of no better starting point to pursue general studies in this arena than the recent works by Hughes, Marcus and Segal, and Pursell. The broadest perspective is that of Marcus and Segal who deliver just what the book's subtitle promises - a brief history. Within this handy tome, the reader will find a concise yet encyclopedic account of technology in America. The authors skillfully link technologies to their underlying political, social, and economic contexts, and establish systematization as a major theme in American technological development. The technology teacher will gain a new appreciation of how interwoven technologies are with one another in both their origins and subsequent evolution.

More detail about specific individuals instrumental in the development of technology in America can be gleaned from the very useful second edition of Pursell's edited volume. A group of 22 eminent historians of American technology present biographical vignettes of 21 key individuals and their ideas. Instead of merely cataloguing of achievements, each essay helps the reader see the individual within an appropriate social and historical context. The essays are nontechnical in nature and many would be suitable for high school technology students to read and consider.

For in-depth treatment of technology in America during the last one hundred years, there is probably no better treatment on the present market than American Genesis from the pen of the noted University of Pennsylvania historian of technology, Thomas P. Hughes. Taking ‘the world as artifact’ as his metaphor, Hughes tries to explain historically how we have come to live and accept life in a technologically fabricated world. He admirably succeeds in his goal to produce not simply another history of technology in America but a rich social history that considers technology's broad impacts and pervasive influence on the culture, behavior, and mores of modern America. The book breaks new ground with bold new explanations and like all books of this type, causes an informed reader to part company with the author at certain points. Yet, that is one of the hallmarks of a worthwhile book.

All five books enable the technology teacher to see technology in a broader and deeper context than is often the case. Each contributes worthwhile perspectives to anyone seeking to think in fuller ways about technology and its role in the modern world. All of these works are accompanied by lists of additional readings, subject and author indices, and period B & W photographs. Some also include diagrams from the period under discussion. If you've been teaching technology without much sense of its history or impact, these books are sure guides that will enrich your teaching and your thinking. ˚

Editorial

Building a Defensible Curriculum Base

Thomas Wright

Educators seem to have a strong desire to relive historical mistakes. During the 1960s, industrial arts innovators divided into three fairly distinct camps. One group could be characterized as the technology camp and was championed by DeVore (1966) and others. Another group was the industry group which was championed by the Ohio State IACP staff (Towers, 1966). A third group was the child-centered group championed by Maley (1973). These people and their followers spent an inordinate amount of time debating the content base for industrial arts and criticizing the other camps' position. However valuable this discourse was, the vast majority of the field was unmoved. Most programs continued to focus their efforts on the skills involved in woodworking, metalworking, and drafting, (Dugger, 1980).

It took the Jacksons Mill Project (Hales and Snyder, n.d.) to cause curriculum innovators to realize that a central focus was necessary if industrial arts programs were to change. For a period of time, the Jackson's Mill curriculum consensus held and significant program improvement occurred.

Today, technology educators are again beginning to divide into camps over curriculum structure issues and to dissipate the focus of the field. There are number of reasons for this split. Some people feel they must make their ‘unique’ personal contribution to the field. Other leaders are convinced that conditions in their state require a special focus for their state's technology program. Still other people feel that any curriculum structure over five years old is obsolete.

These different positions are dangerous if technology education is to become recognized as a vital area of study for all youth. Instead of everyone going their own way, the leaders of the field must recognize that all subject areas have a fairly stable curriculum structure under which dynamic content fits. For example, science does not change its chemistry, physics, biology, curriculum structure every five years. This action does not cause curriculum stagnation because the content under each of these headings is open for constant review and change.

Tom Wright is Professor of Industry and Technology, Ball State University, Muncie, IN.

The challenge to all technology educators is to apply the same logic as science uses to determine the curriculum focus and structure for the study of technology. This action will require a logical, sequential approach.

First, the arena of the discipline must be established. This action determines the scope of the curriculum. For example, science relies on evidence to develop hypotheses and theories to identify consistent patterns of things and events in the universe (Project 2061, 1989). Its arena, then, is focused on the procedures used to study the natural world and the impacts these findings have on human knowledge.

Technology education also has its focus. Technology is used to create the human-made world. Technologists apply human and physical resources to design, produce, and assess artifacts and systems that control and modify the natural and human-made environments. Also, developing and using technology impacts people, society, and the environment. Therefore the arena of technology is the practices used to develop, produce, and use artifacts and the impacts these actions have on humans and the natural world.

Once the arena of the discipline has been established a second curriculum development step is required. A clear distinction between the ‘hows’ and ‘whys’ of technology must be made. For example, the Project 2061 report suggests ‘...the various scientific disciplines are alike in their reliance on evidence, their use of hypotheses and theories, the kinds of logic used, and much more. Nevertheless, scientists differ greatly from one another in the phenomena they investigate...’ This statement suggests there is a fairly common way scientists investigate the universe and that various scientists focus their investigation to specific areas of science.

Technology, likewise, has a way new artifacts are developed. It, also, has an accumulated body of knowledge that explains existing technologies and provides the foundation for new technological advancements. Technology educators need to look at these foci so students can study (1) the processes used by practitioners to develop new technology, (2) the areas of technology which represent the accumulated knowledge of practice, and (3) the impacts of technology. A program that focuses on one of these elements at the exclusion of the others will be incomplete.

However, identifying the primary foci of a program is not enough. The curriculum developer must address each of these foci individually.

Investigating the first focus requires identifying the procedure used to address technological problems and opportunities. This procedure establishes the ‘scientific method’ of technology. Over time it has been described as the design method (Lindbeck, 1963), problem solving (Waetjen, 1989), and the technological method. A common outline for this process includes (1) defining the problem, (2) developing alternate solutions, (3) selecting a solution, (4) implementing and evaluating the solution, (5) redesigning the solution, and (6) interpreting the solution (Savage and Sterry, 1990).

This procedure describes how technologists approach a problem or opportunity. It describes the way the human-made world is created through discovery, invention, innovation, and development. However, it is only part of a study of technology. The other part becomes clear when the second program focus is describe which will result in developing a system to identify and categorize the accumulate knowledge of technology.

This system must meet the rules for all category systems (Ray and Streichler, 1971):

1. Each entry must be mutually exclusive of other entries.
2. The entries must be totally inclusive of the phenomena being categorized.
3. The system must be functional.

Establishing a way to structure the knowledge of technology causing the profession considerable trauma and is dividing the profession the most. A number of systems have been developed to meet this challenge. Two that seem to have the most promise are the Jackson's Mill (Hales and Snyder, n.d.) human productive activities of communication, construction, manufacturing, and transportation and the Dutch pillars of technology (Wolters, 1989) which allow for studying energy, information and matter (material) processing.

Whichever model the field chooses, one of those listed above or some other, we must resist the product consumption mentality presently being used by some change agents. We need not discard our curriculum structures and philosophical foundations with the frequency we do automobiles and clothing. Chasing fads and personal promotion will do little to develop a credible profession or defensible programs. We urgently need to reach a curriculum compromise in the spirit of Jackson's Mill. Only then can states or local districts address their need for curriculum change with confidence they are not buying into a fad or an incompletely developed curriculum structure.

The third focus of a complete technology education program has received the least attention and may well be the most important. It requires identifying the relationship and interaction among technology, people, society, the environment and other disciplines. Technology is not a natural phenomena. It is the product of human volition.

People saw its development, production, and use as necessary or economically profitable. However, reaching this human vision has positive and negative impacts on people, societies, and the environment.

Likewise, technology is not an isolated body of knowledge. It has strong connections with all other areas of knowledge. Science explains the naturals laws that are applied by technology. Mathematics and mathematical models explain the operation of technological systems. Language and art can be used to describe technology and its impacts. The social studies can describe how technology has, is, and may well impact and be impacted by people and society.

This challenges educators to seek content and course integration. In a recent discussion, an aeronautical engineer (Thompson, 1991) suggested that he didn't see knowledge as discrete subjects like educators do. He said that life's experiences and challenges immediately integrated knowledge. The solutions to the challenges facing society are not the domain of a single discipline.

Clearly defining and describing technological knowledge while seeking its integration with other disciplines will lead the profession, as a whole, to a recognition that (1) technology education is the study of the human-made world, (2) technologists use the technological (problem solving) method to develop new and improved artifacts and systems, (3) technology is used to help people meet their communication, product, and transportation needs and, (4) technology impacts and is impacted by people, society, and the environment.

This four-point philosophy leads us to believe that, like science, there is a generic way to approach a technological problem or opportunity; there are unique practices used to produce, operate, and maintain each device or system; and these actions operated in historical, personal, and societal contexts (see Figure 1). Standing on this solid philosophical ground we can get on with the important task that must be addressed: developing meaningful laboratory-based, action-oriented courses that will introduce students to the exciting field of technology. Only then can we build a case for requiring all students at all grade level to study technology.

Figure 1. A model of the relationship between problem solving, technical actions, and technological contexts.

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Miscellany

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