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From the Editor

Scenarios for the "Technology Standard"

"Technology for all Americans" is no longer the battle cry of a few, but rather the expectation of many—an expectation that every girl and boy formally study about our technological world throughout their schooling years. Even as I write this, innovative administrators and curriculum specialists may be beginning to look for ways to teach technological concepts and activities in every grade from kindergarten through high school. Why might this be so? Because "technology" appears as one of the Content Standards in the new *National Science Education Standards*, published by the National Academy of Sciences this past December.

Some will find reasons to be less optimistic about this new Standard. First, though the *National Science Education Standards* represent consensus, their use isn't legislated. Nevertheless, while no school is *required* to implement these new *Standards*, it is likely that, along with the *Benchmarks for Science Literacy*, the *National Science Education Standards* will serve as a driving force behind curriculum revision and school reform for decades to come.

Second, this "technology" Standard could be overlooked among the list of other *Science Standards.* That doesn't seem likely to me, however. It is one of only seven general Content Standards that comprise the entire list. The others are Inquiry, Physical Science, Life Science, Earth and Space Science, Science in Personal and Social Perspectives, and the History and Nature of Science. So, "technology" may be no more likely to be left out of the future science curriculum than is Physical or Life Science.

Finally, those who currently call themselves "technology educators"—particularly those who dirtied their aprons at lathes and offset presses, then graduated to communication, production, and transportation systems, and now subscribe to the design and technology approach—are prone to think, "Yes, but *they* don't mean technology the way *we* mean technology!" On the contrary. . . despite the fact I did not recognize *a single person* from "our field" among the more than 150 contributors listed in the Appendix, *National Science Education Standards* does a stellar job of articulating technology as we have come to know and teach it. Here, for example, is the "Science and Technology" Content Standard identified for grades 9–12:

> *SCIENCE AND TECHNOLOGY: CONTENT STANDARD E:*
> As a result of activities in grades 9-12, all students should develop
> • Abilities of technological design
> • Understanding about science and technology

Guide to the Content Standard:
Fundamental abilities and concepts that underlie this standard include:

Identify a problem or design an opportunity. Students should be able to identify new problems or needs and to change and improve current technological designs.

Propose designs and choose between alternative solutions. Students should demonstrate thoughtful planning for a piece of technology or technique. Students should be introduced to the roles of models and simulations in these processes.

Implement a proposed solution. A variety of skills can be needed in proposing a solution depending on the type of technology that is involved. The construction of artifacts can require the skills of cutting, shaping, treating, and joining common materials—such as wood, metal, plastics, and textiles. Solutions can also be implemented using computer software.

Evaluate the solution and its consequences. Students should test any solution against the needs and criteria it was designed to meet. At this stage, new criteria not originally considered may be reviewed.

Communicate the problem, process, and solution. Students should present their results to students, teachers, and others in a variety of ways, such as orally, in writing, and in other forms—including models, diagrams, and demonstrations.

Doesn’t this sound remarkably like “technology education” as we have come to know it? Moreover, the Science and Technology Content Standards for grades K-4 and 5-8 use the same “steps” indicated by the italicized statements in the 9-12 Standard above, though the activities recommended are developmentally appropriate for those other grade levels.

So, as technology educators, we may have reason to celebrate. Throughout our careers, we have worked to convince our fellow educators, administrators, friends in the community, and (less frequently) educational policy makers that every boy and girl would benefit from a well articulated K-12 program of technology education. After reading the *National Science Education Standards*, I am more optimistic than ever regarding the likelihood of “technology for all Americans” coming to fruition in my lifetime. Though neither of my middle school-aged daughters will benefit from more technology education than I received three decades ago, it is beginning to look like my *grandchildren* may have the opportunity to learn about our technological world throughout their school years!

Technology teachers reading the Science and Technology Content Standard above for the first time might not see it in the positive light I’ve tried to paint it.

It may look, instead, like *they* (science educators) are subsuming *our* (technology education) role in the schools. That may be so, but I prefer to think of it as a friendly merger rather than a leveraged buyout. If we really care about technology for all Americans, then this new Science and Technology Content Standard might be viewed as a giant leap forward, rather than as a threat to our future.

The fact is, the science education establishment has *no real idea* how they might actually operationalize this Science and Technology Content Standard in their classrooms and curriculum. As I see it, science teachers have neither the time in their curriculum, the facilities, nor the background to address technology in meaningful ways. So it is plausible that they may ultimately rely upon technology teachers to supplement their work *at every grade level*.

Here is how it could shake down: Technology teachers might be employed in the elementary schools the same way that art, music, and physical education teachers are currently utilized. At the middle school level, one part of each year of science might be dedicated to a technology education class. *All* students would enroll in these classes for a 6, 9 or 18 week block—as *some* now do. This strategy, of course, would require more technology teachers than currently employed in the middle school. In high school, technology might just be added to the traditional list of science subjects: biology, chemistry, physics, *and technology*—and/or the middle school model might be modified so that all students enroll in some technology education during each of their high school years.

The new *National Science Education Standards* could result in several substantive changes for technology education as we now know it. First, technology education could become a required subject at each grade level from K-12. This, in turn, would force us to develop new models for preparing technology teachers. Finally, technology teachers might be administered within the science department rather than the vocational education department, thereby placing technology education within the "general education core."

To be sure, there are no guarantees it will work out this neatly for technology education in America. In a darker scenario, science education could ignore our expertise and end up with a watered-down version of technology education (for example, one which involved limited use of tools, materials, and processes). Despite its shortcomings, this diluted approach to technology education might be acceptable to education decision-makers, thereby relegating our more robust approach to lesser distinction/possible extinction.

If this latter scenario seems more plausible than those noted earlier, then it's time to "get political."

MES

Guest Article

A United Vision: Technology for All Americans

Richard E. Satchwell and William E. Dugger, Jr.

Over one hundred years ago, the departmentalization by institutions of higher education validated the movement to make language arts, mathematics, science, foreign language, and history essential components of our schooling. Throughout the twentieth century, these core subjects have endured to become situated at the center of our current educational paradigm.

A century later, in the current context of educational reform, parents, students, and educators are questioning what students should be expected to know and be able to do by the end of their formal instruction. In addition, the call for technological literacy continues to grow stronger each year. Employers, policy makers, and educational leaders are starting to agree that all citizens need to be technologically literate in order to succeed in today's world. What should be essential education for all pupils regardless of their socio-economic background, gender, or heritage? What should be taught? At what step between a technological novice and expert do we want students to exit formal instruction? How will this degree of technological knowledge be achieved at a national level? Are the core subjects of one hundred years ago still appropriate today? These questions and many more led to the development and implementation of the *Technology for All Americans* project.

Technology as a Core Subject

Those concerned with technological literacy have proposed that the best way to achieve technological knowledge and abilities at a national level is through our schools (National Commission on Excellence in Education, 1983; National Research Council, 1996). It is only through an articulated technology program of study that every child will be empowered with the needed technological knowledge and abilities to become confident problem-solvers, who are able to view issues from different perspectives and in relation to a number of different contexts. Proponents of technological education envision more than an area of study that trains students to use computers. They envision an articulated, hands-on, program that enables students to gain the needed knowledge and experience working with a wide spectrum of technological devices and processes. Such programs can help students "begin to think differently about all their school subjects as they put knowledge from several

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Richard E. Satchwell is the Assistant Director and William E. Dugger, Jr. is the Director of the Technology for All Americans Project in Blacksburg, VA.

fields to work in an attempt to solve practical problems" (Raizen, et. al., 1995, p. 53).

Technology as a core subject in our public school curriculum is a relatively new concept. While references to technology as a subject matter for schools can be found in the theme of the first conference of the American Industrial Arts Association in 1947 entitled "A Curriculum to Reflect Technology," only in the past decade has technology education gained national consideration. Because of its newness as a field of study, technology is often misunderstood and technology education is often confused with other areas of study such as educational technology (i.e., the use of hardware and software to facilitate learning). In its simplest terms, technology can best be described by the following set of generally accepted characteristics identified by Johnson, Foster and Satchwell (1989, p. 12):

- Technology is applied human knowledge. It is more than applied science.
- Technology is application based. It is a combination of knowing, thinking, and doing.
- Technology extends human capability. It enables humans to adapt to and change the physical world around them.
- Technology exists in social domains as well as physical domains. There are both "hard" technologies (e.g., tools, equipment, etc.) and "soft" technologies (e.g., management systems, software, Internet, etc.).

Technology draws its domain along the dynamic continuum that starts with human wants and needs and ends in the satisfaction of those wants and needs. It includes such human capability as designing, inventing, innovating, practical-problem solving, producing, communicating, and transporting. Technology influences our society and culture by changing our lives and our environment. Since education is an important component of our culture, the study of technology must be an essential part of our educational core or basic subject requirements in grades K-12 and beyond. As a core subject, technology education strives to help students understand, use, and evaluate the effects of current and emerging technological devices and activities. Technology education can provide a continuum of educational benefits to all students, from awareness to competence.

The Importance of a United Vision for an Emerging Field of Study

The National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) are funding an effort to develop a national rationale and structure for technology education. The effort is spearheaded by the International Technology Education Association (ITEA) and is entitled "Technology for All Americans." The ultimate goal is to offer those who are interested in technology education as an essential core subject a clear vision for what it means to be technologically prepared, how this preparation can be achieved at a national level, and why it is important for our nation.

The Technology for All Americans Project set out to achieve this goal by establishing a National Commission to serve in an advisory capacity to the project staff. The 21-member Commission functions independently of both the project and ITEA. The Commission is composed of persons who are especially aware of the need for a technologically literate society. Members represent the fields of engineering, science, mathematics, the humanities, education, government, professional associations, and industry. They serve as a vital resource of experts who are knowledgeable in technology and its interface with science, mathematics, engineering, and education.

A six member writing team was formed from the National Commission. The writing team represents a wealth of knowledge, extensive background, and a unique diversity that has played an important role in the development of the Project's final product entitled *Technology for All Americans: A Rationale and Structure for the Study of Technology* (TAA:RSST).

Toward a United Vision

Draft document development. The individual strengths and diversity of the writing team came into play from the beginning of its first meeting. This meeting resulted in a number of working papers ranging from a public commentary explaining the importance of technology education and its role as an essential core subject to an intellectual discourse on the meaning and structure of technology as an academic discipline.

The single draft document entitled *A Rationale and Structure for Technology Education* emerged from the visionary thinking of the working papers. The review of this draft document was the focus for the National Commission at its second meeting in Dearborn, Michigan on June 23-25, 1995. Many revisions were offered and incorporated into the TAA:RSST document that represented the best current thinking on the content, methods, and benefits of studying technology.

The Consensus Process. Consensus has been defined in a number of different ways. Most definitions indicate that some form of majority agreement is necessary in order to declare consensus. The draft document went through a dynamic process as a result of a very structured consensus process. It underwent the scrutiny of over 500 reviewers inside and outside the profession of technology education. During the initial review process, which took place during the month of August, 1995, the draft document was mailed to 150 professionals. These professionals were selected via a nomination process. Each state supervisor for technology education and president of state associations for technology education were asked to nominate mathematics, science, and technology educators from elementary through high school levels to participate in a series of consensus building workshops. These workshops were hosted by the following NASA field centers: Ames Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center, Langley Research Center, Lewis Research Center, and Kennedy Space Center.

The draft document was disseminated to the participants prior to the consensus building workshop. They were asked to review the draft document and respond to several prepared questions, as well as provide comments directly on their copy of the draft. At the workshops, participants were divided into heterogeneous groups that represented the interest groups of those involved (i.e., elementary school, middle school, high school, mathematics, science, technology). These small groups were then asked to respond to prepared questions as a group and come to consensus on the content of the draft document.

Generating input and reactions from the field was very valuable during the consensus process. Perspectives were shared that had not been discussed in prior writing team meetings. Ideas for improving the draft document were generated from the group synergism, and regional philosophies or viewpoints were acknowledged.

This input was analyzed to determine the needed changes for its content. Changes were made to reflect the data from the summer workshops. In addition, these changes were "tried out" with groups throughout the fall of 1995 at the state and regional conferences indicated in Table 1. The project staff found that by focusing on "hot buttons" identified from the summer review process, changes made in subsequent versions of the draft document were well received and the hot buttons cooled off.

Table 1.
Consensus Building Workshops Conducted by the Technology for All Americans Project

Workshop Name	Location
The Southeast Technology Education Conference	Atlanta, Georgia
The Learning Institute for Technology Education	Lansing, Michigan
New England Technology Educators Conference	Farmington, Connecticut
Pennsylvania Annual Technology Education Conference	Camp Hill, Pennsylvania
Rocky Mountain-Colorado Technology Education Conference	Denver, Colorado
Mississippi Valley Industrial Teacher Education Conference	Chicago, Illinois
TSC Professional In-Service Conference	Trenton, New Jersey
American Vocational Association	Denver, Colorado
Technology Education Association of Massachusetts	Worcester, Massachusetts

Changes and revisions go hand-in-hand with the consensus process. This process continued throughout the fall until a second version of the draft document was disseminated for review in early November, 1995. This draft of the document was disseminated to over 250 people who were identified as having an interest in technology education as a core subject in our schools. This group contained a large number of administrators. It was felt that an important part of the consensus process includes a "buy-in" component. In other words, if technology education is to become a core subject in our schools, then those who hold the power to enable this vision to become real must be involved in the front end of this process.

Additional efforts were made to expand the audience that reviewed this document by making it available to anyone having access to the Internet. Throughout this project, a World Wide Web home page has been maintained in an effort to disseminate timely material generated by the project. Access to the draft document became part of our home page in December, 1995, and reviewers were invited to fill out a comment and review form on-line and submit it to the project for consideration prior to the final revision.

The final version of the document will represent the broad support and input that was provided throughout this consensus process. Mino (1995, p.4) clearly characterizes the consensus process when he states that, “Consensus building should be a time for discussion and debate among the concerned members of our [technology education] profession. But after all is said and done those who are impeding progress toward the real goal of technological literacy for all students need to lay aside their objections and endorse the most significant effort ever undertaken by our profession.”

Reflections

The consensus building process is not unique to technology education. However, it provided the needed opportunities for the profession to reflect on its past, discuss its status, and guide its future. Each person concerned with technology education and its role as an essential core subject in our future educational paradigm had the opportunity to speak up and be heard. This process provided the needed time to reflect on technology education and many of the workshop participants agreed that it was a worthwhile process.

Many critical issues have surfaced during this process that go beyond the scope of this project. These issues are important and should provide guidance for research projects for many years to come. The following are just of a few of the questions and issues that will need to be addressed:

- How will *Technology for All Americans: A Rationale and Structure for the Study of Technology* be received in the field? The project has spent a great deal of time gaining consensus on the document’s contents so that it is well received. What about the future?

- Does the document provide the needed guidance and direction? Will the document be useful for those making an effort to establish technology education as a core subject?

- Will there be the needed “buy-in” to establish a new core subject? It is too early to predict the impact that this document and the project’s efforts will have. An important question for our future is how well this effort succeeded in positioning technology education as an essential part of every child’s education—time will tell.

- What political processes are needed to ensure that technology education can be positioned as a core subject in the schools of tomorrow? Who will guide this effort? Will it come from the top down, or will this endeavor be guided by those in the field who are beginning to provide a united vision for technology education?

- What technological knowledge and abilities should students exist with? Many paradigms have been offered (Bensen, 1995; Dreyfuss & Dreyfuss, 1986; Dyrenfurth, 1991; Savage & Sterry, 1990; Snyder & Hales, 1981); however, this question has not been put to rest. It will be addressed in the second phase of this project, which seeks to establish standards for technology education.

The Technology Education Standards

Another important issue considered central to this project relates to educational standards. The second phase of this project, when funded, will attempt to establish standards for what every child should know and be able to do related to technology. This issue is considered paramount in the process of establishing technology education as a core subject in our schools.

These technology education standards will also provide criteria for assessing curriculum content in technology education, teaching, and evaluation, which can then provide opportunities for all students to learn technology in ways that are more consistent and coordinated across all levels of the education system.

The use of standards to improve the quality of technology education will have a positive impact on the student, school, community, and nation. The students should be the first to benefit through enhancement of technological content, instructional program, teaching methods, the physical environment of technology education laboratories, and the preparation and quality of teachers providing instruction for the field. Teachers will be able to assess their curriculum programs against a set of nationally developed and validated standards. After the assessment is made, curriculum and program strengths should be enhanced.

The school system should also benefit from having technology education standards. The technology education standards should mandate that effective, open communication be established with all elements in the school system, especially those in technology, science, and mathematics, and be used consistently by technology education faculty and staff. An additional benefit that the technology education standards will provide is that non-technology educators, students, and parents will be informed about the technology education programs, thereby generating opportunities for support, guidance, and interdisciplinary educational activities.

Summary

In the fall of 1995, during the first phase of the Technology for All Americans Project, a draft document entitled *Technology for All Americans: A Rationale and Structure for the Study of Technology* emerged from much debate and review by the writing team, project staff, and hundreds of people who are concerned about technology education and its role in our nation's schools. The project staff conducted several consensus building activities at national, regional, and state technology education meetings throughout the United States in an attempt to provide an avenue for individuals to review and comment on this important document.

The results of this consensus process have been positive; however, the results have also been challenging. This challenge has provided the much needed opportunity for reflection about our profession, as well as an opportunity to direct our destiny.

Today, there are very diverse offerings in the technology education profession ranging from basic programs reflective of the early manual arts to state-of-the-art technology education programs that reflect technology-based curriculum activities. It is hoped that this project will provide a means for improving the quantity and quality of technology education programs. Technology education has a bright future as an essential core subject in our schools.

As is true with the end of other millennia, the end of this millennium promises to close having sparked many changes in our society. One of those changes felt certain to evolve is that the core subjects in our schools will be amended. The core subjects of one hundred years ago are no longer enough to adequately produce technologically prepared citizens in our changing world of today.

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Articles

Selected Leaders' Perceptions of Approaches to Technology Education

Patrick N. Foster and Michael D. Wright

The arena in which the history of technology education has been played out may be considered a marketplace of ideas. As far back as can be reasonably traced, several versions of formal industrial and technological education have existed simultaneously, often in competition with each other. There has never been complete consensus about which direction the field should take—and there probably never will be. At times, however, a proliferation of competing models has preceded major change in the field.

Is the present one of those times? The Jackson's Mill curriculum, released in 1981, was heralded as a demonstration of consensus in the field (see Householder, 1989), yet the debate regarding the direction of the field continued, only quieting after the American Industrial Arts Association changed its name in 1985 to the International Technology Education Association.[1]

But since then it has become clear that while a reasonable degree of consensus has been reached regarding the *name* of the field—"technology education"—a lack of uniformity has been ascribed to ostensibly more substantial characteristics of the field (Wright, 1992; cf. Petrina, 1993). In response, various approaches to technology education have been advanced. Bensen and Bensen (1993) suggested taking a new approach to the field, while Lewis (1994) implored technology educators to be true to the original objectives of the field (cf. Zuga, 1994; Petrina, 1995).

As demonstrated in the following review of the literature, if professionals desire to redirect the field in response to its problems and opportunities, they clearly have a wide variety of models of technology education from which to choose. In this study, selected leaders in technology education were asked to provide their opinions of the efficacy of these models.

Pertinent Literature

For as long as (industrial) technology education has been a part of American education, multiple approaches to the profession have been advanced and advocated. Technology educators may be well aware of current approaches to

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Patrick N. Foster is an Instructor and Michael D. Wright is an Assistant Professor in the Technology and Industry Education Program, University of Missouri, Columbia, MO.

[1]Of course the debate was not entirely ended; see Feirer (1985), Nee (1993), Hutton (1992).

the field, but few are conversant with its history (Petrina & Volk, 1995). Pertinent literature was reviewed as an investigation of the history of competing conceptions of the field.

Before the 20th Century

At least three distinct conceptions of industrial education are often presented simultaneously as the early history of the field. These include “object teaching,” a teaching method advocated by, for example, Pestalozzi and Sheldon (see Mossman, 1924, p. 3); “cultural industrial education” such as that represented by Comenius, Basedow, and later, Bonser and Mossman (Anderson 1926, p. 223-224); and programs of tool instruction or “manual training” for children and young adults operated by educators such as Woodward and Sheldon (see Barella & Wright, 1981; Snyder, 1992). These competing models and others would eventually interact to produce movements familiar today.

The First Quarter of the 20th Century

In 1907, Bennett contrasted a growing “industrial education” movement in the schools, which was “cultural by virtue of being highly vocational,” with manual arts, which he defined as “work that is cultural first and then vocational” (p. 190). He recommended that the manual arts profession make specific and deliberate adjustments to meet more vocational demands (p. 193-195). A decade later President Woodrow Wilson signed the Smith-Hughes Act, which initially provided $1.86 million in funding for vocational programs in public schools. As Snyder (1992) noted:

> There were now two similar, yet distinctly different, forms of industrial education provided for by the American public educational system. Traditional general education programs, whether they were called manual training or industrial arts, were now in company with the new vocational education program (p. 90).

Meanwhile Teachers College, Columbia University faculty members Bonser, Mossman, and Russell were formulating the industrial arts movement in reaction to the lack of social and cultural context of manual training (Bonser & Mossman 1923; see p. 479). Whereas today the general-education conception of technology education can claim its theoretical basis directly from the cultural-industrial conception as interpreted by Bonser and Mossman (Foster, 1994), the actual *practice* of the field may in fact be more closely associated, at least historically, with the distinct movement of manual training (Lindbeck, 1972).[2]

From the 1960s to the 1980s

Cochran’s (1968) dissertation and subsequent book (Cochran, 1970) provided detailed accounts of twenty competing approaches to industrial arts, primarily from the 1960s. What is of special interest is the means employed by

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[2] See Petrina and Volk (1995; and in press) for a more complete (re)consideration of the time period following the work of Bonser and Mossman.

Cochran to divide the approaches evenly into four groups of programs—integrative, occupational-family, interpretation-of-industry, and technology-oriented—based on Swanson's (1965) four "visualizations" of industrial arts. Both Swanson and Cochran viewed varying conceptions of the field from the point of view of "a body of knowledge from which to draw…content" (Swanson, 1965, p. 59), whereas in this study, conceptions which viewed technology education as a process or methodology were considered along with content-oriented conceptions of the field.

In 1973 AIAA president DeVore suggested that the name of the association be changed to the "American Technology Education Association" (p. 484); soon he and Lauda were suggesting that the name of the profession be changed "to technology education to reflect cultural reality" (DeVore & Lauda, 1976, 145). By the turn of the decade, *technology*—instead of the traditional *industry*—was often being considered the content base for industrial arts in the US. This was evident in the influential *Jackson's Mill* curriculum (Snyder & Hales, n.d.), which refined earlier works by Warner (1947), Olson (1957), and others, and subdivided industrial arts into communication, construction, manufacturing, and transportation. The name of the American Industrial Arts Association was changed to the *International Technology Education Association* in 1985 (Streichler, 1985).

It should be noted that most of those who urged the profession to carefully consider the name change were not simply opposed to change. In fact, they were generally in favor of progress in the field. Other suggestions for advancing the field included teaching the industrial sciences (Lange & Hayes, 1981), industrial technology (e.g. Wright, 1985), aligning more closely with vocational education (Good & Good, 1981), and many others.

The Present

The recent technology education literature is replete with new approaches to technology education, a number of which have appeared repeatedly. Some are more commonly associated with certain levels of schooling (i.e. elementary, middle, high-school) than others.

Several of the approaches have an integrative theme, often involving science content or instruction. These include math/science/technology integration (e.g. LaPorte & Sanders, 1993), the science, technology, and society view (e.g. Roy, 1990), and the practical science approach (White, 1983). The engineering systems approach (e.g. Bensen and Bensen, 1993) is also a variation of this.

Many writers advocate viewing technology education from an organizational standpoint. A career-awareness focus has been suggested as part of an elementary program (e.g. Technology Student Association, 1994); the modular approach (e.g. Neden, 1990) is often advocated for middle or junior-high schools, and a "tech-prep" program as a part of—or the basis for—a high-school program (Conroy, 1995). Technology education has also been viewed as constructive methodology for teaching important content from other school subjects (Kirkwood, 1992a, 1992b), or as a student-centered means for increasing self-awareness and self-worth (Maley, 1973; Petrina & Volk, 1991).

Finally, others see new roles for technology education in schools. Examples of this include the process-driven design and technology (Todd & Hutchinson, 1991) or problem-solving (Sittig, 1992) view, and the quickly growing field of educational technology (Hornsby, 1993).

Purpose of the Study

Although the alternatives for technology education today may differ from those advanced in the early 1980s, it is clear that the profession has many directions from which to choose. The purpose of this study was to identify the opinions of leaders in technology education in the United States regarding future directions for the field at the elementary, middle, and high-school levels.

Specifically, the study was designed to address three research questions:

1. Which approaches are perceived by the selected leaders of technology education as most appropriate for elementary-, middle-, and high-school technology education?
2. Are the opinions of the different groups of leaders regarding appropriate approaches for technology education similar or different?
3. Do leaders feel that the same approach(es) to technology education are applicable at all three levels of schooling?

Methodology

Perceptions of Members of the Profession

In the field of technology education, a common method of determining the perceptions of individuals has been the use of a survey instrument. For example, Bensen (1984) randomly sampled AIAA members, asking their opinion regarding the name of the profession. That survey generated data which allowed comparisons between different groups of industrial-arts professionals. Shortly after the Bensen study, Dugger coordinated a series of annual “surveys of the profession” (e.g. Dugger, French, Peckham, & Starkweather, 1991). The surveys were designed to collect various data, most prominent among them high-school course offerings. They have often been used in the literature to show a lack of change in the field over time (e.g. Komacek, 1992).

Population

An effort was made to include a broad array of leaders in the profession, including classroom teachers, supervisors, teacher educators, pre-service teachers, and members of the boards of directors of professional associations.

Leaders among those in the latter category were the eight members of the American Vocational Association’s Technology Education Division (AVA-TED) board and the twelve members of the Board of Directors of the International Technology Education Association (ITEA). Leaders among pre-service teachers were the six student officers of the Technology Education Collegiate Association (TECA).

The forty-six recipients of the 1994 ITEA Teacher Excellence Award were the leaders among classroom teachers; department chairs, or the person responsible for the technology education program, of the twenty-nine technology education programs accredited by the National Council for Accreditation of Teacher Education (NCATE) were selected as leaders among college professors. Finally, leaders among technology education supervisors were the fifty-five state and territorial supervisors for technology education and/or industrial arts.

Thus the raw total population for the study was 156. In two cases, an individual's name appeared on two different lists of leaders. Their names were removed from the larger of the two lists on which they appeared. This brought the population to 154. Furthermore, five state supervisors for technology education whose surveys were returned by the US Postal Service as undeliverable were removed from consideration for this study. Thus the total population was 149.

While many leaders in the field may not be members of the groups selected for this study, and despite the population limitations of any such study in technology education (see Volk, 1995), this methodology provided a mechanism to select leaders recognizable as such to their peers.

Instrument

A careful review of the literature resulted in a list of approaches to technology education to be included on the instrument. The instrument was reviewed by six leading researchers in technology education from six different states and was refined on the basis of their recommendations.

The final survey instrument contained a list of twelve approaches to technology education which have appeared recently in professional literature. Each was assigned a letter from A to L. The instrument also included blank lines for write-in responses. The approaches included on the instrument are listed in Table 1. Every item on the list was further described with a parenthetical statement. For example, the item "constructive methodology" was described as "hands-on activities for teaching school subjects."

Respondents were asked to rank the three approaches they felt were the most appropriate at the elementary, middle, and secondary school levels. Thus each instrument contained fields for nine responses: one each for the respondent's first, second, and third choices at each of three levels of schooling. This was to be done by writing the letter corresponding to the respondents' choice in each of the fields.

Data Collection

The data were collected in the first quarter of 1995. One hundred fifty-four surveys were prepared. Each potential respondent was assigned a distinctive identification number which distinguished them as an individual and as a member of one of the six population groups (TECA officers, AVA-TED board members, ITEA board members, teacher excellence award winners, state supervisors, and chairs of NCATE-approved technology education programs). The surveys were coded using the same scheme.

Table 1
Items Included on Survey

A.	applied or practical science approach (e.g. principles of technology; unified science & technology)
B.	career emphasis (career awareness/exploration; career clustering)
C.	constructive methodology (hands-on activities for teaching school subjects)
D.	computer emphasis (educational technology)
E.	design/problem-solving approach (e.g. TIES magazine; modified U.K. model)
F.	engineering systems approach (engineering as basis for technology education; e.g. Bensen & Bensen approach)
G.	extra- or non-curricular activities (e.g. TechnoKids, TSA; in-school, non-curricular projects)
H.	math/science/technology integration
I.	modular approach (self-contained learning stations)
J.	socio-cultural approach (liberal-arts focus; STS)
K.	student-centered approach (Maley, Dewey)
L.	tech prep (school-to-work; articulated 2+2 program; parallel track to college-prep)
--	(fill-in)

Each potential respondent was mailed a personalized letter, the appropriately numbered survey, and a postage-prepaid envelope. The letter informed the addressee of the intent of the research and thanked him or her for participating.

Individuals who did not respond within a specified time frame were mailed or faxed follow-up letters. In all, 131 individuals (87.9%) returned usable instruments. Group response rates were as follows: state supervisors, 83.7%; teacher educators, 89.2%; teachers, 84.8%; ITEA board members, AVA-TED board members, and TECA officers, 100% each.

Data Analysis

Since respondents were asked to rank their choices, responses were weighted in the following manner: one point for each third-choice response, two points for each second-choice response, and three points for each first-place response. These points were summed to determine each item's *weighted score* assigned by each group at each grade level.

To address the first research question, ranks were computed for the items based on these weighted scores. At each level of schooling, a separate ranking was calculated for each group of leaders; in addition, a ranking based on the responses of all groups was calculated for each level of schooling.

To address the other two research questions, which related to agreement among groups and among grade levels, the Kendall concordance (W) statistic was employed.

Results

Research Question 1: Which approaches are perceived by the selected leaders of technology education as most appropriate for elementary-, middle-, and high-school technology education?

Based on all responses, the total weighted score of each item was calculated for each of the three levels of schooling (elementary, middle and high school). Table 2 lists the top five choices of the aggregate sample at each level of schooling. Item names in this table have been abbreviated from those in Table 1.

Table 2
Leaders' Perceptions of the Most Appropriate Approaches to Technology Education: Top-ranked Choices of all Respondents [n=131 (87.9%)] by Level of Schooling

Rank	Elementary	Middle School	High School
1	Constructive methodology (221)[a]	Modular (158)	Math/science/technology integration (129)
2	Design/problem-solving (99)	Design/problem-solving (137)	Design/problem-solving (127)
3	Career emphasis (80)	Career emphasis (88)	Tech prep (123)
4	Math/science/technology integration (72)	Math/science/technology integration (83)	Engineering systems (92)
5	Student-centered (71)	Constructive methodology (80)	Applied/practical science (91)

[a]The number is the item's weighted score at the respective level of schooling.

The table suggests strong agreement regarding the most appropriate approaches to elementary-school technology education; *constructive methodology* was the top choice of more than twice as many respondents as any other approach. At the middle-school level, the *modular approach* to technology education was the highest-ranked of the aggregate, although *design/problem-solving* received strong support as well. At the high-school level there was, in essence, a virtual tie among three approaches.

Additionally, two items were highly ranked at all three levels of schooling. *Design/problem-solving* was ranked second at each level by the aggregate; *math/science/technology integration* was ranked among the top five at each level. Finally, four of the top five items at the elementary-school level were also among the top five choices at the middle-school level.

It should be noted that the aggregate listings in Table 2 consider each respondent equally, and thus differ from "true rankings" Kendall (1947, p. 410) in Tables 3, 4 and 5 which are based on group data, not individual responses.

Table 3
Leaders' Perceptions of the Most Appropriate Approaches to Technology Education at the Elementary School Level by Group

Item	ITEA Board *n=12*	TED Board *n=8*	Dept Chairs *n=25*	State Sup's *n=41*	Tchr Awrds *n=39*	TECA Offcrs *n=6*	*M*
Constructive methodology (C)	1	1	1	1	1	1	1.00
Design/problem-solving (E)	2	3.5	3	4	2	4	3.08
Career emphasis (B)	4	3.5	5	2	6	4	4.08
Extra/non-curricular activs. (G)	3	2	6	5	5	6	4.50
M/S/T Integration (H)	5	8	4	3	7	2	4.83
Computer Emphasis (D)	9	6	7	6	3	4	5.83
Student-centered (K)	7	5	2	7	4	11	6.00
Socio-cultural (J)	6	8	8.5	10	9.5	7.5	8.25
Applied/practical science (A)	8	11.5	8.5	8	9.5	7.5	8.83
Modular (I)	11.5	11.5	10	9	8	11	10.17
Tech prep (L)	11.5	8	12	13	13	11	11.42[b]
(other)	11.5	11.5	12	11	11.5	11	11.42[b]
Engineering systems (F)	11.5	11.5	12	12	11.5	11	11.58

Sum of Squares: 5332.5; Kendall's W: 0.8139; Adjusted W: 0.8357 (p<.01)
[b]Indicates tie

Table 4
Leaders' Perceptions of the Most Appropriate Approaches to Technology Education at the Middle School Level by Group

Item	ITEA Board *n=12*	TED Board *n=8*	Dept Chairs *n=25*	State Sup's *n=41*	Tchr Awrds *n=39*	TECA Offcrs *n=6*	*M*
Modular (I)	5	2	2	1	1	1	2.0
Design/problem-solving (E)	3	5	1	2	2	2.5	2.6
Career emphasis (B)	2	4	4	3	5	10.5	4.8[b]
M/S/T integration (H)	4	7.5	3	4	4	6	4.8[b]
Constructive methodology (C)	6.5	3	6	5	3	5	4.8[b]
Student-centered (K)	1	1	5	6.5	8	10.5	5.3
Engineering systems (F)	8.5	11.5	8	10	9.5	2.5	8.3
Applied/practical science (A)	10	9	7	8	7	10.5	8.6
Computer emphasis (D)	11.5	11.5	10	9	6	4	8.7
Extra/non-curricular activis. (G)	13	7.5	12	6.5	9.5	10.5	9.8
Socio-cultural (J)	6.5	11.5	10	13	12.5	7	10.1
(other)	8.5	11.5	10	11	11	10.5	10.4
Tech prep (L)	11.5	6	13	12	12.5	10.5	10.9

Sum of Squares: 4107; Kendall's W: 0.6268; Adjusted W: 0.6391 (p<.01)
[b]Indicates tie

Research Question 2: Are the opinions of the different groups of leaders regarding appropriate approaches for technology education similar or different?

A ranking of the items on the instrument (including an item for "other choice") was identified for each of the groups surveyed. Research Question 2 concerned whether these six rankings were in agreement. Kendall's concordance (W) statistic (see Hays, 1976) is specifically intended for this purpose. It is a measure of "general agreement" among more than two rankings (Kendall, 1947, p. 410), and as such was the appropriate means for addressing this research question.[3]

Tables 3, 4, and 5 present the results of the calculations for each level of schooling. Again, item names have been abbreviated.

Table 5
Leaders' Perceptions of the Most Appropriate Approaches to Technology Education at the High-school Level by Group

Item	ITEA Board *n=12*	TED Board *n=8*	Dept Chairs *n=25*	State Sup's *n=41*	Tchr Awrds *n=39*	TECA Offcrs *n=6*	*M*
M/S/T integration (H)	1	2	2	2.5	2	3	2.1
Design/problem-solving (E)	4	7.5	1	4	1	1	3.1
Tech Prep (L)	7	1	4.5	1	4	2	3.3
Applied/practical science (A)	3	3.5	3	5	3	12.5	5.0
Engineering systems (F)	2	10	4.5	2.5	5	10.5	5.8
Constructive methodology (C)	6	5	6.5	6	6	12.5	7.0
Socio-cultural (J)	5	3.5	10	12	13	5	8.1
Modular (I)	11.5	10	8.5	8.5	7	4	8.3
Career emphasis (B)	8	7.5	11	10	8	7.5	8.7
(other)	9	12.5	8.5	7	10	7.5	9.1
Student-centered (K)	11.5	6	6.5	11	12	10.5	9.6
Computer emphasis (D)	11.5	10	12.5	13	9	7.5	10.6[b]
Extra/non-curricular (G)	11.5	12.5	12.5	8.5	11	7.5	10.6[b]

Sum of Squares: 3648; Kendall's W: 0.5569; Adjusted W: 0.5659 ($p<.01$)
[b]Indicates tie.

The six groups were found to be significantly in agreement at all three levels of schooling ($p<.01$ in all cases).[4] Kendall's original test for significance (Kendall, 1948) was employed over the more common chi-square equivalent (Hays, 1976) because of the number of rankings.

The concordance figures indicate that the six groups in the study were considerably more in agreement regarding the appropriateness of approaches at

[3]All Kendall's W figures have been adjusted for ties per Kendall (1948).
[4]Due to the number of items being ranked, the degrees-of-freedom figures used in the test for significance were relatively large. Therefore, for example, although less than 57% of the possible agreement existed at the high-school level, the concordance figure was easily significant at the .01 confidence level. It should be noted that the test for significance of W is a test of the (null) hypothesis that the rankings do not represent a significant departure from randomness.

the elementary level (W_{adj} = .836) than at the middle-school level (W_{adj} = .639); they were in less agreement about the high-school level (W_{adj} = .566) than the middle-school level. Symbolically, this may be expressed as $W_{elementary} > W_{middle} > W_{high-school}$; in general, the groups of leaders in technology education surveyed tended to agree about which directions would be most appropriate for the field at each level of schooling.

Research Question 3. Do leaders feel that the same approach(es) to technology education are applicable at all three levels of schooling?

The benefit of testing for the significance of Kendall's W calculated for agreement among groups of leaders (Research Question 2, above) is that significant concordance among a set of rankings implies that a "true ranking" of items exists. Significance was found for intergroup concordance at the elementary, middle, and high school levels, so the orders in which the items appear on Tables 3, 4, and 5 may be considered "true." According to Kendall (1947, 1948), a "true ranking" is the order assigned to a series of objects judged by three or more concurring judges.

Research question 3 concerned the concordance of these three rankings. Kendall's W was used again, in this instance to identify agreement among the true rankings at the various levels. The result (W_{adj} = .122) was found not to be significant ($p>.05$), suggesting that no true ranking of items on the instrument exists when level of schooling is not taken into account. Three pairwise post-hoc Spearman's rho (r_s) tests were performed to determine whether significant correlations could be found between any of the pairs of grade levels. Again the results were not significant ($p>.05$). Table 6 summarizes the statistics calculated for this research question.

Table 6
Agreement Among Rankings at Various Levels of Schooling

test	*levels compared*	*result*	*significant?*
Concordance of true rankings	elementary, middle, and high school	W_{adj} = .1221	no ($p>.05$)
Correlation of true rankings	elementary and middle school	r_s = .4876	no ($p>.05$)
Correlation of true rankings	middle and high school	r_s = .2569	no ($p>.05$)
Correlation of true rankings	elementary and high school	r_s = -.0330	no ($p>.05$)

There was a perceptible, albeit statistically insignificant, correlation between favored approaches to elementary- and middle-school technology education, and a weak correlation between approaches at the middle- and high-school levels. It is clear from the comparisons of opinions at the elementary- and high-school levels, as well as from the simultaneous comparison of all three levels of schooling, that the groups felt that technology education should be approached quite differently at the elementary level than in secondary technology courses.

Discussion

The review heretofore of the results of the study has begged a serious question: what do the items on the instrument mean? Did they mean the same things to all respondents and to all groups? The overwhelming support for *constructive methodology* at the elementary level suggests some degree of shared meaning within and across groups, yet a variety of interpretations might still be possible. On the other hand, the groups were clear in recommending an emphasis on design at all levels, and a career awareness emphasis in elementary and middle school.

Two major points may be made about the results of this study, neither of which are hampered by possibilities of multiple interpretations of specific instrument items.

It is clear from the results of the study that there is significant agreement about approaches to technology education among widely varied groups of leaders in the field. This agreement is very strong at the elementary level, less so at the middle-school level, and even less so at the high-school level. This may confirm the sense some professionals have that the field's high-school program has yet to be solidified (e.g., Savage & Bosworth, n.d.). Although the ITEA and AVA-TED have historically represented significantly different philosophies (Bell, 1964), there was surprising agreement between the boards governing the two. Both felt that the *student-centered* approach was the most appropriate at the middle-school level, for example—although this approach received very little support from any other group. The boards—both of which were comprised of individuals represented by three of the other groups (teachers, supervisors, and teacher educators)—also supported a *career emphasis* at the elementary and middle-school.

Second, the six groups of leaders indicated that an approach to technology education appropriate at one level of public education may not be as appropriate at another. Respondents overwhelmingly chose to view technology education as a *method* at the elementary level; at the middle school level, they regarded it from an *organizational* standpoint. There was less agreement at the high school level, where the top choice related to the *content* of technology education and its integrative nature. Despite this variety, at all levels the leaders placed the *process* of design second among all priorities at every level of schooling.

The implications for K-12 curriculum and program development, including the impending national technology education standards, may be that technology education cannot be explicated by a single model which is simpler at lower grade levels and more complex in later schooling. Perhaps the form which such a curriculum would take should vary. At the high-school, for example, a list of what students should know might be sensible if technology education at that level has a content focus. But elementary-school technology education, the results of the survey suggest, is not simply a watering-down of secondary curricula.

Final Thoughts

For technology education, "it is clear that the good old days no longer exist" (Johnson, 1993, p. 45). It seems unlikely that the profession can survive in the current educational climate without redefining its role in the public schools. If this is to be done, the field has a variety of approaches to and models of technology education among which to choose.

This study has raised and addressed a number of questions about appropriate models for technology education at different levels of schooling. The purpose in raising such questions is not to accentuate division in the field—in fact a substantial degree of consensus was found. On the other hand, the purpose is not to employ this consensus to understate the seriousness of the immediate problems the profession faces. Rather, the purpose in raising these questions is to identify agreement and diversity in the field. Such inquiry should be an ongoing process and should help to ensure that leaders in the profession have appropriate information upon which to base decisions about the future of the profession.

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A Different Storytelling of Technology Education Curriculum Re-Visions: A Storytelling of Difference

Patricia O'Riley

> Narrative theory has challenged literary critics to recognize not only the various strategies used to configure particular texts within the literary canon, but to realize how forms of discourse in the natural and human sciences are themselves ordered as narratives. In effect narrative theory invites us to think of all discourses as taking the form of a story.
>
> (Knoespel, 1991)

> Any narrative that predetermines all responses or prohibits any counter narratives puts an end to narrative itself by suppressing all possible alternative actions and responses, by making itself its own end and the end of all narratives.
>
> (Carroll, 1982)

Taking up Knoespel's invitation "to think of all discourses as taking the form of a story," this paper is an attempt to open technology education curriculum re-visioning to different angles of vision by thinking about it as a form of storytelling. Over the past two decades there have been efforts "to understand curriculum work as a storytelling practice" (Gough, in press), and as a "collective story we tell our children about our past, our present, and our future" (Grumet, 1981, p. 115). Gough (1993) adds that curriculum narratives are not only collective but "selective" stories, and in the case of technology education the selection of technology stories have been articulated from a particular, relatively small, cultural community—industrial education/arts. In light of global restructuring with its different allegiances and arrangements of information, capital, time and space, bodies and geographies, and poststructuralism's skepticism of narrative authority, I would like to place into question both the adequacy of the selection of technology narratives to represent the study of technology in our current technologized/technocratized society, and the relevancy of these stories to meet the needs and interests of the diversity of students entering today's technology education classrooms.

Although curricular changes from industrial education/arts to technology education have been viewed as constituting a paradigm shift (Clarke, 1989; Todd & Hutchinson, 1991), from my positioning as one of few women in this programme area and writing within feminist and poststructural leanings, the

Patricia O'Riley is a doctoral candidate in Educational Policy & Leadership at The Ohio State University . She is completing her research in Vancouver, BC, Canada.

possibilities for a generative re-visioning of technology education that creates space for difference appear to have been missed, as have the opportunities for living up to the justificatory rhetoric of creating curricula for all students. While the technological processes within the selected "domains" of knowledge in the re-visions are more diverse and more high-tech, many of the values, assumptions and beliefs underpinning industrial education/arts curriculum, which historically excluded many students, remain unproblematized and unchallenged. Moreover, the International Technology Education Association's current high-profile project, *Technology for All Americans*, to create *standards* for technology education seems to be a movement towards tightening rather than opening technology education discourses to difference, and to different ways of understanding and experiencing technology. The desire to configure standards resonates with what Harding (1986) refers to as "the longing for the 'one true story' that has been the psychic motor for Western science" (p. 193). Haraway (1991) writes that questing for universals, is nothing less than reductionism "when one language . . . must be enforced as the standard for all translations and conversions" (p. 187).

Gough (1995) maintains that realist curriculum stories "largely ignore the ways in which agency is *produced* by and within the complex circuits and relays that connect—and contingently reinforce—knowledges and subjectivities in the technocultural milieu of postmodern societies" (p. 5). Rather than shutting down conversation in technology education through the imposition of standards, taking a cue from efforts in environmental education (Gough, in press), I would like to consider the possibility of reconceptualizing technology education discourses as a postmodernist textual practice. Re-visioning from a position that there is no nondiscursive reality, that there is no outside of text, is a move to make visible the invisible—the historicity, materiality, and agency of the textual practices within our technology storytelling. What is viewed as fact and reality to one storyteller may be fiction and fantasy to another storyteller. From different perspectives, each story may have validity.

Haraway (1989) suggests that "[m]ixing, juxtaposing, and reversing reading conventions appropriate to each genre can yield fruitful ways of understanding the production of origin narratives in a society that privileges science and technology in its constructions of what may count as nature and for regulating traffic between what it divides as nature and culture" (p. 370). So, from my own partial perspectives, my voice "always to be present, marking off the edges of the text, revealing or at least characterizing, its mode of being" (Foucault, 1984, p. 107), I begin with a re-telling of two curriculum narratives: one Canadian, *Technology Education: Primary through Graduation Curriculum/Assessment Framework* (British Columbia Ministry of Education [BC], 1992), and one American, *A Conceptual Framework for Technology Education* (International Technology Education Association [ITEA], 1990). Next, from the infinite number of technology stories that I could chose from, I introduce merely a glimpse of the richness, contradictions, and complexities of feminist and postcolonial technology stories that appear to be overlooked in technology education curriculum re-visioning. My re-telling is neither to erase, co-opt, and integrate with the curriculum writers' knowledge claims, nor to unveil the Truths or falsities of their stories; it is an effort towards understanding how things have come to be the way they are. And, it is neither to provide alternative stories, nor to prescribe curriculum content. However, this storytelling may be helpful to those who seek other stories to enhance their pedagogy. From a place of awkwardness and odd angles within the terrain of technology education discourses, this is an attempt to blur and reshape the borders of technology education narratives, and to open them to different ways of knowing, being, and becoming in the world. It is a movement towards un-standardizing curriculum narratives and towards re-visioning technology education as a space of possibilities for "becoming something else than what our history has constructed us to be" (Lather, 1993, p. 687).

Representing the One True Story: A Universal Story

Over a decade ago, industrial educators decided to revise and update their curriculum stories and rename them technology education. In some places technology education has been constructed as a separate subject for study and in others it is seen as an emphasis to be included in all subject areas—technology-across-the-curriculum (e.g. Saskatchewan Education, 1988). In the United Kingdom and Wales, technology education has incorporated several existing subject areas (craft, design and technology; home economics; art education; business education; and information technology) into one programme area (Department of Education and Science, 1990). North American technology education re-visioning exists mainly as a new version of industrial arts/education. For at least a century, industrial education in one form or another has primarily taught boys the knowledge and hands-on skills of woodworking, metalworking, automobile repair, electricity/electronics, and drafting/graphic arts.

In the United States, a conceptual framework for industrial education, the *Jackson's Mill Industrial Arts Curriculum Theory*, was developed in which the authors identified "four universal technical systems . . . communication, construction, manufacturing, and transportation—technical systems that are basic to every society" (Snyder & Hales, 1981, p. 16). Nine years later, the International Technology Education Association updated the Jackson's Mill model, and also identified four universal content reservoirs (ITEA, 1990, p. 17): bio-related; communications; production; and, transportation. Similarly, in British Columbia, four content organizers have been languaged to represent the study of technology: information technology; materials and products technology; power and energy technology; and, systems integration technology (BC, 1992). In a recent re-writing (BC, 1994), the BC writers have re-named their four prescribed curriculum organizers: communication technology; production; control; and, energy and power. Self and society is added as a new framing.

Considering the gender, cultural and socio-economic diversity of students in technology education classrooms, these traditional content organizers need to be opened to different epistemological and ontological positionings so that technology education narratives might become more appropriate, relevant, and equitable to a broader range of students. For example, they might become cultural stories—technologies of aboriginal peoples, technologies of less advantaged countries, technologies of popular culture. They might become stories of technologies of control and normalization, technologies of justice and ethics, technologies of peace and liberation, technology as (hyper)textual practice and virtual reality. We might even invite students to deconstruct technology education discourses and to reshape them to make meaning in their own lives, and in the world.

In addition to limiting technology education to four purportedly universal systems of technology, the BC and ITEA curriculum authors propose that curricular content is to be delivered through a universal problem solving process called *the technological methods model* (ITEA, 1990), and *technological methods* (BC, 1992). The goal of the problem solving activities is to "[create] technology for human purposes . . . using appropriate technological knowledge, resources, and processes to satisfy human wants and needs" (ITEA, 1990, p. 20), and to make "high-quality articles, systems, and environments" (BC, 1992, p. 13). Although not excluding non-technological solutions, problem solving is effectively promoted as the one way to teach technology education, and within the framework of problem solving, only one approach is identified—the technological method. The BC document offers variations on the technological method.

Such an approach to problem solving envisions the world as a series of problems that lend themselves to technical solutions. This perspective mirrors methods that have been practiced in male-dominated areas such as science, the military, engineering, and industry for decades (Hacker, 1989). There is little or no discussion about technology's potential to create problems. Petrina (1993) contends that the perception of the technological method in technology education is flawed and "should be viewed as it is: a heuristic whose efficacy is limited to systems thinking. Methodological claims to the 'technological method' are bereft of any epistemological grounding within the history, philosophy, or sociology of technology" (p. 72). For Robins & Webster (1989), within such a "process-oriented model for the curriculum. . . . the concept of knowledge that is mobilized is instrumental in the extreme and is concerned with control" (p. 226) privileging analytical thinking over holistic and downplaying intuitive, emotional, aesthetic and spiritual dimensions of human experience. Moreover, such a form of consciousness may be particularly dangerous today "with its vision of continued progress in technology and personal freedom, that is now exceeding the life sustaining capabilities of the natural system that makes up our habitat" (Bowers, 1993, p.104). Scott (1995) offers a playful, yet serious re-consideration of problem solving: "we could be unsolving the problem: reversing it: rewriting the problematic into question and returning toward the formulation. it would be a different kind of relation" (p. 3).

Technological literacy is put forward as a goal of technology education in both the ITEA and BC curriculum documents. Lewis & Gagel (1992) maintain that "having set forth its commitment to technological literacy so unambiguously, the field of technology education has had the problem of trying to communicate just what technological literacy means, and how it could be measured" (p. 132). The ITEA authors suggest that a technologically literate population is essential for economic vitality, while the BC authors express the notion that technological literacy is effectively achieved through people solving practical problems.

Statistics and projections of the International Labour Office (1992), United Nations (1993), Statistics Canada (1993), U.S. Department of Commerce (1993), and Department of Labor (1992), indicate that the jobs being created are concentrated primarily in four areas: community, social and personal services; trade, restaurants, and hotels; financing, insurance, real estate and business services; and, manufacturing. A large percentage of these jobs are low-paying, low-status, and part-time. What if we told these stories to students as well, so that they might have the options of preparing not only for employment, but also for the possibilities of un(der)employment? What different technological literacies might students need for such possibilities? To move beyond economic discourses, what shape might technological literacy take without economic expansion, consumption, and commodity production at the centre? What other possibilities might there be for "doing" technology in schools beside designing and making?

Another Storytelling: Technology and Gender

Concepts such as *universal man* and *human adaptive systems* underpin technology education curriculum narratives. Haraway (1989), documents how these concepts have been challenged as a result of feminist struggles for decolonization and liberation. She points out that universal man and human adaptive systems were fostered at a particular historical time by geneticists and physical anthropologists in response to flawed, but important, struggles against racism in science. Universality was judged an advance over views that explicitly placed women and non-whites at a lower order than white males. Regardless, as Foucault (1984) writes, "the universal intellectual, whose task was to speak the truth to power in the name of universal reason, justice, and humanity, is no longer a viable cultural figure" (p. 23).

The predominance of technology stories in the literature are universal stories informed primarily from men's perspectives (O'Riley, 1992). A multiplicity of exclusionary practices have contributed to the mapping of women on the periphery or invisible in technology stories, including: the assignment of women to the private sphere since the Industrial Revolution; the gendering of work and tools; and the omission of women's perspectives and contributions to technology in historical records. Since most historical representations construe technology as "devices, machinery, and processes which men are interested in" (Kramarae, 1988, p. 5), some feminist research is aimed at recovering the history of women and technology. To do this requires substantive broadening of contemporary languaging of technology as "largely interested in manufacturing" (Wajcman, 1991, p. 162). Many inventions designed by women, or for women, have been overlooked altogether as they are not considered to be technology—they are "tools" when associated with men, and "implements" when associated with women (Cockburn, 1988; Kirkup & Keller, 1992; Wajcman, 1991). Cowan

(1979) underscores this point with her discussion about a baby bottle, "a simple implement . . . which has transformed a fundamental experience for vast numbers of infants and mothers, and been one of the more controversial exports of Western technology to underdeveloped countries—yet it finds no place in our histories of technology" (p. 52).

Duelli Klein (1987) argues that many technologies represent "powerful socio-economic and political instruments of control" (p. 65), particularly over women. Faulkner & Arnold (1985), Leto (1988), and Wajcman (1991) document how technologies have been used as a "social tool" to both construct and maintain stereotypical gender roles. For example, household technologies have been a significant market for manufacturers who have a monetary interest in reinforcing ideologies of gender, which is further complicated by women's complex and contradictory embrace of particular technologies. And, outside of the home, industrial and office automation is often used as a technology of power and surveillance to monitor and control workers, "keeping an eye on her nimble fingers" in electronic sweatshops (Garson, 1988; Fuentes & Ehrenreich, 1988). In a film, *Global Assembly Line,* Gray (1986) exemplifies technologies of control as she documents the experiences of poor, primarily non-white, women working for slave wages, under slave working conditions, in transnational electronics assembly plants in the free-trade corridor between Mexico and the United States, in the Philippines, and in Tennessee.

Some feminist researchers consider bio-technologies to be at the core of women's status with women's bodies increasingly becoming colonized by new reproductive technologies (Corea, 1985; Duelli Klein, 1987; Haraway, 1991). When intersected by race and socioeconomic status, bio-technologies take on yet another dimension. According to the Third World Network (1993), women in non-western countries are often used as guinea pigs in the experimentation and testing of contraceptives, drugs, reproductive high-technologies and techniques, which are restricted or banned in western countries before they are considered acceptable for consumption and practice on white women. Added to this are the influences of massive evangelical-like crusades to impose western values on non-western women about birthing techniques and birth control, as well as the downplaying of breast feeding in favour of western infant formulae and other western consumer goods.

Bio-technologies are inscribing more than women's bodies. Billions of dollars are being allocated for high-tech, militarized, bio-technology projects to code our imperfect human bodies for retrieval as perfected genetic mutations (Haraway, 1991; Kroker, 1994). With the current emphasis on nationalism and global competitiveness, there are increasing political and corporate demands for "productive and efficient human resources"—the rhetoric within technology education curriculum narratives. Wells (1995), concerned about "confusion" around understandings of bio-technologies, that they are "far too inclusive, and by definition inaccurate" (p. 11), presents a taxonometric structure of eight bio-technology knowledge areas for consideration by technology educators. Although genetic engineering has a place in this structure, reproductive technologies are absent. From my positioning as a mother, and as a woman with considerable experience inspecting workplaces as an occupational health and safety officer and human rights officer, I ask if technology education textual practices might open to allow room for discourses on reproducing bodies, bodies-as-commodities, and commodity-producing-bodies?

Undoing the 'Whitewash': Technology and Race

Because of my place of privilege as a white Canadian woman, I cannot do justice to this section as I have much to read and many silenced voices to listen to before I am able to gain even a modest understanding of the implications of western technologies on people of colour around the world, including aboriginal people of Canada and the United States, African-Americans, and Hispanic-Americans. According to the Third World Network (1993):

> Modern science and technology has dislocated Third World societies, destroyed traditional cultures and played havoc with the environment of Third World nations. It has also replaced a way of knowing, which is multi-dimensional and based on synthesis, in Third World societies, with a linear, clinical, inhuman and rationalist mode of thought. Western science and technology has systematically plundered Third World countries in the name of scientific rationality. (p. 486)

Rural workers around the world, particularly women of colour, have been pushed off their land and into factories by transnational agricultural corporations that have replaced their way of life and diversity of crops with monocrops, requiring the "latest piece of machinery which may render her labour obsolete, ineffective or more difficult: or with pesticides which endanger her (and her unborn) or her family" (Third World Network, 1993, p. 499). For example, a colleague tells a story of the implications of industrial development for the women of her village in Kenya (M. Ndunda, personal communication, 1992). Her mother and the other women now have to spend much of their day walking to find potable water, where twenty years ago they would only have had a short walk. The water that they do collect is barely suitable for drinking, cooking, and washing, and when they return there is little time left for the children, community, or themselves.

Within our own borders, Grossman (1993) maintains that the discriminatory practices of dealing with toxic waste and polluting by-products of industrial and technological development amount to no less than environmental racism. Grossman writes of toxic waste dumps located in/near inner cities, radioactive contamination of Native American reservations, pesticide-related cancers of Hispanic farmworkers, lead poisoning of inner city children, and exportation of toxic waste to non-western countries.

Western narrative configurations ignore altogether, or portray as antiquated or primitive because of their simplicity, technologies that fall outside a "mechanical model of reality" (Needham, 1993, p. 31) and technologies associated with non-western cultures. Although Chinese, Indian, and European-Semitic are the three greatest historical civilizations in the world, only recently has attention been paid to these technologies and sciences (Needham, 1993).

There is little recognition that a mechanistic view of the world is simply a western project, and that other cultures' more organistic ways of viewing the world, as well as their "low" technologies, are equally valid, and possibly more ethically and ecologically sound.

So, what might technology look like if it included technologies of, and was designed for, the majority of the world? A serious re-vision of technology education curriculum stories might mean a reshaping of technology narratives "committed to increasing consumerism and profit, maintaining social control, and legitimating the authority of elites" (Harding, 1993, p. 3). Rather than converging into standardized narratives, technology education textual practice might become a space of embodiment of divergent, contradictory, and multiple perspectives consisting of "partial, locatable, and critical knowledges sustaining the possibility of webs of connections in solidarity in politics and shared conversations in epistemology . . . but not just any partial perspectives" (Haraway, 1991, p. 191-192).

Opening Technology Discourses to Difference

> standard-*n.* object, quality, or measure serving as a basis, example, or principle to which others conform or should conform or by which others are judged.
>
> (The Pocket Oxford Dictionary, 1992)

Foucault (1980) refers to any combination of knowledge and power as technologies of control, and schooling is one place where "docile bodies" are re-formed "through drills and training of the body, through the standardization of actions over time, and through the control of space" (Foucault, 1984, p. 16). Such disciplinary technologies are about ordering of bodies and knowledge, a technique of normalizing the body social in the name of efficiency and progress so that anomalies do not disrupt the structures of power and control. Perhaps we need to take a pause in all the flurry of designing and making, and to ask ourselves if technology education is not also in the business of designing and making technosubjects —docile bodies—with our continuing insistence on standards and universals? Several writers believe that with our increasing dependency on technologies we have already become *capitalist bodies* (Deleuze & Guattari, 1983, 1987), *possessive/possessed individuals* (Kroker, 1992), and *terminal bodies* (Grosz, 1992, Hayles, 1993).

The world is a very different place from the one in which many of us grew up. Family, church, and school are no longer the primary source of information for students. From my own research in technology education classrooms, students' understandings are informed largely from texts outside of school: students make meaning of their relationships in the world through television, videos, movies, computer games, comic books, magazines, music, body languages, and other cultural and technological interactions (O'Riley, 1995). Haraway (1991) documents how the "informatics of domination" has shifted an "organic industrial society to a polymorphous information system" (p. 161) which has already transformed our bodies into "cyborgs"—part human, part machine. She contends that we need to find ways to converse with "[t]his world-as-code . . . a high-tech military field, a kind of automated academic battlefield, where blips of light called players disintegrate . . . each other in order to stay in the knowledge and power game" (p. 186).

Imagining a way out of the non-innocent border stories we tell to explain our bodies and our tools to ourselves could turn on re-visioning "the world as coding trickster with whom we must learn to converse" (Haraway, 1991, p. 201). Rather than privileging too narrow a range of texts through standardizing curriculum, might it not be more beneficial for students to have multiple and different tools so that they can converse in the world as coding trickster, and become actors themselves, agents in the mediation of their own knowledges and subjectivities? Gough (1993) maintains that educators need to provide students with more complex and complicating discourses as we can no longer assume to represent, interpret, and explain "reality" and the "complexity and instability of the phenomenal world that presents itself to human sensibilities" (p. 621).

Technology for All Americans is supported by the National Science Foundation and the National Aeronautics and Space Administration in the "creation of new National Standards for Technology Education. . . . to enhance America's global competitiveness in the future" (Dugger, 1995, p. 4). This project is a *persistence of vision* (Haraway, 1989) that continues to perpetuate the prevalent practices within technology education of linking technology primarily with industry, science, and mathematics, traditionally male-oriented areas. Meanings for technology are much more complex, fluid, and ambiguous than those presently articulated within these selective and partial perspectives. Nietzsche (1979) writes that "nobody can get more out of things, including books, than he [*sic*] already knows. For what one lacks access to from experience one will have no ear" (p. 70). If girls and students of diverse cultural backgrounds are to become more than ontological and epistemological optical illusions in technology education re-visions, a reshaping, a different way of seeing, a move beyond rhetorical gestures of gender and cultural inclusivity is needed. Sanders (1995), writing specifically about the *Technology for All Americans* project, suggests that technology educators "should welcome those different models while unabashedly promoting those which have made us so successful for the past century" (p. 3). There have been certain successes as a particular cultural community. It is now time to re-vision with different angles of vision towards an optics of care and compassion and to create openings for both difference and different visions of technology and of the world. As Scott (1995) writes, it would indeed be a different kind of relation.

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Building Their Future: Girls and Technology Education in Connecticut

Suzanne Silverman and Alice M. Pritchard

Why do a disproportionate number of girls turn away from math, science and technology? Research into the teaching of math and science in schools has identified a number of factors which are critical, but there has been very little attention given to technology education. In *How Schools Shortchange Girls*, the American Association of University Women (AAUW, 1992) reviewed the available literature. Despite the fact that there was no evidence of any innate differences in ability between men and women, they found significant differences in participation and achievement rates in math, science and technology.

How do we explain these differences? Caine and Caine (1991) maintain that traditional teaching practices, classroom organization and performance testing fail to acknowledge the impact of emotions on the ability to learn. They stress the importance of connecting what is taught to the lives and interests of students. While such interconnectedness is important for all students, the authors of *Women's Ways of Knowing* contend that women are particularly disadvantaged by teaching methods that are not connected (Belensky,Clinchy,Goldberger and Tarule, 1989). They found that women respond better to teaching which relates to their own lives and gives them encouragement about their own abilities.

In trying to explain gender differences in mathematics, Fennema and Peterson (1985) seek to explain why males surpass females in high-level cognitive skills, the type that problem-solving tests measure. They contend that to develop these skills an individual must participate in autonomous learning behaviors (ALB). These behaviors include choosing to do high-level tasks, working independently on tasks, persisting on them and achieving success. Fennema and Peterson propose that males have more opportunities than females to pursue ALBs. Conditions outside the classroom give them greater practice, but in-school experiences also affect chances for independent action. In-school experiences include the nature of contact between teacher and students, particularly teacher expectations about different groups of students.

Suzanne Silverman and Alice M. Pritchard conduct research and manage the Vocational Equity Research, Training, and Evaluation Center, a project of the Connecticut Women's Education and Legal Fund, Hartford, Connecticut. This study was conducted with the assistance of Dr. Agnes Quinones, Gender Equity Consultant, Connecticut State Department of Education and Greg Kane, State Supervisor for Technology Education.

The AAUW report (1992) found that research spanning the past twenty years consistently reveals that males receive more teacher attention than do females. The issue is broader than the inequitable distribution of teacher contacts with male and female students; it also includes the inequitable content of teacher comments. Myra and David Sadker (1984) conducted a three-year study which found that while males received more teacher comments than females, the difference favoring boys was greatest in the more useful teacher reactions of praise, criticism and remediation.

Alma Lantz (1985) found that beliefs about math and science were also an important factor in the decision of girls not to take advanced courses or pursue such subjects as careers, despite their proven ability in these subjects. She found that stereotypes about subjects which have traditionally been identified as "masculine" are operating to discourage girls from pursuing nontraditional careers.

Since most of these studies focus on the teaching of math and science, we felt a look at the teaching of technology education would be valuable. While participation rates for girls in technology subjects are low and they have traditionally been identified as "masculine" subjects, the teaching methods and classroom atmosphere in technology education differ significantly from math and science classes. As opposed to abstract concepts being presented by the teacher, most technology education classes are taught in a lab setting involving hands-on projects, where students move around the room sharing materials and equipment. There are group as well as individual projects, some of which involve competition, but in a different context from the kind of competitive tests common in science and math classes.

This article reports on the findings of a two-year research project looking at girls' participation in technology education in Connecticut schools. The project was funded by the Connecticut State Department of Education and full reports are available from the Connecticut Women's Education and Legal Fund (Silverman and Pritchard, 1993 and 1994). It was designed to identify viable strategies to change enrollments and attitudes toward the success of girls and women in technology education.

Phase I of the study focused on girls taking technology education in middle school, when all students are required to "explore" a variety of vocational subjects. We wanted to examine whether the same factors which tend to discourage girls from pursuing math and science careers were operating in technology education during the girls' early exposure to the subject, at an age when gender differences first begin to appear.

Phase II of the study explored the reasons for the wide gender gap in participation rates in technology education in high school. We wanted to look at the factors encouraging or discouraging students from choosing technology education as an elective, and in particular to examine the differences between boys and girls.

Methodology

Research Questions

Phase I of our study examined the impact of teaching methods, classroom organization and atmosphere, and teacher interaction on girls in technology education classes in middle schools. In Connecticut, these classes are divided into a number of subjects areas, which vary in different school districts. They generally include some drafting and measurement, some building of bridges, cars or simple machines and some graphic arts and design.

While Phase I of the project focused on middle school girls, we also conducted a survey of both girls and boys taking technology education classes in high school. This survey was designed to explore why students decide to follow up their exploratory programs in middle school by taking further technology education classes in high school. We were also interested in whether there were significant differences between girls and boys in their attitudes toward technological careers.

In Phase II, we focused on high school girls and asked why so few elect to take technology education in high school. We decided to follow up the high school survey, which was limited to students already in technology education classes. In order to explore the reasons why some students chose not to take technology education, we needed to talk to high school students and let them express their thoughts and feelings directly. Therefore, the major emphasis of this stage of the research was a series of focus group interviews with high school students.

We conducted focus group interviews with both boys and girls, some of whom were taking technology education and some who were not. This strategy enabled us to look at the factors encouraging or discouraging all students from choosing technology education as an elective, and in particular to examine the differences between boys and girls which could account for the huge differences in participation.

Sample Selection

The sample of school districts was chosen to provide the widest range possible in terms of regional characteristics, size, and student population. For Phase I, we were able to gain access to three school districts in different parts of the state. These included one rural district whose student population was predominately White, one urban district with a predominately African-American and Latino/a population and one suburban district with a mixed population. For Phase II, we visited four school districts, of which three were consistent with the sample from Phase I. We also added a fourth district, which was in a medium sized industrial town with a mixed student population.

Research Instruments and Data Collection

Classroom observation in middle schools. We decided that classroom observation would provide one source of information about teaching methods, classroom organization and atmosphere and teacher interaction. While students and teachers were aware that we were in the classroom, we attempted to minimize the interaction of observers. This type of observation was designed to capture as much as possible of what was going on in the classroom, following the model developed by Leacock (1969).

We developed a protocol for classroom ethnography which included a physical description of the classroom, a chronological log, and a ratings form for each class. In the log, the observer recorded how the class was organized, what the teacher did, how students reacted or participated and the responses of the teacher in chronological order. After the class, she filled out a ratings form in which she evaluated the content, atmosphere in the classroom, student participation, and teacher expectations and attitudes.

We observed from two to four technology education classes in each of three middle schools for a period of three weeks, for a total of 77 observations. The technology education classes were offered as exploratory sessions of varying length, in one school as short as 20 days. We observed sixth, seventh and eigth grade classes in a range of different subjects, including construction, manufacturing, communication, woodworking, and drafting.

Focus group interviews with female middle school students. In order to determine whether girls in technology education classes were being influenced by the same factors which have been documented in research on math and science classes, we decided to interview girls in focus groups. We wanted the chance to explore girls' attitudes toward their technology education classes. Were they influenced by stereotypes about "masculine" subjects? Did they find the content too abstract or unconnected? Did they lack confidence in their abilities? Did they feel that teachers gave more attention to the boys?

The researchers conducted focus group interviews with the girls in each of the middle school classes which they were observing. We interviewed a total of 58 girls in these focus groups. We asked girls how they felt about their technology education classes and the possibility of a career in a technological field. We asked girls whether they felt there were differences in ability between girls and boys and about what subjects they liked best.

Interviews with middle and high school teachers, guidance counselors and principals. We also interviewed teachers and other school staff, at the middle and high school level. We interviewed 13 technology education teachers, 6 principals and 18 guidance counselors. We were interested in how teachers felt about the recent changes in technology education and whether the curriculum was related to students' experiences and the real world of work. We asked whether girls responded differently to various teaching methods and the kind of atmosphere the teachers wanted to create in the classroom.

Survey of high school technology education students. The high school survey provided an opportunity to examine the attitude of students who decided to take further technology education classes in high school. By surveying both girls and boys, we could compare their attitudes toward technological careers and the various influences on their decision to take technology education. We developed six questions for a pilot survey which was tested in one school and reviewed by an outside academic consultant before being finalized.

In the three high schools associated with the middle schools in the study, we gave the survey to all technology education students. We surveyed a total of 737 students, including 133 girls and 604 boys in grades 9-12. The questions centered around the reasons for their choice of technology education, the major influences on that decision and some information about their attitude toward technological careers. The students were quite evenly mixed in terms of grade level, with 22 percent in 9th grade, 24 percent in 10th grade, 23 percent in 11th grade and 30 percent in 12th grade.

Statewide Vocational Enrollment Data. As a base line, we wanted to know how wide a gender gap already existed in participation rates in technology education classes in high schools, so we also looked at enrollment data across the state. This data is based on vocational enrollment by gender and course for 1990-91, compiled by the State Department of Education, Bureau of Evaluation and Student Assessment.

Focus group interviews with high school students. Phase II of the project concentrated on focus group interviews with high school students. We asked students what they liked and disliked about various subjects, particularly technology education, and how they decided what electives to take. If some girls were discouraged from taking technology education, we wanted to explore the reasons. The focus group format allowed us to follow up statements with more detailed discussion and exchange of ideas. We were interested in whether boys and girls chose to take technology education for different reasons and the important influences on their choices. We wanted to assess the impact of teachers and guidance counselors on their decisions, as well as parents and other factors outside of school.

In our focus group interviews, we tried to give students the opportunity to speak for themselves. Often education research fails to ask the people most directly affected about their feelings and beliefs. We had some heated and enthusiastic discussions, often with disagreements between students about controversial issues. In our full report (Silverman and Pritchard, 1994) we quote students directly as much as possible. In this article, we try to give a sense of the most common attitudes and comments.

In the available time frame, we determined that we could interview students in four classes in each of the four high schools we visited. In order to compare the attitudes of students who decided not to take technology education with those who did, we divided the classes evenly. We picked two technology education classes, usually drafting or graphic arts, because they tended to have the most girls enrolled. We picked two academic classes which were required courses for all students, mainly English or social studies. We conducted focus group interviews with the boys and girls separately, typically in groups of eight or nine students. We conducted a total of 32 interviews with 241 students, including 134 boys and 107 girls.

The scarcity of girls taking any technology education class was brought home to us immediately on trying to set up the interviews in the four participating high schools. There were only one or two classes in any of the high schools with as many as four girls and most classes had at most two girls. As a result, we talked to considerably more boys taking technology education, a total of 60 boys and 22 girls, although we talked to both boys and girls in academic classes who were also taking technology education.

Quiz on Women in the Workforce. In our focus group interviews with girls in Phase I, we were struck by the lack of connection between what students were doing in class and the world of work. They lacked basic information about careers, including any sense of salaries or promotion prospects. While boys and girls may have shared this lack of information, for girls it was combined with stereotypes about technology as a male occupation, which reinforced their reluctance to considerer nontraditional careers.

To follow up this finding in Phase II, we decided to test high school students' understanding of the economic realities involved in earning a living and the paying for further education and training, as well as the relative earnings and promotion prospects of various occupations. We developed a short quiz about the economic realities facing women in the workforce. It covered such issues as the salary and promotion prospects of traditional verses nontraditional careers for women and the length of time women spend in the workforce. A total of 516 students in both academic and technology classes took the quiz, including 320 boys and 196 girls.

Findings

Phase I

We found that in middle school, girls appear to enjoy technology education and have confidence in their abilities, but emerging sexism among peers begins to differentially affect participation on the basis of gender. Classroom observation and focus group interviews showed that hands-on activities were very attractive to the girls. Most of the teachers we interviewed felt that the transition from industrial arts to technology education makes the subject more attractive to girls, since there is less emphasis on the use of heavy equipment. While girls may come into class with less experience using tools and machinery than the boys, they learn quickly and do not seem to be at a disadvantage.

In our classroom observation, girls did seem to have confidence in their ability to succeed in technology education and this was confirmed in focus group interviews. We did not find evidence that teachers called on boys more often than girls, but since most of the class time is spent at worktables engaged in hands-on projects, teachers must move around the room, helping each individual or group who needs it. While many students had to wait for the teacher to assist them, we did not observe that teachers gave more help to the boys or took less interest in the girls' work.

Because students engaged in building projects must move around the room to get materials and use machinery, the atmosphere in these classrooms is clearly different from the atmosphere in classes where students basically remain at their desks. Whether students are working in groups or as individuals, they are encouraged to help each other and must share tools and equipment. In the lab setting, teachers allow students to talk and move around and the students seem to enjoy the informal atmosphere in all the classes we observed.

In this kind of informal atmosphere, however, the dynamics of boy/girl interactions can cause problems if the teacher does not establish clear guidelines and rules for behavior. We found evidence of growing sexism among peers. For example, on two occasions during our classroom observation, the boys monopolized the tools. In focus group interviews, girls complained that the boys always rushed off to get supplies and made fun of girls trying to use equipment, and the teachers sometimes let them get away with it. They described how the boys would sometimes criticize girls, resorting to stereotypes about girls' lack of technological skills.

Teachers have not necessarily thought about the best way to deal with this problem and its impact on their choice of teaching methods. We encountered teachers who were aware of the need to control sexist behavior but who didn't know how.

In our classroom observations and focus group interviews, we also found evidence that girls may respond more positively to some projects and be more interested in some aspects of their technology education classes. We did not observe these differences between boys and girls in all classes, but we did notice that girls found the design aspects of their projects appealing. While some teachers spoke of projects which were "gender neutral", many of the objects being built are more likely to be attractive to boys. Because of differences in early socialization, boys are often more interested in cars, planes and bridges. (Skolnick, Langbort and Day, 1982). One teacher had students build houses, giving them some leeway from a basic design and letting them go on to decorate it if there was time. The girls in this class showed more enthusiasm than girls in a similar class who complained that building bridges was "boring".

We also found that middle school girls are discouraged from taking more technology education in high school because of two major factors which tend to reinforce each other. First, technology has until recently been a field dominated by men. We found evidence that traditional stereotypes about male/female occupations are still operating and are strong enough to outweigh girls' positive feelings about their experiences in technology education classes.

Second, we found that girls were uninformed about economic realities and the world of work. They lacked basic information about careers, including any sense of salaries, promotion prospects or the amount of education and training needed to pursue different occupations. While boys and girls may share this lack of information, for girls it is combined with stereotypes about technology as a male occupation, which reinforces their reluctance to consider nontraditional occupations.

In our focus group interviews, girls did not reveal a lack of confidence in their ability to do any kind of career. The girls who spoke up said they were just as good as the boys in all areas, including math, science and technology. However, if girls by eighth grade are not informed about the requirements of different careers, don't make the connection between what they are doing in the classroom and the world of work, and are unaware of the kind of technology classes they can take in high school, they may close off options that could lead to high wage careers.

This lack of knowlege about different careers is also reflected in the high school survey. Findings suggest that while girls who go on to take technology education in high school are ready to challenge the traditional identification of technology as a male occupation, they have less confidence in their abilities and are thinking less in terms of well-paid careers than the boys in their classes. When asked why they decided to take technology education, only 11 percent of the girls chose "I am good at it" compared to 24 percent of boys. Only 14 percent of girls chose "I want a job that pays well" compared to 24 percent of boys.

More girls than boys reported being discouraged from taking technology education. The nine percent of girls who said they were discouraged listed a number of different people who had done this, including peers, siblings, teachers, counselors and parents. When asked who had most encouraged them to take technology education, 43 percent of all students chose to write in an answer under "other", instead of picking one of the more obvious choices of family, teachers, friends or guidance counselors. Of all the girls, 28 percent wrote in "myself" as the sole response, which we found surprising, considering the expected role of parents or school staff in discussing options with students. Teachers and guidance counselors were mentioned by only 36 percent of all students. Fewer females reported that they were encouraged by their middle school experiences than boys, with more females indicating that their classes in middle school had no effect on their decision to take further technology education.

Phase II

For the second phase of this project, we wanted to explore the reasons for the wide gender gap in participation rates in technology education. In our focus group interviews, we found that while both boys and girls are attracted to technology education for many of the same reasons, there were significant differences between girls who take technology education and girls who don't. Our findings can be summarized in terms of two basic questions.

Why do some students decide to take technology education? Both boys and girls are attracted to technology education because they enjoy working with their hands and like the independence and chance for creativity provided by these classes. An interest in technology education was often encouraged by relatives or friends outside the school. This kind of encouragement was particularly important for girls, because boys are more likely to have experience with technology.

Girls taking technology education shared a sense of being "pathbreakers" who could prove that girls were as good as boys at nontraditional subjects. They didn't mind being one of the few girls in a class and did not feel the boys made it difficult for them, although they did worry about teachers treating them differently. Girls taking technology education rejected stereotypes about appropriate subjects or jobs for women, but discussions with boys and girls revealed that stereotypes are still powerful. While both boys and girls rejected the idea that males are inherently better at some subjects or jobs, the fact that there are few females in nontraditional occupations was often cited as a reason for girls not to take technology education or consider a technological career.

While some students were encouraged to take technology education as a result of their middle school experience, the most common response was that it had little impact, because what they did in middle school was not comparable to the range of classes available in high school. Girls were generally not aware of what was available in high school and were not being encouraged by their middle school experience to challenge stereotypes and explore nontraditional subjects.

Many students reported getting little advice or information about technology education from their guidance counselors. This lack of information was particularly difficult for girls to overcome, since they are less likely to have experience with technology outside of school and must be willing to fight stereotypes about appropriate subjects for girls. Some girls reported that they were discouraged from taking technology education.

Why do some students decide not to take technology education? Girls who chose not to take technology education were often reluctant to take classes where they would be one of the few girls. While only a few girls openly accepted stereotypes about appropriate careers for women, many of the girls felt uncomfortable with the picture of themselves in nontraditional jobs. They lacked confidence in their abilities and worried about the reaction of friends and family. Better information about technological careers could have broken down stereotypes about "male occupations" and fears expressed by some girls about the physical demands of jobs, since high tech areas like computer-aided design and manufacturing do not involve heavy lifting or high risk of injury.

Many students lacked a sense of economic realities which could inform their choice of careers and help them make reasonable plans for further education and training after high school. Girls seemed unaware of salary or promotion prospects of traditional careers for women and less concerned with economic realities than boys. The quiz results demonstrate that boys and girls share misconceptions about how long women are likely to spend working, the level of earnings they can expect and the relative salaries of traditional jobs for women.

Conclusions

Looking at the findings from both Phase I and Phase II, we are encouraged by the fact that girls in middle school appear to enjoy technology education and have confidence in their abilities. But the positive aspects of their experiences in middle school do not lead most of them to take more technology education in high school. We have uncovered a number of important factors which contribute to this gender gap.

In middle school, teachers have not necessarily considered the importance of emerging sexism among peers or thought about the best way to deal with this problem. The culture of the school and the attitude of teachers is important in insuring that boys do not get away with sexist behavior and girls are not forced into stereotyped roles.

Because technology education has traditionally been such a male-oriented subject, teachers need to be aware of the differing interests of girls and consider ways of making the environment and the subject attractive to them. Decisions about what kind of objects to build and what aspects of technology should be considered valid are important for attracting the interests of both boys and girls. The principles of technology can be learned as well from building a house as from building a bridge.

Looking at the factors which discouraged both boys and girls from taking technology education, we found that many of these factors had a particularly strong impact on girls. The lack of knowledge of technological careers, the failure to connect what students were doing in class with future careers and the lack of a sense of economic realities were particularly discouraging to girls because they had less information about technology from experiences outside of school. Even more important, they had to overcome stereotypes about "appropriate" careers for women.

We found a major difference in attitude between girls who choose to take technology education and those who do not. Only a few girls are willing to be "pathbreakers" and challenge stereotypes about nontraditional careers for women. Most girls could not picture themselves in technological jobs and were reluctant to be in classes where they were one of the few girls. They had never seriously considered taking technology education in high school. The fact that most girls could not picture themselves in technological jobs reflects the barriers set by sexism and the failure of schools to provide role models and positive programs to overcome stereotypes.

In noting the lack of information about technological careers, we are not suggesting that technology teachers should be concentrating on job preparation, which involves the teaching of skills needed for specific jobs. The new vision for technology education is an experience-based program involving the application of math and science concepts in technological systems. There is an emphasis on thinking processes and problem solving rather than developing particular skills. The provision of career information is not job preparation but is rather the opportunity for students to explore options and see the connection between what they are learning in class and possible future careers. If this kind of career exploration is structured in such a way as to challenge stereotypes about appropriate careers for women, it can help girls who might not otherwise consider nontraditional options.

Recommendations

Based on the findings of this research project we feel that actions can be taken to improve enrollments of girls in technology education and change attitudes about careers for girls and women in technological fields. As a first step, we believe schools must put a high priority on hiring more female technology teachers, who can be important role models for girls interested in technology.

Strategies for Teachers

Technology education teachers need to meet together and discuss gender equity through a number of different forums, including workshops with outside facilitators and in-school meetings to discuss guidelines. High school teachers need to consider strategies to attract more girls to their classes. These strategies could include curriculum revisions or reorganization of labs. Teachers may need to attend training sessions or obtain new materials.

Teachers need to discuss:

- the affect of different kinds of competitions, whether there should be group or individual projects, etc.
- guidelines and ground rules on acceptable behavior for both boys and girls to insure that girls play an equal role in the classroom and are not forced to take stereotyped roles, boys are not allowed to take over, etc.
- how to make the classroom and subject matter more attractive to girls, including choices about what kind of projects to pick, whether design and decoration can be given credit on a project along with mechanical aspects, etc.

Teachers need to consider how to make the connection between school and work clearer:

- providing information to students and their parents about the world of work designed to challenge stereotypes about careers for women. Videos and other materials designed to show students how the skills they are learning are used in the workplace and the contribution of women in technological fields need to be incorporated into the curriculum.
- teaching students more about economic realities, particularly about the role of women in the work force. Students need to learn about the economic consequences of choosing careers and the relative salary and promotion prospects of different occupations. These discussions could be developed as interdisciplinary programs with social studies or other departments.
- efforts could be made to make technology education classrooms more attractive and welcoming to girls. Pictures showing women working in technological jobs and products made by female students could be displayed in the classroom. Teachers could consider some kind of forum where girls taking technology education could talk to prospective students considering what electives to choose. Support groups for girls in technology education could be organized.

Scheduling Changes

Efforts could be made to try to maximize the number of girls in a particular technology education class. The current random distribution of girls in technology education classes could be examined with the view of combining as many girls as possible in one class. Once numbers get over 3 or 4 girls in a class, other girls will not be as likely to feel uncomfortable about taking technology education.

Role Models for Girls in Technology Education

In both middle school and high school, girls need to meet and talk to successful women who work in technological fields.

- Technology education teachers could arrange for successful women to visit their classes and talk about their jobs and the kind of preparation and training they needed.
- Careers days or programs presented by schools must be designed to include women in nontraditional occupations.
- High schools can provide more opportunities for students to participate in job shadowing or work experience. Programs with local employers in technological fields could be designed to allow girls to meet successful women and learn more about technological careers.
- Schools can encourage the development of team teaching programs with female teachers in math or science.

Better Information for Students About What is Available in High School

- visits to high school technology education labs to see the kind of work is being done, with participation by high school girls who are currently taking these classes (using "pathbreakers" as role models)
- Elective Fairs with the participation of high school teachers and students (particularly girls) to inform middle school students about the kind of programs which will be available to them.
- Product Shows which display the kind of projects which students have the chance to create in technology education classes.

Strategies for Guidance Counselors

Guidance counselors need to provide more information to students about what electives are available and how they might fit in with various career options. Girls need to be encouraged to consider taking technology education, particularly if they are not sure whether to go to college or express interest in engineering or a technological career. Guidance activities could include:

- establishing clear links between guidance programs in middle schools and high schools, including meetings with technology education teachers to learn more about what is available in their classes. Guidance counselors could schedule presentations by high school teachers in middle schools to tell students and staff about their programs.
- providing more information to both students and parents about the necessary preparation and promotion prospects of various kinds of technological careers.
- working with technology education teachers in the classroom to get more information to students and make the connection between what students are doing in class and technological careers.

- organizing programs for students who do not plan to go to college to give them a chance to explore different options and obtain more information about further education and training. These programs should include information about nontraditional careers for women and/or the participation of women as role models. They could also include the participation of parents and/or relatives.

Reaching the Critical Mass

Many different strategies are needed to attract more girls to technology education. These strategies will need to attack the problem from as many different directions as possible. Action needs to be taken not just by technology education teachers, but in cooperation with administrators, guidance counselors and parents.

Because stereotypes about appropriate subjects or careers for women are still powerful, schools need to provide better information to all students about the options for technological careers and the role women can and do play in such occupations. Teachers and guidance counselors need to help students make the connection between what they are doing in class and the world of work. Our research results clearly show that girls are not well informed about what is available in technology education classes in high school before they have to choose electives. Because they have less experience with technology outside of school and they must fight stereotypes, girls need encouragement from teachers and guidance counselors and much more detailed information about what is available.

If we look only at the girls taking technology education, we might conclude that everything is fine and girls are doing well. The real picture is revealed in the enrollment numbers, which are reinforced by our interviews with girls not taking technology education. As long as participation is limited to a few girls willing to be "pathbreakers", the critical mass needed to convince the majority of girls that technology education is really for them will not be reached.

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Technological and Personal Problem Solving Styles: Is there a Difference?

Tain-Fung Wu, Rodney L. Custer, and Michael J. Dyrenfurth

Introduction

Problem solving, and technological problem solving in particular, is clearly a critical survival skill in our technologically advanced world. Government, business, vocational and technology education leaders have increasingly called for more emphasis on higher-order thinking skills and problem solving in both general and technological areas. The American technology education profession has identified problem solving as *the* technological method (Savage & Sterry, 1990). Authors outside technology education have also suggested that both general and technology teachers would be well advised to focus on enhancing problem solving skills. Given this, the authors sought to examine several key aspects of problem solving in more depth. Of these, the first was problem solving style. Problem-solving style is defined as a tendency to respond in a certain way while addressing problems and *not* as the steps employed in actually solving the problem. It has been operationally defined by Heppner (1988) in terms of three distinct dimensions which can be measured by the Problem Solving Inventory (PSI). Collectively, these dimensions (problem-solving confidence, approach/avoidance, and personal control) comprise problem-solving style.

Although many educators claim to address problem solving, if the increasing frequency of mention in the literature is to be believed, the portion of citizens who have developed adequate problem solving capabilities is insufficient. It is no coincidence that this inadequacy is occurring at the same time when our society is experiencing a decrease in technological literacy. This problem is all the more critical given that the pace of technological growth is escalating (Dyrenfurth, 1991; Johnson, 1989).

For over twenty years, psychologists have focused on real-life, applied problem solving (e.g., Folkman & Lazarus, 1980; Heppner, Hibel, Neal, Weinstein, & Rabinowitz, 1982). Investigators have attached various labels to the applied problem solving process including: interpersonal cognitive problem solving (Spivack, Platt, & Shure, 1976); personal problem solving (Heppner & Petersen, 1982); social problem solving (D’Zurilla & Nezu, 1982), and coping

Tain-Fung Wu is on the faculty at the National Changhua University in the Republic of China, Taiwan. Rodney L. Custer is an Assistant Professor and Michael J. Dyrenfurth is a Professor in the Technology and Industry Education Program at the University of Missouri, Columbia, MO.

(Coyne, Aldwin, & Lazarus, 1981). However, because of the ambiguity of these terms, one challenge is to distinguish between the various types of problems. Problem solving is a critical process skill that involves virtually all aspects of existence. It is clear that problems of various types exist and that not all problems are technological. Furthermore, problem solving has been identified and promoted by many disciplines including mathematics, psychology, the physical sciences, the arts, and more. In different contexts, and in unique ways, all employ the problem solving process.

The linguistic and conceptual challenge is apparent. The term, *problem solving* has evolved into a generic construction that covers a wide range of different types of activity. For example, the *problems* of an alcoholic besieged with numerous financial, marital, and personal difficulties share little common ground with the *problems* that a design engineer encounters when designing ways to safely dispose of hazardous waste. It is clear that the well-structured problem presented to the chess master is something quite different from the problems facing a diplomat, a psychological counselor, or a local police department. Problem solving is frequently used in an imprecise and undisciplined manner to encompass numerous activities that are substantially different in type, focus, and intent.

Given this, and given our profession's focus on technology, the following question can be posed, How can technological problems be distinguished from other types of problems? Custer (in press) has developed a conceptual framework for making this distinction as well as for structuring technological problem solving into its various types (e.g., design, trouble-shooting, development, technical procedures, etc.). However, by and large the literature revealed relatively little that focused on the contrast of technological and personal problem solving. Given this lack of precision and the focus of technology education on problem solving, this study attempted to clarify some of these distinctions along one potentially key dimension, "problem solving style." A methodology and findings will be described indicating that differences exist between personal and technological problem when these were examined from the perspective of problem solving style.

Purpose of the Study

The purpose of this study was to better understand the problem solving style dimension of problem solving. Our goal was to explore whether technological problem solving is similar to, or different from, personal forms of problem solving.

We compared the problem solving styles (personal and technological) of a group of university students with a high inclination to and involvement with technology to those with minimal inclination to and involvement with technology. The intent was to ascertain whether there were significant differences among the groups with respect to their problem solving styles. Differences among these groups would provide insight into the nature of problem solving and provide empirical evidence that technological problem solving is distinct from other forms of problem solving or at least possesses some distinct features.

Research Questions

The study's research questions were:

1. Do distinctly different types of university students exhibit significant differences in their styles of personal and technological problem solving?
2. Do students from different academic majors and with different demographic characteristics exhibit significant differences in personal and technological problem solving styles?
3. Can differences in technological and personal problem solving be inferred on the basis of problem solving style?

Method

While problem solving has many dimensions, and therefore could be approached in different ways (e.g., the steps or procedures used, the situation's characteristics, the solver's traits, etc.), this study focused on problem solving styles. Building on Heppner's (1988) work, this study was designed to explore the relationships among selected factors that could be expected to affect problem solving (personal and technological) styles in different ways.

Design and Variables

The study employed a quasi pre-test and post-test approach (Campbell & Stanley, 1969) (see Figure 1). Three different treatment groups were used. Each received the treatment (i.e., the curricula and teaching methods employed by each program) characteristic of their own discipline. Freshman and senior samples were drawn at the same point in time in a cross-sectional approach that assumed equivalent groups.

The dependent variables were personal and technological problem solving styles as measured by the Personal Problem Solving Inventory (PSI-PSYCH) (Heppner, 1988). This instrument was specifically adapted to measure technological problem solving style (PSI-TECH). The Problem Solving Inventory (PSI-PSYCH) reflects an individual's awareness and evaluation of his/her personal problem solving style and thus provides a global self-appraisal of that individual's ability to cope with personal problems. The technological version (PSI-TECH) examines perceived efficacy with technological problems. The PSI contains three subscales (Heppner, 1988): Problem solving Confidence ["…self-assurance while engaging in problem-solving activities" (p. 1)]; Approach/Avoidance ["…a general tendency of individuals to approach or avoid problem-solving activities" (p. 2)]; and Personal Control ["…the extent to which individuals believe that they are in control of their emotions and behavior while solving problems" (p. 2)].

Because previous conceptual and empirical studies of personal problem solving (Heppner & Petersen, 1982) have validated these three dimensions of style, they were selected as the dependent variables in the study. On close examination, Heppner's three-dimensional construct appears to apply well to technological problem solving. For example, the concept of self confidence would appear to affect one's ability to successfully solve a design problem just as much as self confidence affects the ability to solve a personal difficulty. The same can be said of the approach/avoidance and personal control dimensions. The technological versions of the instrument provided a means of examining the same subscales in relation to technological problem solving.

Type of Students	Type of Selection	Pre-test of Students (Freshman)	Treatment Program and Discipline	Type of Selection	Post-test of Students (Seniors)
Technology	P	O1	X1	P	O2
Engineering	P	O1	X2	P	O2
Humanities	P	O1	X3	P	O2

Figure 1. Design of the Study

P = Purposive class sampling
O1 = PSI-PSYCH, PSI-TECH, and demographics for pre-test assessment of freshmen
O2 = PSI-PSYCH, PSI-TECH, and demographics for post-test assessment of seniors
X1, X2, X3 = Three disciplinary/program areas

The independent variables were undergraduate students' academic area (technology, engineering and humanities) and demographic characteristics; such as grade levels, amount and type of prior work experiences (general or technological), grade point average, and gender.

Academic Area. This study involved undergraduate university students in the technology, engineering, and humanities disciplines. Based on their significantly different goals it was assumed that these three disciplines differ substantially in the nature of their academic training as well as in the career expectations they develop. It was also assumed that students enrolling in each discipline largely reflect the predominant characteristics of that discipline. The interrelationships among these three different disciplines can be conceptualized as a function of technological and theoretical dimensions (see Figure 2).

Technology-related programs exist to develop an understanding of, and capability to use, key aspects of industry and technology. They also aid in the discovery, development and application of student problem solving skills in a technological environment that draws from both engineering and technology theory. Thus, the orientation is practical, hands-on and applied.

Engineering programs, while also technological in emphasis, are generally much more theoretical and less *hands on*. Curricula emphasizing physical science, mathematics, and engineering sciences are geared toward theoretical solutions and highly quantified modeling of technological problems. By contrast, humanities students receive significant portions of their training in general courses as well as a concentration in a given liberal arts discipline. Their careers generally do not involve technological or engineering concepts but rather focus on abstract liberal arts content.

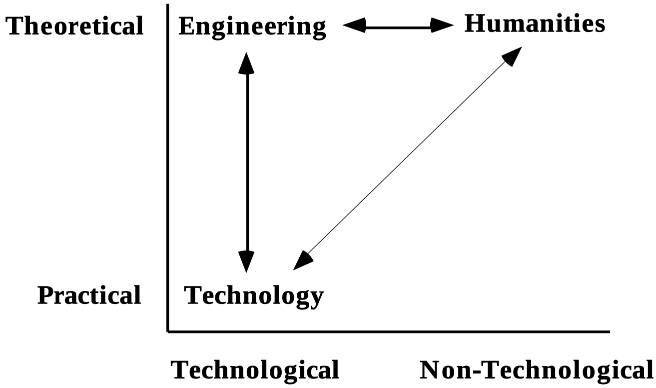

Figure 2. Envisioned Relationship Among Three Different Academic Areas

Central to the design of this study was the thesis that while these three different types of students could be anticipated to have similar PSI-PSYCH scores, based on their different educational experiences, the engineering and technology students would have more positive PSI-TECH scores than humanities students. It was also anticipated that educational experiences in engineering and technology programs would result in enhanced perceptions of technological problem solving effectiveness as compared to humanities students.

Demographic Variables. These consisted of student grade level, work experience, GPA, and gender. It could be expected that seniors would have higher self-confidence, personal control, and approach than freshmen (Heppner, 1988). These differences would also be expected to translate into differences in technological problem solving because technological problem solving is a significant component of industrial technology and engineering programs.

The sampled students' work experiences were classified by type and amount of general and/or technological experience. Differences in work experience might not logically be expected to influence PSI-PSYCH scores. However, if there is indeed a difference between personal and technological problem solving, differences in technological work experience could well affect PSI-TECH scores.

Students' Grade Point Averages (self reported) were also examined. It could be anticipated that students with low and high GPA scores might show significant differences in their PSI-PSYCH scores. For example, students who are successful in school subjects could be expected to demonstrate similar levels of success in personal problem solving. The reverse could well prove to be true with the PSI-TECH scores.

Gender was another factor that might affect PSI-PSYCH and PSI-TECH scores differentially. In this study, male and female responses were compared to examine the pattern of problem solving style characteristics for both personal and technological problem solving.

Population & Samples

The study's population was considered to be mid-west public university students. From this population, the respondents were purposively selected, by class, from industrial technology students at Murray State University (Kentucky), Pittsburg State University (Kansas), and Central Missouri State University; engineering students at the University of Missouri-Columbia and the University of Missouri-Rolla; and humanities students at the University of Missouri-Columbia, Central Missouri State University, and Murray State University (see Figure 3).

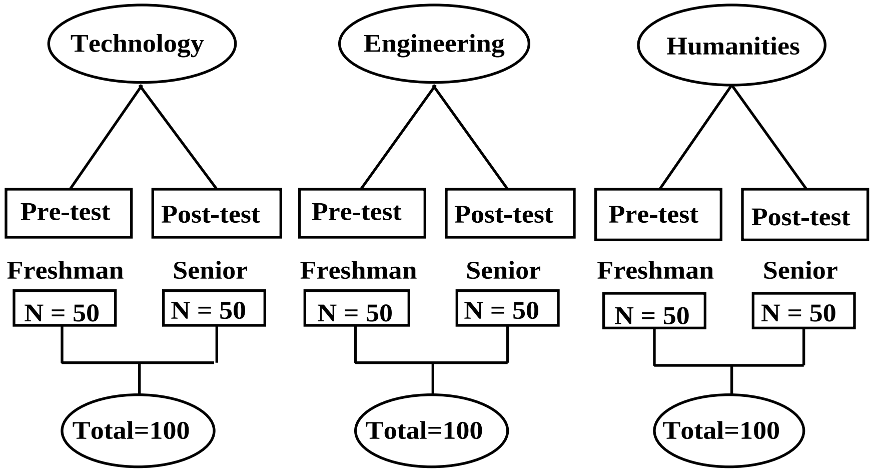

Figure 3. Research Samples

This approach of assembling a sample from several universities was used because of the difficulty of finding accessible midwest universities with sufficient enrollment in each of the three target programs. Furthermore, the focus of analysis was on discipline rather than individual universities. The minimal specified N was 300, consisting of 100 technology students, 100 engineering students and 100 humanities students. This targeted sample size was based on an anticipated medium effect size and a desired power of 0.70 (Stevens, 1992). However, because of the *sample by class* strategy used to ensure the targeted numbers of freshmen and seniors, an oversampling approach was used. This was to compensate for anticipated high numbers of sophomores and juniors in the selected classes. The final sample was derived from the five collaborating universities and it was assumed that since approximately half the sample came from a Research-I university and half from regional universities, that the sample was representative of the population (see Table 1).

Table 1
Student Sample By Major, Level and Institution

	Student Major						
	Technology		Engineering		Humanities		
University	Freshman	Senior	Freshman	Senior	Freshman	Senior	Total
UMC	0	0	41	27	44	35	147
UMR	0	0	9	23	0	0	32
MSU	22	21	0	0	2	7	52
PSU	22	20	0	0	0	0	42
CMSU	6	9	0	0	4	8	27
TOTAL	50	50	50	50	50	50	300

Instrumentation

Two test instruments were used to collect data on the dependent variables. The Personal Problem Solving Inventory, Form B, developed by Heppner (1988) was termed PSI-PSYCH. The Technological Problem Solving Inventory (PSI-TECH) was a modified version of the Personal Problem Solving Inventory created by altering *only* the directions to focus respondents on technological problem solving rather than personal problem solving. Specifically, the PSI-PSYCH version asked the respondents to think of personal relationship types of problems and then illustrated with depression, choosing a vocation, and inability to get along with friends. In contrast, the PSI-TECH version asked them to shift their mindsets to technological problems and then used examples such as lights that do not light, doors that stick, and a car that does not start. The PSI is scored such that high scores indicate low levels of a given quality. For example, the relatively high score for the humanities students on the PSI-TECH form of the instrument should be interpreted as low levels of problem solving self-confidence, high avoidance, and low personal control. Permission for the inclusion, modification and reproduction of both inventories was granted by the instrument's publisher.

The Personal Problem Solving Inventory (PSI-PSYCH). This inventory is a standardized self-report measure designed to assess perceptions of personal coping problem solving styles and ability (Heppner, 1988). Factor analysis revealed three factors: (a) problem solving confidence, (b) approach/avoidance, and (c) personal control (Heppner & Petersen, 1982). In essence, people who perceive themselves as effective problem solvers (having high confidence, high personal control, and a positive attitude on approaching problems) differ significantly from those who perceive themselves as ineffective (lacking confidence and personal control, and avoiding problems). In addition, the PSI has been found to be significantly correlated with behavioral observations of actual problem solving competence (Heppner, Hibel, Weinstein, & Rabinowitz, 1982). Reliability estimates revealed that the three factors were internally consistent (coefficient alpha a = 0.72 to 0.90) and stable over a two week period (0.83 to 0.89).

The Technological Problem Solving Inventory (PSI-TECH). The PSI-TECH inventory was a modified version of Heppner's (1988) PSI-PSYCH. This approach to investigation was used because it appeared reasonable that careful modification of an existing tool, with established psychometric properties, was preferable to developing a new inventory. The only change made to create the PSI-TECH inventory was in its directions to deliberately shift the respondent's focus from personal to technological problem solving. The thirty five questions that form the actual inventory remained unchanged.

Demographic Information. A form was developed and included with the instruments to collect necessary demographic information; gender, age, academic level, work experience, and college grade point average.

Pilot Study

During April 1993, a pilot study was conducted to explore the instrument's usability with three groups of university students (technology, engineering and humanities). The results indicated that clearer directions were needed to adequately focus the respondents on the distinction between technological and personal problem solving. Consequently, additional examples of the two types of problem solving perspectives were developed and added to the directions. Additionally an explicit set of verbal instructions was developed to focus the subjects' attention on the key differences between the two instruments. These changes (both written and verbal) were reviewed by a sample of pilot test participants to confirm that the distinction between the instruments had been achieved. To further emphasize the distinction, the two forms of the instrument were color-coded.

Data Collection and Analysis

The data were collected from students in the three different disciplines. A trained test administrator asked students to respond to the two different forms of the instrument. The order of administration was reversed for half of the sample to control for administration order bias.

A 3 x 2 x 2 multivariate analysis of variance procedure was used to compare the various mean scores [three levels of discipline programs (technology, engineering and humanities), two levels of student's academic levels (senior and freshman) and two levels of different work experience (general and technological)]. The six dependent variables used in the study consisted of the subscales of the two forms of the instrument (problem solving confidence, approach/avoidance style, and personal control for both the PSI-PSYCH and the PSI-TECH). Subsequent to MANOVA analysis, a split plot univariate analysis of variance was conducted to explore the effects of the various levels of the factors (three disciplines) on the multiple dependent variables. This approach was necessary in order to provide a method of testing the differences between the two composite scores and among the six subscales. A probability level of 0.05 was used throughout to judge the findings.

The PSI-PSYCH and PSI-TECH means and standard deviations for all subjects were calculated. For normative purposes, PSI norm means and standard deviations from the PSI-PSYCH college student samples of Heppner (1988) were also consulted.

Several preliminary approaches were employed to analyze the data. A regression analysis detected no significant relationship between GPA, age, and students' personal or technological problem solving styles. Thus, it was concluded that the effects of these variables need not be included in the overall data analysis model. No attempt was made to compare male and female scores because of low percentages of females responding in engineering and technology programs and the analytical method's requirement for equal cell sizes. Further justification for this decision is based on Heppner's previous research with American college students, which has consistently indicated a lack of statistically significant differences on PSI-PSYCH scores between the genders (e.g., Heppner, et al., 1982; Heppner, Reeder, and Larson, 1983; Larson & Heppner, 1985; Neal & Heppner, 1986; Mcallister-Salehi, 1990). Given that Heppner’s findings with respect to gender differences about problem solving style are different than the PATT research (de Klerk Wolters, 1989) about attitudes towards technology, this suggests that these two characteristics (style and attitude) are different.

During the Winter and Summer semesters of 1993, pre-test data were collected from 180 freshman students and post-test data from 204 senior students. Data were gathered from purposive samples representing the study’s three academic majors. In all, instruments were distributed to 750 university students. A total of 546 or 72.8% of the distributed instruments were returned. After eliminating those instruments which were incomplete or which had been completed by students who were inappropriate for this study (e.g., by sophomores and juniors), 384 or 70.3% of returned instruments were usable. The actual 50 students used in each cell were selected on a random basis from the returned and usable instruments.

Findings

The demographic characteristics of the sample include gender, age, academic major, academic level, amount and type of work experience, and grade point average. The data showed that the highest percentage of students involved in this study was male (67.7%) with ages ranging from 17 - 51 years old. The average age was 22.6 years. Their average GPA was 3.02 with the majority reporting in the 3.0 - 4.0 range. The average general work experience (e.g., sales, fast food worker, grocery store shelf stocker, etc.) was 2.37 years, whereas the average technological work experience (e.g., farm work, factory work, etc.) was only 1.73 years. In addition to the two types of work experience, the actual amount of experience was stratified into two levels; one with no work experience and one with more than three years work experience. Higher percentages of general work experience were reported (111 - 37%) than for technological work experience (68 - 22.7%) (see Table 2).

Table 2
The Number and Percentages of Students Selected for the Study by Gender, Age, Program, Level, Work Experiences, and Grade Point Average

Variable	Category	Number	Percentage
Gender	Female	97	32.3%
	Male	203	67.7%
Age	17 - 20 years	109	36.3%
	21 - 25 years	137	45.7%
	26 - 30 years	33	9.0%
	31 - 35 years	14	4.7%
	36 - 40 years	5	1.6%
	More Than 41 years	2	0.7%
Academic Major	Technology	100	33.3%
	Engineering	100	33.3%
	Humanities	100	33.3%
Academic Level	Senior	150	50.0%
	Freshman	150	50.0%
Work Experience			
General	No Experience	102	34.0%
	Some but less than 3 years	87	29.0%
	More than 3 years	111	37.0%
Technological	No Experience	181	60.3%
	Some but less than 3 years	51	17.0%
	More than 3 years	68	22.7%
GPA	Less Than 1.99	4	1.3%
	2.00 - 2.99	110	36.7%
	3.00 - 4.00	186	62.0%

Cronbach's coefficient alpha estimates of internal consistency reliability were computed for each of the three subscales on both forms of the instrument (PSI-PSYCH and PSI-TECH). For the three subscales (problem solving confidence, approach/avoidance, and personal control) of the Personal Problem Solving inventory (PSI-PSYCH) these estimates were 0.85, 0.80. and 0.71 respectively. On the Technological Problem Solving Inventory (PSI-TECH) the same three subscales yielded alpha coefficients of 0.88, 0.81, and 0.76 respectively. The estimates obtained in this study were very similar to those obtained by Heppner (1988) and were judged to be sufficiently high to warrant the use of the PSI-TECH on the basis of reliability.

Question One - Overall and Subscale Score Analyses

This research question focused on the effect of participation in the three academic majors on personal and technological problem solving style scores. Problem solving styles of groups of university students with a high inclination to and involvement with technology were compared to those with a minimal inclination and involvement. The intent was to ascertain if any significant differences existed among the groups with respect to their problem solving styles. If such differences did exist, this would suggest the existence of a difference between technological and personal problem solving.

No significant differences were detected *among* the three majors on the overall personal problem solving scale (PSI-PSYCH). However, the findings *did* reveal, pursuant to acceptance of the sampling assumptions, statistically significant differences *among* the overall PSI-TECH scores comparing engineering, humanities, and technology students. On the PSI-TECH, the humanities students had the highest score (least positive) while the engineering students had the second highest score and the technology students had the lowest score (most positive). (As documented in this article's instrumentation section, it is important to note that *Low* scores on the PSI indicate high levels of problem solving self confidence, high approach behavior and high levels of personal control.)

The difference between personal problem solving and technological problem solving scores *within* the individual disciplines was found to be significant for humanities students and technology students, but not for engineering students. Humanities students had the highest scores (least positive) in technological problem solving and the lowest scores in personal problem solving. Technology students had the lowest scores (most positive) in technological problem solving and medium scores in personal problem solving (see Figure 4).

The data were also analyzed at the sub-scale level. Significant differences were found when comparing the two problem solving style subscales (problem solving confidence, and approach/avoidance) for both PSI-PSYCH and PSI-TECH scores across the three disciplines. Further comparisons of scores on each of the technological problem solving confidence, technological approach/avoidance, and personal control subscales among the three purposeful samples of students revealed that humanities students had the highest scores (i.e., were least positive) on all of the three technological subscales, while engineering students had medium scores and technology students had the lowest scores (i.e., were most positive) on each of the three subscales.

PSYCH problem solving confidence and TECH problem solving confidence. The differences between the self-confidence levels of humanities and technology students and between engineering and technology were significant for TECH problem solving confidence. There were no significant differences in PSYCH problem solving confidence subscores among technology, engineering, and humanities students. There was, however, a significant difference between the PSYCH problem solving confidence and TECH problem solving confidence subscores for humanities students but not for engineering or technology students.

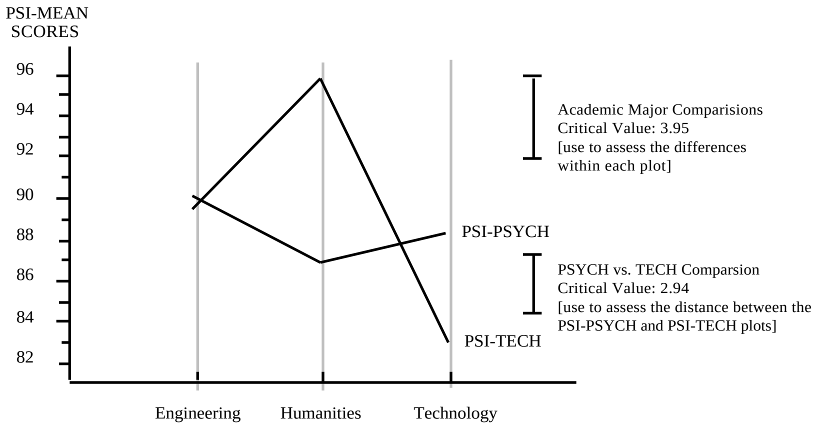

Figure 4. Comparison Between Personal Problem solving (PSI-PSYCH) and Technological Problem solving (PSI-TECH) Scores of Three Academic Majors

PSYCH approach/avoidance and TECH approach/avoidance. The differences among academic majors were significant on the TECH problem solving approach/avoidance scale. Differences between the PSYCH approach/avoidance and TECH approach/avoidance subscores of humanities students and between PSYCH approach/avoidance and TECH approach/avoidance subscores of technology students were also significant, but this was not the case for engineering students.

PSYCH personal control and TECH personal control. None of the differences in this subscale were significant, across either the personal or technological dimensions among the three academic majors. Also, no difference was detected between PSYCH and TECH problem solving for each discipline.

Research Questions Two and Three

No significant differences were found between freshmen and seniors on either the overall personal or technological problem solving scores or on the subscales. There were also no statistically significant differences in either form (personal or technological) of problem solving style related to amount and type of work experience. No significant interactions were found among academic majors, levels, problem solving types and subscores.

Conclusions

The following conclusions were drawn pertaining to the differences between personal and technological problem solving styles. The consistent lack of significant differences across the three academic majors along the personal problem solving style dimensions indicate that students in distinctly different academic majors are similar in personal problem solving style. However, significant differences on the technological problem solving dimension across all three academic majors suggest that students in different academic majors differ in technological problem solving style. This pattern of differences was also consistent across the subscore profiles for PSI-PSYCH and PSI-TECH forms of the instrument. Specifically, for a given discipline, when a technological confidence score is low, the approach/avoidance and personal control scores also tends to be consistently low.

Given the significant differences between PSI-PSYCH and PSI-TECH scores for humanities and technology students (2 of the 3 academic majors), it may be concluded that there is a high likelihood that personal and technological problem solving styles for these two groups of students are different. However, no significant difference existed between these two problem solving styles (personal and technological) for engineering students. This may be explained by noting that engineering has grown to be highly abstract, theoretical and removed from practical hands-on applications (i.e., closer to the Humanities in Figure 2). Given that the PSI-TECH instrument instructions defined and illustrated technological problem solving in a highly applications-oriented manner, it is not surprising that the response patterns of engineering and technology majors were different, even though both deal with technology. The difference between the results of engineering and technology students suggests that there may be multiple forms of technological problem solving (i.e., a distinction may exist between applied and theoretical technological problem solving style) (For a more in-depth discussion of this point, see Custer, in press).

Given the persistent lack of significant differences between freshmen and seniors, it can be concluded that four year degree programs do not substantially change either an individual's personal or technological problem solving style. Similarly, work experience also does not appear to affect either personal problem solving or technological problem solving styles.

Discussion

One purpose of this study was to explore whether style differences existed when students were confronted with different types of problems. Given that these two types of problem situations are typically quite different in nature, intuitively it makes sense that the problem solving styles used to solve them would also differ. For example, a psychology major might be expected to be more self confident in resolving a conflict with a friend than in repairing an automobile. The results of this study provide evidence supporting that such differences between technological and personal problem solving style may, in fact, exist. This suggests that problem solving style is one of the important individual differences university students bring to their study of, and interaction with, technology.

No significant differences were found in personal problem solving style among the three different academic majors. In this case, personal problems refer to problems such as depression, interpersonal conflicts, agonizing over important life decisions, etc. It could have been anticipated that humanities students would have different personal problem solving styles than their more technically-oriented engineering and technology counterparts. The results of this study did *not* bear this out. Instead, it appears that college students are, by and large, fairly homogeneous when it comes to personal problem solving style.

However, a very different pattern emerged when the focus shifted to technological problem solving styles where significant style differences *did* exist among different academic majors. In terms of technological problem solving style, different discipline areas seem to be populated by different types of people, as demonstrated by their differing PSI-TECH scores. As noted above, this makes intuitive sense because college students are not homogeneous in terms of technological interests, background, or ability.

At this juncture, a comment should be made regarding an essential distinction that must be maintained between style and capability. The focus of this study was deliberately and exclusively on problem solving *style* rather than *ability*. While it might be anticipated that some correspondence could exist between the two, an examination of such a relationship was clearly beyond the scope of this research. It is also important to note that style, defined as a tendency to respond in a certain way, is something different than strategies actually used to solve problems (e.g., spiral, four-step, rational, etc.).

Educational levels did not appear to affect problem solving styles. This study found that the differences in the overall personal and technological problem solving scores, and their subscale scores, between freshmen and seniors were not significant. Congruent with this finding, Neal (1983) found that there were no significant differences between freshmen and seniors in personal problem solving. One possible explanation is that the time span between the freshman and senior years (three years in this study) is not long enough to effect major change in personal problem solving style. Again, it is very important that style not be confused with knowledge and/or capability. Certainly college programs are predicated on the assumption that they augment knowledge and capability but this was not measured by this study.

This study found no significant relationship between work experience and problem solving style. These results were somewhat different from the research findings of other studies (Gabel & Sherwood, 1984; Johnson, 1988; Malone, 1987; Pumipuntu, 1992; Reeder, 1986). The Gabel and Sherwood (1984) study indicated that prior knowledge or experience was a factor in determining student success in problem solving. Johnson (1988) found that the problem solver's knowledge, past experience, and expertise affected problem solving behavior. One reason for this study not being supportive of Gabel and Sherwood's (1984) and Johnson's (1988) results may be that their studies focused on *ability* rather than *style*.

Implications

Problem solving has become an important survival skill in our technologically advanced society. In technology education areas, teacher and curriculum design studies are increasingly calling for more emphasis on "higher-order thinking skills" and technological problem solving. The prominence afforded to problem solving by the technology education profession (Savage, et al., 1990) coincides with the critical thinking/higher order skills thrust which is occurring throughout education. Therefore, both general and technology teacher educators and researchers would be well advised to explore methods of enhancing the problem solving skills of their students.

The results of this study suggest that personal and technological problem solving styles may well be separate and distinct. The tendency in education has been to employ the term "problem solving" generically to include such diverse activities as coping with marital problems and trouble-shooting electronic circuits. The results of this study suggest that such generalization may be inappropriate. Instead, problem solving should be viewed as nature specific. In other words, different types of problem situations (e.g., personal or technological) require different kinds and levels of knowledge and capability. This is substantiated by this study's findings that individuals manifest different style characteristics when addressing problems of different natures.

It was also noted that problem solving style did not change from the freshman to the senior year. Despite this stability over a three year period, however, it is conceivable to posit that were a longer treatment period employed, (e.g., the twelve years from grades one to twelve), it would be more likely that significant change could be effected. The reason such earlier involvement (particularly elementary school level) might have a substantial effect on problem solving style is that the impact would be felt before critical style and attitudinal characteristics solidify in students (around ages 10-14) as documented by de Klerk Wolters (1989). Thus, this suggests that problem solving, and particularly technological problem solving, education should begin in the elementary grades to encourage children to actively explore and interact with both personal and technological problems when they are inherently curious about and actively engaged with their world and while their problem solving styles are still in the developmental process.

This study suggests implications for technology education teachers as well. Much remains to be learned, not only about problem solving style but also about how students solve problems and how to teach students how to do so more effectively. Furthermore, given the likelihood that technological and personal problem solving are different it is necessary for teachers to be able to assist students in learning how to solve both types of problems. Therefore, it may also be important that teachers' knowledge and training be extended to include an awareness and appreciation of the myriad of factors, psychological and technical, and including problem solving style, which affect problem solving.

Additional research should include longitudinal studies designed to investigate the evolution of problem solving styles and capabilities, both general and technological. Additionally, in-depth studies pursuing the relationship between problem solving style and actual problem solving capability/effectiveness are also needed.

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Editorials

Program Equity and the Status of Technological Education: The Apologetic Nature of Technology Teachers

Ronald Hansen

Equity issues are often a formalized part of teacher certification programs. Their relevance and importance, beyond underscoring the egalitarian mission of schools, is to sensitize teacher candidates to the many cultural, social, political, and economic concerns which are relevant to students' welfare and performance in schools. Seldom discussed, however, is the way that the subjects or programs in which students register are victimized or segregated as a result of a program being mis-represented or treated in a different way from other subject areas. This paper will examine differential treatment issues with respect to programs, particularly the importance and place of technology education in relation to liberal/humanist programs. Is there a subtle but significant bias among school and university educators that needs to be explored or exposed? Are technology programs and, by association, technology educators victims of a subtle but deeply entrenched set of anti-technology values and attitudes held by people, schools, and the community? If such sentiment exists, how universal is this viewpoint and what can be done about it?

The premise that schooling and, by association, teacher education, are not neutral in their organization and curriculum content with respect to program equity is one that investigators in a recent teacher development project at The University of Western Ontario (Hansen, 1995) analyzed in their research. The literature is conspicuously vague about the problem. The one exception is Goodson's (1987) writing in which technical education in Britain is analyzed and depicted as too utilitarian to be a mainstream subject in schools. What is found in the literature is expressed in terms of either classism in the schools or program politics. Wotherspoon (1987), for example, suggests that "despite claims for 'democracy,' 'objectivity,' and 'equality of opportunity,' schooling has continued to reinforce a social structure which is highly stratified along class, gender, and racial lines" (p. 2).

The idea that some school policies and practices may work against rather than for the betterment of all student groups may seem a radical and absurd one to raise. However, the notion of schools proclaiming "equality for all" but also serving as a screening mechanism which segregates students into less than equal

Ronald Hansen is a Professor on the Faculty of Education at The University of Western Ontario, London, Ontario, Canada.

groupings was found during the teacher development project (Hansen, Fliesser, Froelich, and McClain, 1992), to exist and to be significant. Moreover, technology teachers , albeit unknowingly, were found to be perpetuating rather than discouraging such program differentiation. Project investigators assumed that an understanding of the political realities that face technology educators in their day to day practice was/is crucial to personal survival and ultimate effectiveness, in instructional activities and in everyday school programming matters.

Naively, many people, teachers included, assume schools are democratic institutions and every student has an equal opportunity to achieve the literacies espoused in educational goal statements. Others recognize that schooling is a socializing process in which people are screened by attribute and ability for certain roles in society. Few understand how the screening purpose of schooling (Collins, 1979) prospers and how subject/program status promotes or deters this unwritten purpose of schools. Just recently, a university faculty member announced to a colleague (a school principal) that efforts to secure tenure had been successful. The colleague's response was: does this mean that you can now teach some subject other than technology? One might infer from this anecdote that teaching in the field of technology is not much of a calling, perhaps in comparison to other more classic subject areas. This story suggests there is an inferior status associated with technological education as a subject/program.

The Complexity of Equity Problems

Equity is defined as a system of rules and principles based on fairness and justice. It covers cases in which fairness and justice require a settlement not covered by common law (Canadian Senior Dictionary, 1979). It is most often rooted in the democratic and ideal notion of justice and equality for everyone. It is manifest in many forms within Canadian and American societies. The most prominent of these forms are class, gender, and race, (Government of Ontario, Ministry of Education Report, 1987). The themes common to all three forms are underepresentation, stereotyping, disenfranchisement, misunderstanding, bias, discrimination, and prejudice. Given these themes at least three important issues for technology educators can be identified. Is the subject/program misrepresented in school and university settings and, if so, why? What form does the misrepresentation or misunderstanding take? Is the underepresentation significant?

Exposing or illuminating the technology program equity problem which besets schools and teachers is a challenge. The problem, like many forms of differential treatment, is often so prevalent that it is taken for granted and accepted as part of everyday practice without being scrutinized. A hierarchy between or among school subjects, by definition, undermines the goals and purposes of schools. Why would learning activities undertaken in the name of human development for all need to be differentiated. As educators, we are guilty of modeling inequity the moment we give special status to people or programs. Equity issues, as such, are important to understand, especially for teachers and teacher educators.

In sociology of education terms, schools initiate the working class versus governing class distinctions found in communities and regions across North America. Much of the literature on the conflicting purposes of schooling over recent decades (Bowles and Gintis, 1976), has brought attention to both the latent and manifest function of schools. Teachers and school leaders seem to have an insufficient understanding of the dissonance between espoused purpose and actual function so as to be able to counter it through teaching and curriculum policy. Or, if they understand it, they choose to ignore it as something over which they have no control. At the personal level most teachers will acknowledge often making unique or unusual decisions regarding a particular student or group of students because of some intangible factor. When asked about such decisions teachers elude to correcting an injustice without making a big issue out of it. The prudent teacher simply addresses what he or she perceives to be an imbalance. The same scenario could be played out for a school principal who is responsible for the allocation of finite resources across a range of subjects or programs. In both cases the action taken may or may not have been in the best interest of the student(s) or program(s).

At the state or provincial level the imbalance and subsequent action associated with the imbalance is more complex. The opportunity for corrective or judicious action is also more cumbersome. A recent Royal Commission report (Government of Ontario, Ministry of Education and Training, 1995) articulated the dilemma very clearly. The challenge, according to the report, is one of balancing excellence and equity. Paquette (1995), in a review of the report, articulated the challenge for school leaders as a "troubling nexus". The schools are, on the one hand, victims of the "the popular but destructive myth of 'excellence for all'" (p. 1). Equity, on the other hand, "lies in the distribution of education benefits across the population as a whole" (p. 1). The authors admit, states Paquette, that it is better to be honest at the outset about what the school system is capable of.

> ....only a substantial minority will receive truly superior standing in the multiple literacies offered as a basis for renewing the Ontario curriculum. That, in my view, is a crucially better and more realistic stance from which to embark on educational improvement, than creating unfulfillable expectations of excellence for all--as so many other recent educational policy statements and proposals in this country have done. (p. 1)

The Apologetic Nature of Technology Teachers

During the teacher development project at the University of Western Ontario (UWO), the preconceptions and perceptions of a sample group of teacher candidates were probed (Hansen et al, 1992). Project investigators wanted to know if technology teacher candidates could conceptualize the "competing purposes" view of schooling. All student participants questioned were sure the intent of the schools was to help students develop their intellectual, affective, and psychomotor skills. Even direct discussion about an alternative purpose for schooling was greeted with disbelief. How could the main purpose of school practice be anything less than a completely democratic one? Attempts within the teacher education program (foundation and curriculum courses) to provide a broader picture and perspective, moreover, made little difference in the deeply held conviction and mind-set that schooling truly gave every student an equal chance at success. For some reason many of the technology teacher candidates in the project could not accept that a larger and more complex reality might exist. Investigators found many of the randomly selected participants to be almost apologetic in their personality make-up, about both their own achievements and their role as autonomous and reflective professionals.

The conclusion we reached is that teachers need a comprehensive and discerning mind-set to guide them in their everyday practice. The classification of school subjects is an issue, for example, about which technology teachers should be informed. Good policy development and practice within and across schools is enhanced when teachers are involved in the process. The "competing purposes" function of schooling must be more widely proclaimed and addressed. The school system is designed first and foremost to be egalitarian. These positions and opinions, moreover, are central to the teacher development process, especially for technology teachers.

The Challenge in Technological Teacher Education

Based on the perceived differential treatment experienced at The University of Western Ontario by teacher educators and associate teachers in nearby schools, a pro-active teacher education curriculum for teacher candidates was designed. The professional development patterns that emerged from the teacher development project suggested there was a need to modify how technology teachers were recruited and prepared in teacher education programs, if a more reflective and proactive kind of teacher who could recognize, understand and resolve equity matters, was to emerge. For starters, teacher candidates with formal postsecondary studies in the social sciences as well as technological expertise, were/are recruited to the profession. In the teacher education program itself, case studies were developed, refined, and inserted into the curriculum. Their content built upon leadership and curriculum policy experiences. The preconceptions of candidates were also identified at the beginning of the program and teacher candidates asked to establish a set of goals for themselves. In short, teacher and curriculum development was conceptualized and the program re-designed in such a way that equity issues were an important segment of the curriculum. The framework was/is one within which curriculum studies in technology can be liberated.

One case study (Hansen, 1995) looks constructively at the arguments for and against technology as a curriculum area in the schools. It [the case] is germane to the program equity problem outlined in this paper.

> The ideological connections technological education is perceived to have with business and industry provide a vivid example of how technology educators and programs are often labeled by others. Those connections, according to Apple (1990), make technological education vulnerable to the "corporate agenda". Policy level leaders who treat programs and students differentially will continue to do so, Apple suggests, unless their biases and

prejudices are exposed. The claim made recently by a faculty member at a nearby university serves as a case in point. His view was that many educators, technology educators in particular, serve business and industry interests rather than the interests of students and the schools. Such "social engineering", the faculty member suggested, is contrived and propagated by business and industry to produce yet another generation of human widgets for business and industry exploitation. His argument was countered by an opposing and equally compelling position outlined in the following quote:

> Educators, who in the name of "humanistic" education or any other slogan, refuse to entertain manpower [sic] considerations in educational planning should ponder whether anything is less humane than for their students to experience unemployment or demeaning, inappropriate employment after years of well-intentioned and hopeful endeavour under their tutelage. (Pratt, 1980, p. 70)

One might well ask of the conspiracy theory advocates: which is worse, preparing our young for a world of work characterized by differentiated roles, or perpetuating a school system which inadvertently or willfully condones bias? Imagine you are a professional teacher trying to fully and successfully articulate a position which neutralizes the conspiracy view. What arguments would you make and how would you express them?

Real instances of competing interests are a common feature of institutional life in universities and schools. Students benefit from group discussion and analysis of them. In fact, the case study method may be the only way to prepare teacher candidates for program politics.

Layton (1993) describes technological education as the only subject/program area in schools which contextualizes knowledge. Such a statement is encouraging to and supportive of technology educators trying to map out the program and research terrain for this emerging field of study. However, technology teacher educators and the research associated with teacher development need to assist prospective teachers with conceptual frameworks for contextualizing issues beyond knowledge. Such context can be built into curriculum courses. It can also be an important factor to consider in the recruitment and selection practices of education faculties as they improve their programs. Teacher candidates who have both the necessary characteristics and competencies to teach, and the political savvy to survive in antagonistic institutional environments need to be identified and recruited into the profession. Our teacher education syllabi need to include curriculum conflict resolution strategies.

The general principles that were developed at UWO to guide the teacher education program included; a "students are all equal and capable" conception of human development, attitudes and belief systems (one's preconceptions) need to be continually scrutinized by oneself and checked against changing social situations, technology as a subject/program serves a liberal as well as an instrumental purpose, and institutional policies and practices are often politicized thereby requiring political responses.

At issue and associated with the "political will" principle is whether or not technological education is to be fully included in or excluded from the curriculum of the schools. Curriculum reform has the potential to increase the relevance of school courses by introducing reasoned and balanced views of technology, or it may falter due to on-going misunderstanding and distrust among rival interest groups. The good intentions and work of all teachers, when and where differential status problems exist, can be undermined by feelings of inadequacy, anxiety, powerlessness, uncertainty, and alienation. Differential treatment is a silent and subtle phenomenon and such feelings often enslave and limit segregated individuals and groups. Technology educators would do well to be alert to rhetoric, well-intentioned but oblique leadership, and complex outside interests, as they prepare themselves for a politicized profession.

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Book Review

Arnow, Jan. (1995). *Teaching Peace*. New York, NY: The Berkley Publishing Group, $12.00 (paperback), 239 pp. (ISBN 0-399-52155-0)

Reviewed by Dale L. Kohlsmith

Teaching Peace, by Jan Arnow, is an excellent resource for teachers interested in reforming schools. This book discusses two primary problems facing our public schools today: violence (in its various forms) and discrimination. Of particular importance to technology teachers is the discussion of gender discrimination in the areas of mathematics, science and technology. The book is not about teaching peace as much as it is a manual on identifying discrimination in culture and schooling. *Teaching Peace* provides several suggestions for addressing discrimination and resources for the motivated teacher.

Many schools are plagued by violence and forms of discrimination. Patterns of discrimination in classrooms can be selective, such as gender biases made manifest in mathematics, science and technology practices. Teaching Peace recognizes this issue and proposes solutions. The book identifies several sources that can help interested teachers reform their practices. For example, Arnow points out that boys and girls approach learning from different perspectives: "Girls prefer to use conversational style that builds group accord. . . [while] boys learn through argument, individual activity and independent work. . . which is in direct opposition to the learning style of girls." Furthermore, "the mathematics, science and technology classes support the learning style of boys and leaves out a large percentage of the learning styles of the learning community." The solution is first of all becoming aware of the differing styles of learning and then incorporating them into the classroom. *Teaching Peace* provides several sources for doing just that under the headings of "For your Information" and "Equity in Technology" which list both books with ISBN numbers for ordering and information files through ERIC. Additionally Arnow lists several organizations which offer education in gender fair training under the heading of "Programs that Work."

This book is written for two audiences, parents and teachers. From the parents' perspective, it is an informative eye opener, with most plans of action urging parents to push teachers to act. For the teachers, it is a clearly laid out plan on how to recognize discrimination and violence in schools and classrooms. Arnow provides several plans of action for raising self-esteem, reducing peer pressure, interpreting media images, breaking down stereotypes, developing

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Dale Kohlsmith is an Instructor in the Department of Visual Communications & Technology Education, Bowling Green State University, Bowling Green, OH.

critical thinking and producing practical solutions. For instance in the area of interpreting media images, which falls into the category of visual communication technologies, Arnow provides multiple examples under the headings of "What You Can Do." One example is "giving your (students) journals and asking them to jot down a note about every reference to aggression in the media that they encounter during a week's time, real or fictitious. . . Not only will this give you a platform from which to begin a serious dialogue about aggression and violence, but you will also have a clearer concept of the sheer quantity of aggressive messages to which your (students) are exposed on a daily basis."

Multi-cultural issues apply to all teachers, but those in the mathematics, science and technological content areas need to be all the more gender-sensitive. Conscious efforts to include females and eliminate discrimination in these content areas are essential to reform. Over twenty percent of this book is focused directly on the issue of gender inequality in the areas of mathematics and science. Gender discrimination is not only found in classroom instructional methods, but also in the support materials teachers use: the text books, the films, and other media sources. As unwitting participants in gender discrimination, teachers must be aware of the messages that they are sending in content and of their students' need for appropriate role models. This book not only points out some solutions but also has several sections titled "How Do You Rate?" which present probing questions that will help instructors evaluate the materials they presently use for instruction. Examples include: "Are all teaching materials free of stereotypes, presenting accurate, multidimensional pictures of cultural groups?" and "Can each of your students see in her classroom a picture or some other visual image of someone with whom she can identify?"

Teaching Peace is not preachy, and it tackles some tough issues which ought to be dealt with. It is easy reading, with many charts and questionnaires to support the text. It identifies problems, and then provides suggestions to bring about solutions. More importantly, *Teaching Peace* provides resources for obtaining additional information on specific problems; many by traditional means as well as e-mail or World Wide Web sites. This book is an excellent resource for any teacher interested in helping to bring their technology classroom or laboratory in line with reality. Multi-cultural and gender issues in the mathematics, sciences and technologies are of paramount concern. The more knowledgeable we are about the issue, the better we can improve the teaching environment of technology education.

Miscellany

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