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ARTICLES

Standards: Mathematics and Science Compared To Technological Literacy

By Franzie L. Loepp

Standards for Technological Literacy: Content for the Study of Technology was released in April 2000 by the International Technology Education Association (ITEA, 2000). This was the first attempt by the ITEA to set forth comprehensive specifications regarding what students should know and be able to do within each of four grade bands from kindergarten through 12th grade. The purpose of this article is to compare the technological literacy standards with those that have been developed for preK–2 in mathematics (National Council of Teachers of Mathematics [NCTM], 2000) and K–12 in science (National Research Council [NRC], 1996).

Developmental Process

In some ways the development of standards in the three disciplines was similar. The main reason is that other disciplines appear to have used components of the developmental process used by the NCTM. All three disciplines relied heavily on working groups to develop draft standards. They sought input from teachers, teacher educators, and professionals in their respective disciplines. Drafts of the documents were reviewed by large numbers of practitioners, and their input was used to make revisions (Dugger, 2001). By its very nature the developmental process became somewhat political. For example, Dr. John Dossey1 said that while the majority of the leaders in the discipline favored a stronger emphasis on content in statistics, probability, and discrete mathematics, others feared inclusion of new content would detract from traditional mathematics. In the development of science standards, leaders in the subdisciplines of biology, chemistry, physics, and geology were not convinced that a single set of standards could possibly give their area of study adequate coverage.2 In technology, persons from the discipline tended to want a long list (200+) of rather specific standards, whereas the advisory committee, made up of professionals from other disciplines, particularly science and engineering, strongly advised a shorter, more manageable number.3 Nevertheless, each discipline's professional organization did publish a set of standards. Short descriptions of the processes used to develop content standards are provided below.

Technology Education

The development of the standards for technological literacy actually began in 1994 when the Technology for All Americans Project (TfAAP) funded by the National Science Foundation and NASA began to develop a *Rationale and Structure for the Study of Technology* (TfAAP, 1996). Based on this document, additional funding was received to write standards for technology education. A "standards team" made up of three groups (one for grades K–2 and 3–5; one for 6–8; and one for 9–12) was formed to write content standards. The standards team was mostly made up of technology education teachers plus a few administrators and teacher educators. These groups met periodically from 1996 through 1999, writing six drafts of the standards. The TfAAP staff refined each draft and conducted many regional reviews along with electronic reviews. A special advisory group consisting of leaders in technology education, engineering, mathematics, and science reviewed draft documents and provided valuable feedback. The NRC's standards review committee, the National Academy of Engineering special review committee, a National Academy of Engineering focus group, The National Commission for Technology for Education and elementary, middle, and high school field test sites, and hundreds of technology education teachers reviewed drafts of the document. A professional writer was hired to write the finished document that was published. See Table 1 for a listing of the Standards for Technological Literacy (ITEA, 2000). The leaders of the TfAAP are to be commended for managing this complex process (ITEA, 2000).

Mathematics

In 1986, the board of directors of the NCTM established the commission on standards

Table 1. Standards for Technological Literacy

Nature of Technology	
1. The characteristics and scope of technology	10. The role of trouble-shooting, research and development, invention and innovation, and experimentation and problem solving
2. The core concepts of technology	**Abilities for a Technological World**
3. The relationships among technologies and the connections between technology and other fields.	11. Apply the design process
Technology and Society	12. Use and maintain technological products and systems
4. The cultural, social, economic, and political effects of technology	**The Designed World**
5. The effects of technology on the environment	14. Medical technologies
6. The role of society in the development and use of technology	15. Agricultural and related bio-technologies
	16. Energy and power technologies
7. The influence of technology on history	17. Information and communication technologies
Design	18. Transportation technologies
8. The attributes of design	19. Manufacturing technologies
9. Engineering design	20. Construction technologies

Source: ITEA, 2000, pp. 211-214.

for school mathematics to improve the quality of school mathematics. As a result of the commission's efforts, standards were drafted during the summer of 1987 and revised during the summer of 1988. Four working groups appointed by the president of NCTM outlined the draft documents. Each group represented mathematics educators, including classroom teachers, supervisors, educational researchers, teacher educators, and university mathematicians. All work was authorized and reviewed by the commission. In 1989 the *Curriculum and Evaluation Standards for School Mathematics* was published and widely disseminated (NCTM, 1989).

Three years after the standards were published, leaders in NCTM noted that many in their profession thought their identification of content in mathematics was too progressive so they appointed the commission of the future of the standards in 1995 to monitor and review the 1989 standards. By spring 1997, a Standards 2000 writing group and a Standards 2000 electronic format group were appointed, each consisting of teachers, teacher educators, administrators, researchers, and mathematicians. Their primary work was carried out in sessions during the summers of 1997 through 1999. The background information for these sessions was obtained or supported by such groups as Eisenhower National Clearinghouse, the NRC, the National Science Foundation, and NCTM's research advisory committee. Over the course of the development of Standards 2000, 14 association review groups were formed to provide sustained advice and information regarding K–12 mathematics consistent with their organization's perspective. In October 1998, a draft version of the standards was available in print and electronic forms for review. Twenty-five people from a wide range of backgrounds were commissioned to carefully review the draft from their individual perspective. Comprehensive reviews were conducted by more than 650 individuals and more than 70 groups. Nearly 30,000 copies of the draft were provided to interested persons, and thousands accessed the electronic copy. These data were synthesized and provided to a writing group which produced the final document that was disseminated as Principles and *Standards for School Mathematics in April 2000* (NCTM, 2000). See Table 2 for a listing of the content standards for mathematics.

Science

The success of standards in mathematics as well as Project 2061, sponsored by the American Association for the Advancement of Science (AAAS, 1993), caused leaders in science education to initiate the development of national science education standards. The National Science Teachers Association (NSTA) board requested the NRC to coordinate this important task. The U.S. Department of Education and the National Science Foundation provided major funding for this effort. An oversight group, National Committee on Science Education Standards and Assessment (NCSESA), was established. A chairperson was selected and a chair's advisory committee was

Table 2. Mathematics Standards

1.	Number and operations
2.	Algebra
3.	Geometry
4.	Measurement
5.	Data analysis and probability
6.	Problem-solving
7.	Reasoning and proof
8.	Communication
9.	Connections
10.	Representation

Source: NCTM, 2000, pp. ix–xiii.

Table 3. Science Standards

1.	Unifying concepts and processes
2.	Science as inquiry
3.	Physical science
4.	Life science
5.	Earth and space science
6.	Science and technology
7.	Science in personal and social perspectives
8.	History and nature science

Source: NRC, 1996, pp. 13–15.

formed with representation from at least eight professional organizations. This group helped to identify and recruit staff and volunteers for the committees and three working groups (content, teaching, and assessment). Over an 18-month period, input on standards was received from a large number of teachers, scientists, science educators, and other interested parties. Many presentations were made to foster discussion on standards within the discipline. Then a predraft of science content, teaching, professional development, program, and system standards were written and critiqued by selected focus groups. The suggestions received were collated and analyzed, revisions were made, and a document was prepared for public release and review. Approximately 18,000 individuals and 250 groups reviewed this edition. The comments received were again collated, analyzed, and used to prepare the final publication of the *National Science Education Standards* (NRC, 1996). Table 3 includes the science content standards.

Cognitive and Process Standards in T/M/S

In comparing the technology/mathematics/science (T/M/S) content standards, it is interesting to note that science has the fewest with 8, mathematics has 10, and technology has 20. All three disciplines include within their designation of "content standards" standards that are clearly process oriented. Mathematics has the most process-oriented standards with 5; technology, 3; and science, 1+. The process standards in mathematics are problem solving, reasoning and proof, communication, connections, and representation; in technology they are apply the design process, use and maintain products and systems, and assess the impact of products and systems; and in science the primary process standard is science as inquiry, but science and technology has a process element as well. Of special interest is the fact that a discipline such as technology education that has traditionally been highly process oriented only developed three process standards. It can be argued that if these three processes are used in all seven contexts presented in "The Designed World" section, they actually will have high priority in the design of curricula.

Table 4 also shows the number of second-level statements (technology refers to them as benchmarks) in each set of standards, the grade bands in each set, the date the standards were issued, and the Web site where more information can be obtained. With several mouse clicks one can access the entire standards documents in mathematics and science. This makes accessibility quick and affordable.

Source

Each of the disciplines has strategies or standards that are designed to complement or help implement their standards. Along with content standards, science has developed teaching, professional development, assessment, program, and system standards. Mathematics has "principles" within their standards document to set forth the basic precepts that are fundamental to a high-quality mathematics program. The TfAAP has plans to develop assessment, program, and professional development standards by 2003. All three disciplines have implementation workshops or "institutes" to help teachers in the field learn to use the standards. Table 5 indicates topics included in the mathematics and science standards. Similar topics are under development for the technological literacy standards.

Table 4. Comparison of T/M/S Content Standards

Area	# of Stds	Second Level (9-12) Statements	Grade Bands	Date Issued	Website
TECH	17 cognitive 3 process	51 cognitive 15 process	K-2 3-5 6-8 9-12	2000	www.iteawww.org
MATH	5 cognitive 5 process	71 cognitive 18 process	PreK-2 3-5 6-8 9-12	1989/2000	www.nctm.org
SCIENCE	7 cognitive 1 process	27 cognitive 2 process	K-4 5-8 9-12	1995	www.nas.org

Comparison of Similar Standards

Each of the disciplines advocates a particular way to solve problems. In technology this is called design, in mathematics it is problem solving, and in science it is called inquiry. Science also includes design as a part of the science and technology standard. Table 6 illustrates these specific problem-solving strategies. Notice the overlap between the disciplines—particularly between technology and science. Also note the different way each discipline uses the word *connections* in Table 6.

The Impact of Standards on Technology, Mathematics, and Science Education

The impact of the standards for technological literacy is treated separately because there are unique issues. There are a number of positive developments. Support has been received from the engineering community (Gorham, 2002; Wulf, 2000); program standards (Martin, 2002) and assessment standards (Custer, 2001) are on schedule to be completed in 2003 (Dugger, 2001); the NSF has continued to fund the development of curricula based on standards (ITEA, 2002); some states are revising their standards (Mino, Kane, & Novak, 2001; Newberry, 2001); publishing companies are scrambling to produce new textbooks; workshops are being conducted on how to implement the standards6; some teacher education programs are changing to be more in alignment with the standards7; and new standards-based curricula are being developed by the discipline as well as the Center to Advance the Teaching of Technology & Science (CATTS), which is sponsored by the ITEA. However, many questions such as the following remain to be answered: Will technology education become a regular offering in the general education of all K–12 students? Will the human resources (teachers, administrators, teacher educators, etc.) be available to respond to the need for increased involvement in schools? Will technology education become more closely aligned with academic rather than vocational subjects?

The NCTM (not the federal government) identified the need for a common set of expectations so that states would have a guide to follow as they provided direction in preK–12 mathematics. Leaders in NCTM worked hard to develop a document that would be comprehensive and usable by the organization’s constituents. These leaders were actually surprised at the impact their first set of standards had.8 Because of their success, other disciplines followed suit. Let us look at some of the ways mathematics and science standards have influenced education.

1. Nearly all states have used the curriculum

Table 5. Work Completed Beyond Standards

Technology	Mathematics	Science
To be developed (2003)	Principles Equity	Teaching standards Prof. dev. standards
Assessment standards Program standards Prof. dev. standards	Curriculum Teaching Learning	Assessment standards Program standards System standards

and evaluation standards for school mathematics (NCTM, 1989) and national science education standards (NRC, 1996) when developing their own goals or frameworks for math and science for their state. One notable exception is in California where the science standards are more knowledge than process oriented.

2. Significant funding (National Science Foundation, Eisenhower, U. S. Department of Education, Science Literacy, etc.) for the development of mathematics and science curricula as well as for professional development has focused on the implementation of mathematics and science standards.
3. Nearly all textbooks in mathematics and science claim to be "standards-based."
4. Nearly all teacher education programs have changed to be in alignment with the standards. Discipline-specific National Council for the Accreditation of Teacher Education (NCATE) standards for accreditation are also congruent with these standards.
5. Manufacturers and vendors have designed, packaged, and marketed standards-based materials to support teaching and learning in math and science.
6. State and national leaders use the standards to lobby for more resources.
7. The state and national tests now purport to be based on mathematics and science standards. Now that there is common understanding as to what students should know and be able to do, the development and use of standardized tests has become more prevalent.
8. Both sets of standards advocate a new kind of pedagogy—one that is based on research in the areas of teaching and learning, cognitive science, and the function of the brain. This new pedagogy is

Table 6. Comparison of Similar Standards (9-12 BAND)

Technology	Mathematics	Science
Apply the design process • Clearly identify design problem • Identify criteria and constraints • Refine the design • Evaluate the design • Develop a product or system • Reevaluate solution	***Problem solving*** • Build new mathematical knowledge • Solve problems that arise in mathematics and in other contexts • Apply and adapt a variety of appropriate strategies to solve problems • Monitor and reflect on the process of mathematical problem-solving	***Science as inquiry*** • Identify questions and concepts that guide scientific investigations • Design and conduct scientific investigations • Use technology and mathematics to improve investigations and communications • Formulate and revise scientific explanations and models using logic and evidence • Recognize and analyze alternative explanations and models • Communicate and defend a scientific argument ***Science and technology*** • Define a problem or design an opportunity • Propose designs and choose between alternative solutions • Implement a proposed solution • Evaluate the solution and its consequences • Communicate the problem, process, and solutions
The relationships among technologies and the connections between technology and other fields • Technology transfer • Innovation and invention • Knowledge protection and patents • Technological knowledge and advances of science and mathematics and vise-versa (ITEA, 2000)	***Connections*** • Recognize and use connections among mathematical ideas • Understand how mathematical ideas interconnect and build on one another to produce a coherent whole • Recognize and apply mathematics in contexts outside of mathematics (NCTM, 2000)	***Science in personal and social perspectives*** • Personal and community health • Population growth • Natural resources • Environmental quality • Natural and human induced hazards • Science and technology in local, national, and global challenges (NRC, 1996)

referred to as "constructivism" and places emphasis on allowing students to use prior knowledge to new understandings through hands-on, authentic experiences. A careful review of Tables 7 and 8 will help the reader understand the shift in pedagogy from one that is knowledge-based (memorization) to one that engages students in science and mathematics for the purpose of building understanding.

9. The new pedagogy has made it necessary for teachers and administrators to engage in extensive professional development activities.
10. The new pedagogy has also made it necessary to make substantial improvements in facilities.

Personal Experience with Standards

As the director of the integrated mathematics, science, and technology middle school curriculum development project for the past 10 years, this author has had extensive experience in the use of T/M/S standards. Clearly, standards are not curriculum, but they are extremely useful for those who develop curriculum because (a) they provide the scope of content to be included, (b) they give an indication as to what students should know and be able to do for each grade band, (c) they indicate the topics to be included in each grade band, (d) they offer some guidance as to how much priority or time should be devoted to a given topic, and (e) they provide valuable input into the development of student assessments.

Of the three sets of standards, the mathematics standards have been the most useful for those who develop curricula. Each standard tends to be of equal importance, although some standards have higher priority in some grade bands. When one considers the preK–12 bands together, each standard tends to be of equal importance. Each standard is broken into approximately 70 developmentally appropriate subtopics, so it is very clear what students should know and be able to do as they reach the end of a grade band.

Science standards are less user-friendly because they are written in more general terms. In some cases this makes the determination of whether a learner has achieved a standard left to subjective judgment. When a standard has multiple components, the student may have achieved one aspect of the standard very well but another aspect less well. Then it is left to the curriculum developer or teacher to decide if more time needs to be spent on the achievement of the standard. Experience with aligning an integrated mathematics, science, and technology curriculum for at least 20 state frameworks reveals that national standards have influenced their state frameworks. However, in some states the national standards in both mathematics and science are broken down one more level to give more specificity and, thus, clarity as to what content children are expected to master by a given grade level.

The technology standards have definitely expanded the cognitive content to be mastered within the discipline. We have found that most of this added content can be integrated into the application of the three process standards. One problem with the technology standards is that they are inconsistent as to their scope. In other words, some are rather specific and can be mastered in a short amount of time and others are so comprehensive that it could take many class periods to accomplish. Also, the conceptual development of each of the standards from K–12 is in need of improvement. The author has used the standards for technological literacy (ITEA, 2000) on a daily basis since they were released, and he is most appreciative of the direction they provide. However, he would advocate taking a page from the mathematics educators who began to make plans for the revision of their standards three years after they were first released.

Summary

Since the mathematics standards published in 1989 had such a positive impact on the teaching and learning of mathematics, most academic disciplines have developed their own set of standards. In this era of accountability in preK–12 education, content standards play a central role. They define what students should know and be able to do. More and more they are used to develop standardized tests for specific grade levels. This is causing instruction and assessment to be squarely focused on standards, especially in the required subject areas. Although technology education is only required in 14 states (Newberry, 2001), the discipline is fortunate to have content standards and the resources to develop professional development, assessment, and program standards. Together these standards have the potential to make a positive impact on the technological literacy of future generations (Bybee, 2002).

Dr. Franzie L. Loepp recently retired from the Department of Technology at Illinois State University where he served as the Director of the Integrated Mathematics, Science, and Technology (IMAST) Project from 1992-2003. He is a member of the Gamma Theta Chapter of Epsilon Pi Tau and Loepp received his Distinguished Service Citation in 2000.

Table 7. Changing Emphases in Science Education

Less Emphasis On	More Emphasis On
FEDERAL SYSTEM	
• Financial support for developing new curriculum materials not aligned with the *Standards* • Support by federal agencies for professional development activities that affect only a few teachers • Agencies working independently on various components of science education • Support for activities and programs that are unrelated to *Standards*-based reform • Federal efforts that are independent of state and local levels • Short-term projects	• Financial support for developing new curriculum materials aligned with the *Standards* • Support for professional development activities that are aligned with the *Standards* and promote system-wide changes • Coordination among agencies responsible for science education • Support for activities and programs that successfully implement the *Standards* at state and district levels • Coordination of reform efforts at federal, state, and local levels • Long-term commitment of resources to improving science education
STATE SYSTEM	
• Independent initiatives to reform components of science education • Funds to improve curriculum and instruction based on the *Standards* • Frameworks, textbooks, and materials based on activities only marginally related to the *Standards* • Assessments aligned with the traditional content of science education • Current approaches to teacher education • Teacher certification based on formal, historically-based requirements	• Partnerships and coordination of reform efforts • Funds for workshops and programs having little connection to the *Standards* • Frameworks, textbooks, and materials adoption criteria aligned with national and state standards • Assessments aligned with the *Standards* and the expanded view of science content • University/college reform of teacher education to include science-specific pedagogy aligned with the *Standards* • Teacher certification that is based on understanding and abilities in science and science teaching
DISTRICT SYSTEM	
• Technical, short-term, in-service workshops • Policies related to *Standards*-based reform • Purchase of textbooks based on traditional topics • Standardized tests and assessments unrelated to *Standards*-based program and practices • Administration determining what will be involved in improving science education • Authority at upper levels of educational system • School board ignorance of science education program • Local union contracts that ignore changes in curriculum, instruction, and assessment • Knowing scientific facts and information • Studying subject matter disciplines (physical, life, earth science) for their own sake • Separating science knowledge and science process • Covering many science topics • Implementing inquiry as a set of processes	• Ongoing professional development to support teachers • Policies designed to support change called for in the *Standards* • Purchase or adoption of curriculum aligned with the *Standards* and on a conceptual approach to science teaching, including support for hands-on science materials • Assessments aligned with the *Standards* • Teacher leadership in improvement of science education • Authority for decisions at level of implementation • School board support of improvements aligned with the *Standards* • Local union contracts that support improvements indicated by the *Standards* • Understanding scientific concepts and developing abilities of inquiry • Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science • Integrating all aspects of science content • Studying a few fundamental science concepts • Implementing inquiry as instructional strategies, abilities, and ideas to be learned
CHANGING EMPHASES TO PROMOTE INQUIRY	
• Activities that demonstrate and verify science content • Investigations confined to one class period • Process skills out of context • Emphasis on individual process skills such as observation or inference • Getting an answer • Science as exploration and experiment • Providing answers to questions about science content • Individuals and groups of students analyzing and synthesizing data without defending a conclusion • Doing few investigations in order to leave time to cover large amounts of content • Concluding inquiries with the result of the experiment • Management of materials and equipment • Private communication of student ideas and conclusions to teacher	• Activities that investigate and analyze science questions • Investigations over extended periods of time • Process skills in context • Using multiple process skills-manipulation, cognitive, procedural • Using evidence and strategies for developing or revising an explanation • Science as argument and explanation • Communication science explanations • Groups of students often analyzing and synthesizing data after defending conclusions • Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content • Applying the results of experiments to scientific arguments and explanations • Management of ideas and information • Public communication of student ideas and work to classmates

Source: National Science Education Standards, 1996, p. 113.

Table 8. Summary of Changes in Content and Emphases in 9-12 Mathematics

Topics To Receive **Increased** Attention	Topics to Receive **Decreased** Attention
Algebra	***Algebra***
• The use of real-world problems to motivate and apply theory • The use of computer utilities to develop conceptual understanding • Computer-based methods such as successive approximations and graphing utilities for solving equations and inequalities • The structure of number systems • Matrices and their applications	• Word problems by type, such as coin, digit, and work • The simplification of radical expressions • The use of factoring to solve equations and to simplify rational expressions • Operations with rational expressions • Paper-and-pencil graphing of equations by point plotting • Logarithm calculations using tables and interpolation • The solution of systems of equations using determinants • Conic sections
Geometry	***Geometry***
• Integration across topics at all grade levels • Coordinate and transformation approaches • The development of short sequences of theorems • Deductive arguments expressed orally and in sentence or paragraph form • Computer-based explorations of 2-D and 3-D figures • Three-dimensional geometry • Real-world applications and modeling	• Euclidean geometry as a complete axiomatic system • Proofs of incidence and between ness theorems • Geometry from a synthetic viewpoint • Two-column proofs • Inscribed and circumscribed polygons • Theorems for circles involving segment ratios • Analytic geometry as a separate course
Trigonometry	***Trigonometry***
• The use of appropriate scientific calculators • Realistic applications and modeling • Connections among the right triangle rations, trigonometric functions, and circular functions • The use of graphing utilities for solving equations and inequalities	• The verification of complex identities • Numerical applications of sum, difference, double-angle, and half-angle identities • Calculations using tables and interpolation • Paper-and-pencil solutions of trigonometric equations
Functions	***Functions***
• Integration across topics at all grade levels • The connections among a problem situation, its model as a function in symbolic form, and the graph of that function • Function equations expressed in standardized form as checks on the reasonableness of graphs produced by graphing utilities • Functions that are constructed as models of real-world problems	• Paper-and-pencil evaluation • The graphing of functions by hand using tables of values • Formulas given as models of real-world problems • The expression of function equations in standardized form in order to graph them • Treatment as a separate course
Statistics	Add to program
Probability	Add to program
Discrete Mathematics	Add to program

Source: NCTM, 1989, pp. 126-127.

References

American Association for the Advancement of Science. (1993). *Project 2061: Benchmarks for science literacy.* Washington, DC: Author.

Bybee, R. (2002). Technology education standards: Power, peril, and promise. In J. M. Ritz, W. E. Dugger, Jr., & E. N. Israel (Eds.), *Standards for technological literacy: The role of teacher education* (pp. 1-10). New York: Glencoe McGraw-Hill.

Custer, R. (2001). Assessment standards for technological literacy. *The Technology Teacher, 61*(2), 25-28.

Dugger, W. E., Jr. (2000). Standards for technological literacy: Content for the study of technology. *The Technology Teacher, 59*(5), 8-13

Dugger, W. E., Jr. (2001). Phase III Technology for All Americans Project: Creating assessment, professional development, and program standards for technological literacy. *The Technology Teacher, 60*(4), 27-31.

Gorham, D. (2002). Engineering and standards for technological literacy. *The Technology Teacher,* 61(7), 29-34.

International Technology Education Association. (2000). *Standards for technological literacy: Content for the study of technology*. Reston VA: Author.

International Technology Education Association. (2002). Innovation-Invention-Inquiry Project begins. *The Technology Teacher, 61*(7), 5.

Martin, G. (2002). Program standards for technological literacy. *The Technology Teacher, 61*(5) 27-29.

Mino, M., Kane, G., & Novak, D. (2001). Implementing the standards: A state solution to a national imperative. *The Technology Teacher, 60*(7), 30-32.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

Newberry P. (2001). Technology education in the U.S.: A status report. *The Technology Teacher, 61*(1), 8-12.

Technology for All Americans Project. (1996). *Technology for all Americans: A rationale and structure for the study of technology*. Reston, VA: International Technology Education Association.

Wulf, W. (2000). The standards for technological literacy: A national academies perspective. *The Technology Teacher*, *59*(6), 10-12.

A Model for Unified Science and Technology

By Roy Q. Beven and Robert A. Raudebaugh

The Problem

Scientific concepts and processes are best developed in the context of technological problem solving. However, even some of the best secondary science curricula are weak in technology education and visa versa. A goal of technology and science education is to integrate student learning of science and technology. This is evident in the theme and papers of the 1996 Jerusalem International Science and Technology Conference and the efforts of the National Science Foundation, the American Association for the Advancement of Science (Project 2061, 1990), the National Research Council (National Science Education Standards, 1995), and The International Technology Education Association (Standards for Technological Literacy, 2000).

Science and Technology

Humans first used technology in a very intuitive way. Prehistoric evidence indicates that people learned to use the materials at hand, mostly stones and tree branches, to fashion simple tools to aid in gathering food and providing security. Discoveries of copper, bronze, and iron were mostly accidental, and their use in tools and weapons mostly intuitive. During the Renaissance, craft guilds were formed and the skills and knowledge of technology became more formalized, but it was still developed primarily through trial and error by highly creative and intuitive individuals. As societal needs grew and the demands on technology grew more sophisticated, links to the scientific community were forged, giving rise to formal engineering. According to Shamos (1995), "the more complex forms of technology, which could prosper only through painstaking design, eventually gave rise to the formal disciplines of engineering, whose main objective is to reduce the purely empirical content of technology, to make it, in effect, more 'scientific' " (p. 70).

This link has also been recognized in Project 2061: Science for All Americans (American Association for the Advancement of Science [AAAS], 1990) as evidenced by the following statement: "But just as important as accumulated practical knowledge is, the contribution to technology that comes from understanding the principles that underlie how things behave-that is from scientific understanding" (p. 26).

Shamos (1995) also recognized the mix of science and technology as an interdependent relationship in which technology uses the tools of science, which by extending human capability allows us to harness or modify nature to our needs. Project 2061 (AAAS, 1990) described this relationship as one in which

> scientists see patterns in phenomena as making the world understandable; engineers also see them as making the world manipulable. Scientists seek to show that theories fit the data; mathematicians seek to show logical proof of abstract connections; engineers seek to demonstrate that designs work. (p. 27)

This relationship is again described in the *Technology for All Americans* (International

Technology Education Association [ITEA], 1996) document.

> Science is a study of the natural world, and technology extends people's abilities to modify that world. Science and technology are different, yet symbiotic. Technology is much more than applied science and science is quite different from applied technology. When people use technology to alter the natural world, they make an impact on science. Science is dependent upon technology to develop, test, experiment, verify, and apply many of its natural laws, theories, and principles. Likewise, technology is dependent upon science for its understanding of how the natural world is structured and how it functions. (p. 28)

Teaching Science and Technology

Today, probably as a result of the concerted drive during the past few decades to introduce technology education into the schools, science and technology are often considered one and the same. The problem with this is that most of what society experiences are the end products of scientific inquiry, namely those produced by technology, and almost all so-called science-based societal issues are actually based in technology rather than in science.

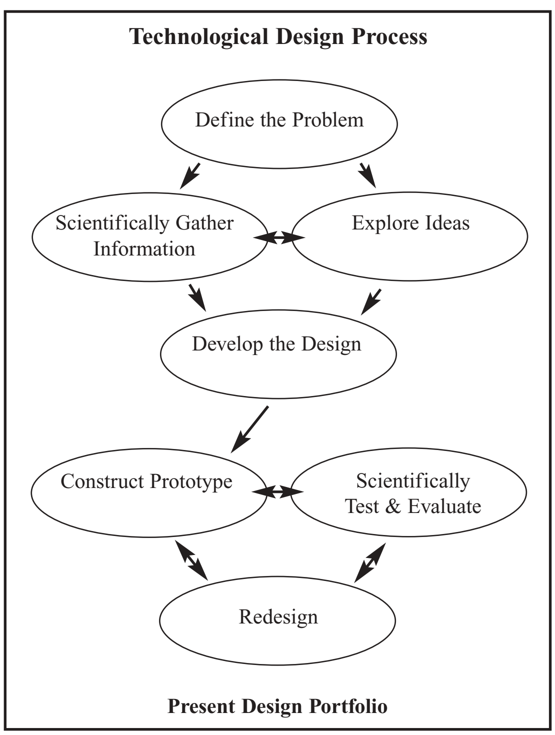
> Hence painting both with the same broad brush is a disservice not only to the science and technology communities, but also to society, which must understand that technology is fundamentally a social activity and that the social and economic forces which prompt technologists to modify nature are very different from those that motivate scientists to seek ways of understanding. (Shamos, 1996, pp. 68)

Obviously one cannot deal effectively with the nature of science solely in the abstract; it must be placed in the context of science itself, both for example and emphasis. According to Shamos (1995), educators now know that given a choice between stressing science or technology for the general student, the better choice is technology. But this poses a problem in respect to certain topics because technology is not the best exemplar of many of these, while science is. It is easy to focus a curriculum on technology alone, but such a program would not convey an awareness of how science works, which should be science education's main objective. Hence, both science and technology must have their own roles in the proposed curriculum, with the former used mainly to depict science process but with the actual content leaning heavily on technology.

This is more easily said than done because it brings us full circle to the question of how to present science to the general student in a meaningful fashion, something we have not managed to do well in the past. "The obvious answer, we believe, is to begin with technology, with problems that evoke familiar images of one's common experiences, and use these to work back to the underlying science needed to deal with such questions as scientific truth, laws and theories" (Shamos, 1995, p. 224-225).

To help guide students toward the kind of scientific awareness that Shamos (1995) believed to be the appropriate objective of general education in science, science education must sharply change the emphasis of conventional curricula from science content to the process of science, continually stressing technology.

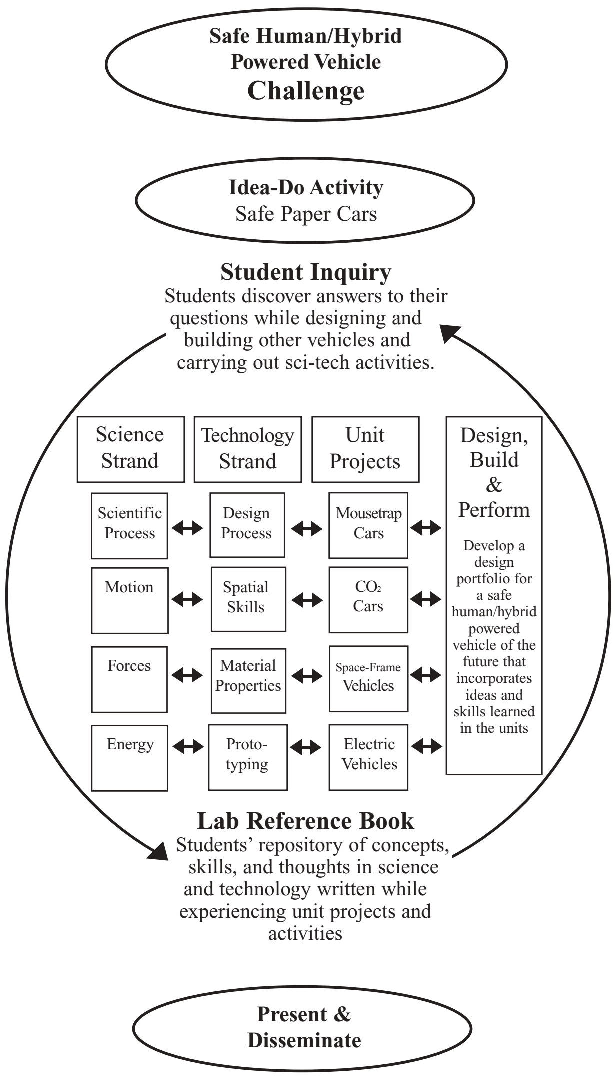
Figure 1. Format for Learning and Curriculum Design



One Proposed Solution

The relationship between science and technology is so close that any presentation of science without developing an understanding of technology would portray an inaccurate picture of science (National Academy of Sciences [NAS], 1996. The key to a unified approach for science and technology lies in the use of the Technological Design Process as the format for learning and curriculum (see Figure 1). The model presented here represents a unified science and technology curriculum with a transportation theme for the middle grades. Students are engaged in the design-build process involving familiar concept vehicles and research of pertinent information in a scientific manner. Thus, students build the middle school science ideas associated with these vehicles while developing an understanding of the design process and building technical skills.

Figure 2. Move with science and technology curricular design



Curriculum Design

The curriculum model in Figure 2, which the authors have titled "Move with Science and Technology," is composed of a unifying project and four related units of study. Students are hooked into the notion of vehicle design with a quick, fun paper-car activity. They are then given the overall design challenge: design and build a human/hybrid-powered vehicle that addresses safety and environmental and transportation problems for the future. To help them in this unifying project, they will be guided through four instructional units of study.

Each unit challenges teams of students to design and build concept vehicles. The result of each design process is written up in individual design portfolios and presented by the team to the class. These vehicles are somewhat familiar middle school technology projects: a mousetrap car, CO2 car, space-frame vehicle, and an electrically powered vehicle. These units build hierarchical science and technology process skills and make a complete science and technology curriculum, especially when tied together with the unifying project. The four units can be used as stand-alone units, but the unifying project adds greatly to the real-world authenticity of the curriculum.

Throughout the curriculum, students return to the unifying project—safe human/hybrid-powered vehicles. As they move through this design process, they employ the ideas and skills developed in the units. The prototype of their human/hybrid-powered vehicle should be, but does not necessarily have to be, a working prototype. The overall assessment of this and the smaller projects is based upon their documentation of the design process, not how well their project actually works.

Conceptual Development

This unified science and technology model is guided by the National Science Education Standards mandate to supplement middle-level science coursework with "activities that are meant to meet a human need, solve a human problem, or develop a product" (NAS, 1996, p. 161). Current trends in technology education include providing middle-level students with activities that allow them to develop "real technological products, systems, and environments" (ITEA, 1996, p. 38) and the recognition that "some technological problem are best solved through [scientific] experimentation" (ITEA, 2000, p. 110).

The human/hybrid-powered vehicle is the central challenge that ties together the four smaller design-build units of this curriculum. These four units build the necessary ideas, knowledge, and skills required to design and build a human/hybrid-powered vehicle.

An additional goal of this curriculum is the understanding of the risks associated with vehicles and how to reduce those risks. Students learn that "science cannot answer all questions and technology cannot solve all human problems or meet all human needs" (AAAS, 1990, p. 169). This curriculum recognizes that middle-level students can "begin to develop the ability to assess the impacts of [technological products and systems] on individuals, society, and the environment" (ITEA, 1996, p. 38). Thus, the activities are designed to allow students to learn the what, how, and why of human safety associated with vehicles.

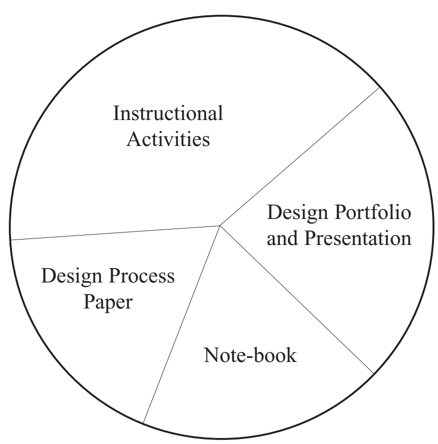
From the first activity, paper cars, students recognize the need to have an energy source that results in a force forward on their vehicle in order to cause the vehicle to move in the desired direction. The relationship between energy, force, and motion is a common theme in each of the design-build activities. The goal is to "provide concrete experiences on which a more comprehensive understanding of force can be based" (NAS, 1996, p. 149). Specifically, students are asked to describe the motion, identify the forces causing it and the energy source in each of the design-build activities, and develop the ability to do this through well-connected science and technology instructional activities. These activities help students develop the concept of energy because they may "have some of the same views of energy as they do of force—that it is associated with animate objects and is linked to motion" (NAS, 1996, p. 154). In addition, students are repeatedly asked to describe energy transfers because middle level students "improve their understanding of energy by experiencing many kinds of energy transfer" (NAS, 1996, p. 154).

Another theme of Move with Science and Technology is establishing the meaning and use of scientific inquiry. All the instructional activities "engage students in identifying and shaping an understanding of the question under inquiry" (NAS, 1996, p. 144). The use of a centering design-build activity provides relevant and meaningful context so that students "know what the question is asking, what background knowledge is being used to frame the question, and what they will have to do to answer the question" (NAS, 1996, p. 144).

Unit Design

Each unit challenges teams of students to design and build a vehicle, create a design portfolio, and present their design to the class. As described above, these vehicles are somewhat familiar middle school technology projects: a mousetrap car, CO2 car, space—frame (crash test) vehicle, and an electrically powered vehicle. These units build hierarchical science and technology process skills. Each unit has eight instructional activities, including four in science and four in technology, all centered upon scientific research and the design process for these concept vehicles. The instructional activities associated with the *scientifically gathering information* and *scientifically testing and evaluation* phases are exemplary science investigations in which a controlled experiment is

Figure 4. Suggested unit assessment

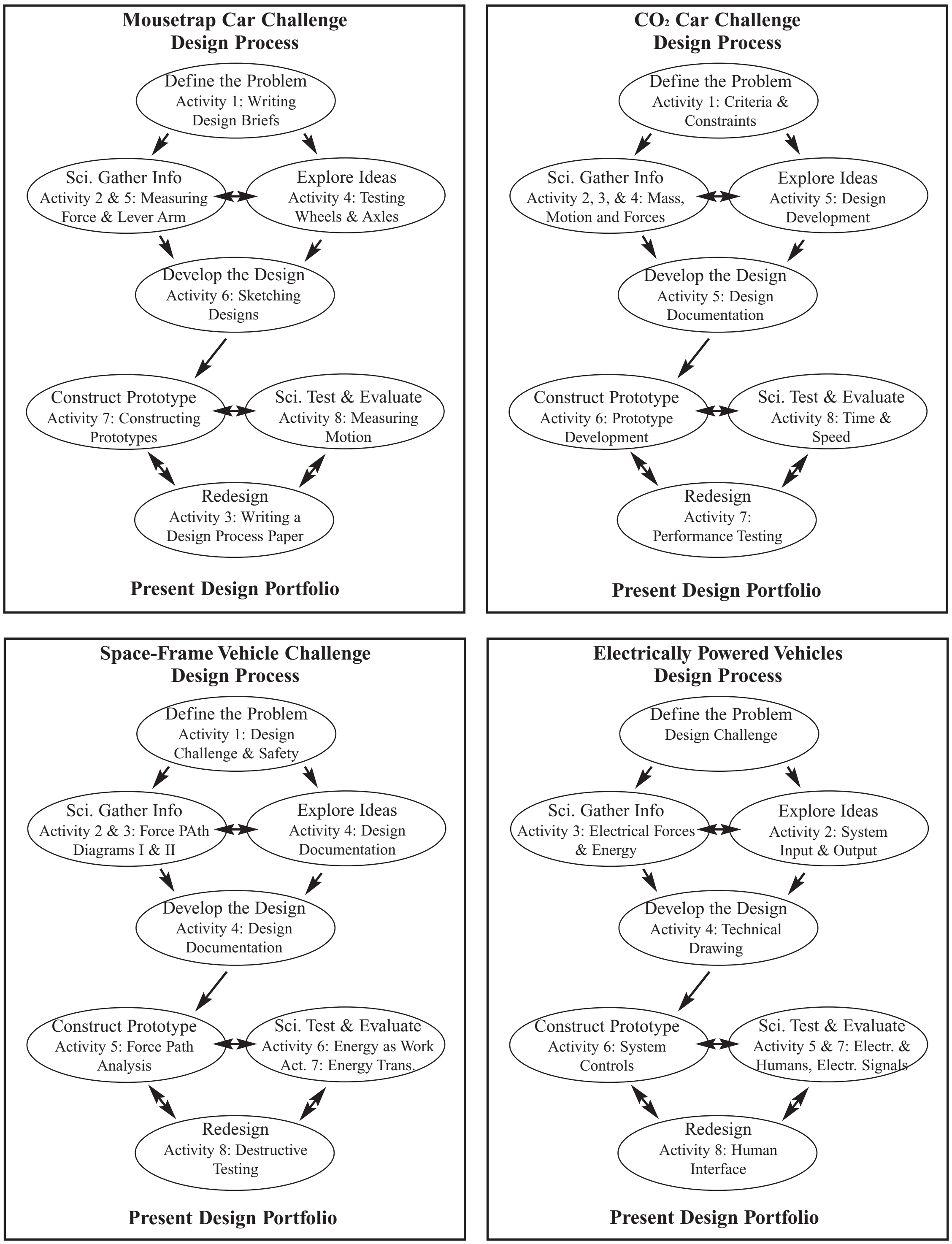


self-evident. Instructional activities associated with *define the problem* phase help students write design briefs while learning about criteria and constraints. Activities associated with *exploring ideas* and *developing the design* lead students through an exemplary sketching and technical drawing process described in an extensive supplemental piece.

In the units, the unification of science and technology is so seamless that students are focused upon a design process involving scientific inquiry and not, unless queried, aware of which activity is science and which is technology. At the completion of each unit, students are asked to write an expository paper documenting their design process. Students are then asked to

Figure 3. Unit summaries with activities and their association to the design process.

Move with Science and Technology Units



create a personal showcase portfolio composed of this technical paper and all the activities and notes of this unit as artifacts. To bring closure to each unit, student teams are invited to present their composite design portfolio to the class, including their vehicle and other artifacts of their design process. Figure 3 shows each unit, the eight activities, and how these activities are associated with phases of the design process.

Assessment

Student achievement in this model can be assessed, as prescribed in the curriculum, as a balance between students' performance in instructional activities, writing in their design process papers and notebooks, and their compiled portfolios and presentation. This balance, shown in Figure 4, indicates suggested weights of each of the artifacts. As students move through the four units and on to the unifying project, more and more weight can be put on the portfolio and its presentation.

The authors have developed, tested, and published the curriculum "Move with Science and Technology" as described in this article. Currently, the National Science Teachers Association (NSTA) Press, through a cooperative agreement with the National Highway Traffic Safety Administration, is publishing three of the units shown in Figure 3 in a curriculum guide called Fender Bender Physics. This curriculum guide includes student pages designed for reproduction as in-class materials and an associated teacher's guide that helps with the delivery of each unit and activity. Fender Bender Physics also contains a supplemental materials section that is written in grade-level, relevant terms intended for the instructor and/or students. Fender Bender Physics is currently available for on-line purchase at the NSTA Website, http://www.nsta.org.

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References

American Association for the Advancement of Science. (1990). *Science for all Americans.* New York: Oxford University Press.

International Technology Education Association. (1996). *Technology for all Americans: A rationale and structure for the study of technology.* Reston, VA: Author.

International Technology Education Association. (2000). *Standards for Technological Literacy*. Reston, VA: ITEA

National Academy of Science. (1996). *National science education standards.* Washington, DC: National Academy Press.

Shamos, M. H. (1995). *The myth of scientific literacy.* New Brunswick, NJ: Rutgers University Press

Technology Education Versus Liberal Arts Education?

By Oscar Plaza

This work analyzes the positioning of technology education within the tradition of classical liberal arts education. I propose ideas for mutual enrichment of classical liberal arts disciplines alongside technology education.

It is my contention that technology education is general education for a technological world. Indeed, there is a correlation between the purpose of critical thinking of general education and being surrounded by artifacts. Yet, thinking and making are inseparable. Both actions inform each other.[1] The design and problem-solving activities that are at the core of technology education do provide an excellent setting for developing qualities such as work habits, decision-making skills, effective use of resources, skills to interact positively with others, and ability to locate, evaluate, and act upon information of all kinds.[1] All these skills are transferable not only to the workplace, but to the making of a competent and humanistic person as well.[2] More and more all work activities, including traditional professions, are becoming service related depending upon complex technological systems.[3] To understand and manage those systems requires a great deal of technology education.[4] The contribution of services was put at the bottom during the industrial era. Now, service delivery promises the most intellectually challenging and technically difficult tasks of the future.[5]

An Inquiry In Common Ground

My proposition is to create a common ground on which to build an educational approach that eliminates the sharp cleavage between liberal arts education and technology education.

Worldview Models

My starting point is the concept that all academic disciplines have a worldview in mind. No matter how small the focus of their lenses, they see the whole world through those lenses. But, we cannot identify "betterness" looking at an academic discipline through the lens of another. Then, my proposition is to accept the idea that each discipline carries a worldview that deserves the same academic respect. This respect will be tested when confronting an issue. The day we think that all issues must be thought of in conjunction with colleagues from different fields, we will be really serious about other worldviews.

Principles

The practice of any discipline implies the guidance of certain principles. Each of us knows that the set of principles we follow is useful to the progress of our discipline. We know other disciplines have their own principles and that probably they are useful to their endeavors. Usually, we do not give attention to the principles of others. However, principles shape the soul of a practitioner. If we are serious about common ground, we should start by attempting to understand the principles of other disciplines.

Technology education cultivates an intellectual domain; therefore, it has developed principles. It has a body of knowledge about how people create, produce, use, and assess human-made artifacts. It has a mode of inquiry that focuses on the practices of invention, innovation, and design. Technology is as ancient as civilization (Dorn & McClellan, 1999; Pacey, 1990), and this historical asset means that technology studies are foundational to any thorough educational process.

Education as a Continuum

Given equally valued worldviews and principles, we could see the educational process and system as a continuum. Education as a continuum does not move from one discipline to another (such as from one discrete point to another), but instead observers in this continuum would search for different perspectives. Liberal arts and technology education would not be different compartments, but they would have different perspectives on addressing the same reality.

In a continuum model of education, we would address any issue simultaneously from the liberal arts and technology education points of view. Practitioners in both fields would engage each other not only for the sake of knowing and understanding the other, but for accomplishing their own aims. We should learn that we cannot address what we must by just getting more involved in our own worldview.

Education as a continuum is not symbiosis or syncretism. Technology education and liberal arts maintain their own identities but they realize that they cannot educate the educand of the future on their own. Liberal arts would learn that tools not only enhance human physical abilities, but also shape human comprehension abilities. Technology education would learn that liberal arts is not only about reflecting reality, but also about seeing reality. Education as a continuum is not about joint efforts but about intellectual honesty.

Instructional Models

Assuming a common ground for liberal arts education and technology education, we can think about common instructional models. These models should not share a common background because we try to work together. Instead, we should reach the point at which we use a common instructional background model due to the needs of our own field.

Building Up An Educational Model for the Future

The Promise of High-Tech

It was said that television was going to change schools, even displace the teacher. Teachers are still here, competing with television shows for student attention, but still here. Therefore, there is reason for skepticism about the high-tech threat to the teacher. Precisely because of high-tech, I think there are reasons for more teachers, yet another kind of teacher. The dilemma is that nobody knows exactly how this "new" teacher will look.

Information-technologies development is the key to the high-tech impact on education. Traditionally, the teacher was the authoritative sole conveyor of reliable information; not anymore. However, information is not knowledge and certainly not wisdom at all. The handling, managing, and rumination of information is becoming the big challenge of the educational process. To "navigate" with the student throughout this ocean of information is becoming the job of the teacher.

Master/Mentor/Facilitator

The role and model of the teacher of the future are highly debated, and it will take time to reach certain consensus. Meanwhile, I propose the master/mentor/facilitator model. I think the idea combines the best of the traditional and of the "new." The master conveys the tradition of the teacher as the knowledge/wisdom authority. The mentor brings the idea of the lighthouse, of someone always there for encouragement and guidance. And, who is going to navigate with the student in the new high-tech school? We need the facilitator. Yet, the teacher will still be the commissioner of an academic discipline whether traditional or not. The teacher will still convey the meaning and excitement of a subject matter.

Multicurricula

The multicurricula idea is a curriculum with many entries. There would be as many curricula as students. No matter the entry, students would have the chance to grasp the core of traditional and new disciplines and end with a specialization on his or her own.

Meanwhile, I see two approaches to the integration of liberal arts and technology education curricula. One approach calls for technology education courses tailored as part of the general education curriculum.[1] There are courses with certain tradition that follow this pattern, such as Technology and Society, Technology and Culture, and Technology and Civilization. There are also new courses that more specifically address the issues of integration and technology education as part of the liberal arts curriculum.[6] These new course developments call for the straight integration of technology education into the liberal arts curriculum.[7]

A second approach, which I propose, attempts a more integrative manner. The idea is to make technology education a component of integrative core courses curricula. Integrative core courses are developed around an integrative topic to which many disciplines, therefore teachers, contribute. I believe that there is no topic about nature, humanity, or metaphysics to which technology education is alien. Furthermore, technology education should come with its own topics for integrative core course development.

Integrative core courses are difficult to develop. They are more than just a lecture series course developed around a common topic delivered by instructors from different disciplines. They are a group of instructors from different disciplines addressing together a common topic. I think that the solving/problem model of technology serves well this purpose because it requires a group of people with different backgrounds to tackle an issue together.

Integrative core courses are more adequate to the multicurricula idea. The issue is not about renegotiation of educational resources allocation, especially time curriculum, or sharing of resources among the different disciplines. The issue is curricula and course structures that address the new environment of the educational process.[8]

While some may see the entire world as a stage, Jones (1997) sees the entire world as a classroom and every "one room hut" as an access point in the age of information. The global culture is progressing at a speed that puts the educational model for the future outside the bounds of any grand design. Nevertheless, this is not a justification for giving up or for business as usual. Education will go through fundamental changes, whether we like it or not, because the outside reality will demand a replacement of the industrial era school model we have now. Nonetheless, I believe that teacher experiences provide extremely valuable advice for change, as the following quotation shows:

> I am reminded of a new technology teacher who began her first teaching job in a classroom that had no equipment for the first two months. In those first two months, however, her students were guided through problem-solving activities, technology-awareness games, simple experiments, and even philosophical discussions about technology. Once the equipment arrived, she found herself teaching primarily about how to use the equipment, and her students spent more time sanding than thinking. In looking back, she remarked that she did more technology education in those first two months than she did in the rest of the school year. (Flowers, 1998, p. 8)

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References

Dorn, H., & McClellan, J. E., III (1999). *Science and technology in world history: An introduction.* Baltimore, MD: The Johns Hopkins University Press.

Flowers, J. (1998, December/January). Teaching the historical perspective – Should we or shouldn't we? *Technology Teacher,* pp. 7-9.

Glyer, D., & Week, D. L. (Eds.). (1998). *The liberal arts in higher education: Challenging assumptions, exploring possibilities.* Lanham, MD: University Press of America.

Heidegger, M. (1977). *The question concerning technology and other essays.* New York: Harpers.

Jones, G. R. (1997). *Cyberschools: An education renaissance.* Englewood, CO: Jones Digital Century.

National Academy on Engineering and National Research Council. (2002). *Technically speaking: Why all Americans need to know more about technology.* Washington, DC: National Academy Press.

Pacey, A.(1990). *Technology in world civilization.* Cambridge, MA: The MIT Press.

Pitt, J. C. (2000). *Thinking about technology: Foundations of the philosophy of technology.* New York: Seven Bridges Press.

Postman, N. (1995). *The end of education: Redefining the value of school.* New York: Knopf.

Rifkin, J. (1996). *The end of work: The decline of the global labor force and the dawn of the post-market era.* New York: Putnam's Sons.

Footnotes

[1] For philosophical developments of this idea, see Heidegger (1977) and Pitt (2000).
[2] For a detailed analysis of contemporary competency, see "Career Development and Workforce Preparation: Educational Policy Versus School Practice," The Career Development Quarterly, September 1996, pp. 20-37.
[3] For a discussion of liberal arts education, see "Initiating the Conversation" and "The Classical Liberal Arts Tradition" (Glyer & Week, 1998).
[4] See, for example, Pitt's (2000) definition of technology as "humanity at work."
[5] See recent report by National Academy of Engineering and National Research Council (2002).
[6] Rifkin (1996) analyzes the impact of technological changes on the workforce.
[7] A good example is the effort of the University of Wisconsin-Stout. "Technology Is Required as University General Education," Leonard F. Sterry, paper delivered at the Annual ITEA Conference, March 23-25, 1997, Tampa, FL.
[8] Examples of this kind of effort include Technology as Liberal Education: A Model Course, ITEA Task Force on Technology Education as Liberal Education, 1993; and Exploring Technology, Leonard F. Sterry and Robert W. Hendricks, T&E Publications, 1997.
[9] For another discussion on integration, see “Integrating Liberal Arts and Professional Education,” Christopher Flannig (Glyer, 1998).
[10] See, Postman (1995) for a discussion of the new educational environment.

Defining the Role of Technology Education by Its Heart and Its Heritage

By Mark S. Snyder

The Committee on Technological Literacy (CTL), a group guided by the National Academies of Science and Engineering, the Institute of Medicine, and the National Research Council, recently concluded that “it is in the best interest of all Americans to understand more about technology” (Pearson & Young, 2002, p. 103). According to A. Thomas Young, the chair of the CTL, “the committee hopes technological literacy will be put ‘on the map’ and the way will be cleared for a meaningful movement toward technological literacy in the United States” (Pearson & Young, 2002, p. viii). The CTL recommended that governmental agencies set education policy to “encourage the integration of technology content into K-12 standards, curricula, instructional materials, [etc.]” (Pearson & Young, 2002, p. 103). If this does, in fact, occur, then technology education offers a clear solution towards helping the committee realize its aims.

This article was written from the perspective that technology is a discipline of its own that is best taught through a variety of methods that necessarily include experiential learning. By definition, technological literacy is, and has always been, at the very heart of technology education. In fact, the phrase *technological literacy* is not new to this field—it has been in use since 1947. Although science and technology are closely linked, they are not the same; learning about science is not the same as learning about technology. Technology education has evolved from a discipline that mostly taught psychomotor skills to one that now emphasizes more cognitive as well as affective learning principles. Nonetheless, a hands-on, problem-solving instructional method is the heritage that endures as one of the best ways to help students learn about and fully understand technology.

Of the Heart

There are numerous definitions for the term *technology*. Etymologically, it is an adaptation of the Greek word tecnologia, which meant a "systematic treatment of grammar," and was formed from the root tecnh, meaning "art" or "craft." Therefore, in the sense most closely related to its origin, the expression is used to signify "technical nomenclature."

The Compact Edition of the Oxford English Dictionary (1971) identified a different use for the word, first applied around 1615. This definition of technology is perhaps the most general: "a discourse or treatise on an art or arts; the scientific study of the practical or industrial arts" (p. 3248). In this sense, technology is considered a body of knowledge, just as sociology is considered a field of study. DeVore (1980) posited that technology is indeed a discipline, which he defined as "the study of the creation and utilization of adaptive systems including tools, machines, materials, techniques, and technical means and the relation of the behavior of these elements and systems to human beings, society, and the civilization process" (p. 4).

Webster's New World Dictionary of the American Language offers similar versions, as well as the following: "The system by which a society provides its members with those things needed or desired" (Guralnik, 1980, p. 1460). DeVore (1980) also recognized that technology exists as systems "ranging from tools, and their use, to the social impact and influence of tools, technics and products on the lives of particular individuals and groups" (p. 4).

Specific artifacts developed by human beings for the advancement of material culture can also be thought of as technologies. The CTL stated: "Technology comprises the entire system of people and organizations, knowledge, processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves" (Pearson & Young, 2002, p. 13). Johnson (1989) wrote, "Technology is best described as a process, but it is more commonly known by its products and their effects on society" (p. 1). This observation is tenable and seems appropriate as an explanation for the prevalent modern perception of the term.

Technology is also used at times to mean "a method, process, etc. for handling a specific technical problem" (Guralnik, 1980, p. 1460). However, in this case, the term *technique* seems more appropriate. Technique refers to the methods of procedure, or way of using basic skills, in carrying out a technical or mechanical operation.

The term *technics* describes the basic skills necessary for the utilization of techniques. DeVore (1980) defined technics as "specific technical skills associated with a particular technological act or behavior" (p. 3). In 1989, Chant wrote:

> The proposed technics/technology distinction has yet to find its way into much academic, let alone popular, discourse, even though it offers a way of tidying up some of the present confusion, and perhaps further a way of relating that confusion to the central historical relations of this volume. For if technics is identified with products and processes, this leaves technology as a form of knowledge. (p. 45)

Chant's (1989) application of the term *technics* is convenient, and yet it seems an oversimplification to contrast technics and technology. Admittedly, technology may be considered a form of knowledge, as when defined as the study of practical or industrial arts. However, technology is also an active discipline that requires a familiarity with technics and their application through techniques. Essentially, technics can be distinguished as a separate but integral element within the realm of technology.

Language may, unfortunately, introduce an obstacle to the clear understanding of this distinction. The book *Man and Technics: A Contribution to a Philosophy of Life* was an early study of technology by Spengler (1932/1960). In the translation from German, by Atkinson, the word *technics* was employed to describe Spengler's philosophical view of technology. The author was interpreted to say:

> *Technics is the tactics of living*, it is the inner form of which the procedure of con-

> flict—the conflict that is identical with Life itself—is the outward expression…*Technics is not to be understood in terms of the implement.* What matters is not how one fashions things, but what one does with them…. Always it is a matter of purposive activity, never of things. (pp. 10-11)

Ellul's (1954/1964) *The Technological Society* was originally published in 1954 under the French title *La Technique ou Lenjeu du Siècle.* In the translator's introduction, Wilkinson interpreted this phrase literally to mean "Technology: The Stake of the Century." Wilkinson continued by stating: "*Technique*, the reader discovers more or less quickly, must be distinguished from the several *techniques* which are its elements. It is more even than the organized ensemble of *all* individual techniques which have been used to secure any end whatsoever" (Ellul, 1954/1964, p. x).

The French have since attempted to distinguish between technics and technology. Daumas (1970/1976) wrote, however, "in French the word *technologie* has no absolute meaning…. It will nevertheless remain true that the equivalent English word, technology, embraces both the French words *technique* and *technologie*" (p. 93).

In this discussion regarding the word *technology* and its related terms, it seems appropriate to offer one more passage that contains the critical elements necessary to accurately define technology: "Technology is a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants" (Savage & Sterry, 1990, p. 2). This seems to be a tangible definition that is concise yet complete.

Mind Over Matter?

The terms *pure science* and *applied science* have often been used as references to science and technology, respectively. Buchanan (1976) wrote the following:

> Attempts to sharpen the definition with derivative terms such as "pure science" and "applied science" have tended only to convert imprecision into confusion. However, it can be agreed that there is a distinction between science and technology in present-day practice, coinciding in general with fairly discrete professional groups. (p. 76)

Price (1975) dedicated an entire chapter of his book *Science Since Babylon* to "The Difference Between Science and Technology" (pp. 117-135), and Chant (1989) summarized Price's philosophical view of this concern when he wrote: "Technology is not applied science, but rather science and technology are parallel structures in a symbiotic, weakly interacting relationship" (p. 76).

The juxtaposition of science and technology is an issue that has been discussed for centuries. As a result, a great deal of confusion has transpired regarding the distinction between the terms. Daumas (1970/1976) wrote, "Weighing these words *science* and *technology* against one another in a rather scholastic manner each historian strives either to assimilate one to the other or on the contrary to oppose them in pretty muddled antitheses" (p. 93). Science and technology have often incorrectly been used interchangeably, and fairly strong opinions have developed regarding the perception of these concepts as separate entities. Lisensky, Pfnister, and Sweet (1985) wrote:

> In discussions of technology, one finds the terms science *and* technology used in combination, as if the one cannot be considered without the other. Historically, however, technology developed without reference to science. The social process that is technology arose empirically, either by accident or as a matter of common experience. (p. 8)

The science/technology dichotomy can be perceived in a variety of ways. Ellul (1954/1964) thought technology was "auton- omous" and that "science had become an instrument of techniques" (p. 10). In his book *John Dewey's Pragmatic Technology*, Hickman (1990) contended that Dewey viewed science as a "type of technology" (p. 11). Chant (1989) described what has been referred to as the *linear sequential* model of technological innovation, stating, "Science is on this account an independent variable, developing largely by way of its own internal intellectual dynamic; technology is a dependent variable, pushed by scientific discovery and/or pulled by public and private need" (p. 42). Lisensky et al. (1985) promoted the view "that science is detached, concerned about knowledge for its own sake, while technology is more directly involved in the social process and is concerned about the solution of problems and application of knowledge to that solution" (p. 9). Johnson (1989) provided a sensible illustration of the relationship between science and technology in the following passage:

> Technology is also a technical process. It is different from science, whose role is understanding. Technology's role is doing, making, and implementing things. The principles of science, whether discovered or not, underlie technology. The results and actions of technology are subject to the laws of nature, even though technology has often preceded or even spawned the discovery of the science on which it is based. (p. 1)

Although the previous statement is a rather broad generalization, and contradictory points of view have been exemplified, this author accepts the premise of science and technology as separate, yet interactive and dependent, entities.

Heritage: The Instruction of Technics

From a historical perspective, the nomenclature surrounding this field can become a hindrance since a wide variety of labels have been applied to systems for the instruction of technics throughout the past. Apprenticeship was the earliest such organized system and has lasted for millennia. Since the advent of civil control over education, mechanical schools, polytechnics, schools of industry, mechanics institutes, lyceums, manual labor academies, technical institutes, workingmen's schools, manual training schools, sloyd schools, public school manual and industrial arts, and vocational schools have all been systems established essentially for the instruction of technics.

In 1918, Crawshaw and Varnum described in their book *Standards in Manual Arts, Drawing and Design* the following point of view:

> *Manual training* as the term is used in this bulletin refers to the method by which industrial work is developed under school control. It signifies a plan by which hand, tool and machine work is made educative through a series of progressively developmental problems.
>
> *Manual arts* as herein used indicates the content of the several subjects which are included in a division of the school dealing with industrial work.
>
> *Industrial education* as used herein refers to the study of all or a branch of *industry* (a manual art) by means of the most approved pedagogical and industrial methods. It includes both information about and practice in industry. (p. 5)

The term *industrial education* has continued to be used as a broad heading that has more recently included all forms of technical education that, as a group, derived their content from industry, whether their focus was vocational or general education. *Manual training* gradually evolved into *manual arts,* which, in turn, influenced the development of other forms of industrial education. There is no doubt that these areas of instruction contributed to the development of yet another system of instruction referred to as *industrial arts*. In 1934, Collicott and Skinner wrote:

> Industrial Arts has had its greatest development on secondary school levels. Here it has passed through two somewhat well-defined periods of professional growth and is now in the midst of a third. The first was "manual training," where the emphasis was on *hand* skill, chiefly in woodworking. The second was "manual arts," where the emphasis while still on skill, was extended to include the *making* of both *useful* and *well-designed* articles. The third is now "Industrial Arts," where the intent is to include all of the old that was good, but to broaden out from the limitation of an emphasis upon manual skill alone to an enriched conception where more of the child's interests and environment, and certainly many of the other school subjects, are involved. (State Committee on Coordination and Development, 1934, p. 5)

A similar passage by Bennett (1937) has often been cited to clear up confusion regarding the three terms used above to describe the slightly different approaches to technical instruction that chronologically overlapped during the early 20th century. It reads: “In the term industrial arts, the ‘industrial’ is emphasized; while in manual arts, the ‘arts’ is historically the distinctive word and, in the term manual training, ‘manual’ is the important word” (p. 455). Although there were subtle differences between these three methods, they all represented a form of instruction that used “hands-on” methods of learning technology-based content as part of a broad educational experience rather than job-specific training.

The emphasis of all these programs was on “learning by doing,” but the focus of the content was always based in, or on, technology. Technology education evolved from, but is not limited to, this strong tradition of hands-on learning.

The Inception of Technology Education

In April 1947, a new interpretation of industrial arts, referred to initially as the “The New Industrial Arts Curriculum,” was imparted by Warner, Gary, Gerbracht, Gilbert, Lisack, Kleintjes, and Phillips. Warner introduced this new plan at the fourth session of the eighth annual American Industrial Arts Association (AIAA) convention held in Columbus, Ohio. For Warner, it was the next logical step in the advancement of his philosophy and practices. Warner and his protégés defined industrial arts as follows:

> Functionally, industrial arts as a general and fundamental school subject in a free society is concerned with providing experiences that will help persons of all ages and both sexes to profit by the technology, because all are involved as *consumers*, many as *producers*, and there are countless *recreational* opportunities for all. (Warner et al., 1965, p. 41)

Curtis wrote a review of Warner’s conference presentation that was printed in the June 1947 issue of *The Industrial Arts Teacher*. He commented, “The presentation by Dr. Warner, and the interpretations that followed, completely redefined the position of industrial arts in general education in the public school, and solicited both re-evaluation of the present program and consideration of the implementation of the new” (p. 1).

Olson (1963) said of this effort, “It was too far ahead of the times to gain general acceptance, but like all advance thinking it has had its impact on the profession” (p. 15). Warner, himself, had a slightly different feeling about the acceptance of the project as evidenced by the following which he wrote retrospectively:

> The result, as herein reported, was featured at the AIAA Convention of 1947 which I revived in Columbus, Ohio, following World War II, and where we were fearful of the outcome until the discussions which followed, when our findings were not only accepted, but praised on all sides. (Warner et al., 1965, p. 5)

Eventually, “The New Industrial Arts Curriculum” became known as *A Curriculum to Reflect Technology*, with content that was “derived via a socio-economic analysis of the technology and not by job or trade analysis as of old . . .” (Warner et al., 1965, p. 41). It included six subject matter classifications: power, transportation, manufacturing, construction, communication, and management. Latimer (1981) summarized:

> For the most part, it remained a proposal, probably because Warner did not have the funds to promote and enhance it nationally. The plan was probably too far ahead of its time . . . .
>
> Even though the curriculum was never totally implemented, today there are many elements of *The Curriculum to Reflect Technology* present in educational systems throughout the United States. (p. 48)

Gordon O. Wilber, the ninth president of the American Industrial Arts Association (AIAA), was another effective industrial arts educator with timely insight. He referred to the influence of technology in his book *Industrial Arts in General Education* when he defined industrial arts as “those phases of general education which deal with industry—its organization, materials, occupations, processes, and products—and with the problems resulting from the industrial and technological nature of society" (Wilber, 1948, p. 2). Wilber also expressed the conviction that education was critical to the development of technology by stating: "If society did nothing more than transmit its culture there would be no progress or improvement. Education has the further objective, therefore, to provide for extending and improving the way of life" (p. 6). This could be accomplished, he believed, through instruction that challenged the critical thinking skills of students.

In 1951, Meyer, an associate professor of industrial arts and vocational education at the University of Florida, Gainesville, asked of his peers, "Industrial Arts—What Next?" Meyer knew that "every boy and girl, regardless of present interest or future occupation, is forced to an acquaintanceship with the products of technology" (p. 15). As a result he felt that "work with materials and toward a grasp of technology needs to be a part of the experience of every boy and girl" (p. 15).

Technological Literacy—The Aim of Technology Education

In 1948, Williams, who was a professor of education at the University of Florida as well as the vice president of the AIAA, declared that "Industrial Arts Faces a New Era." In an article by that title for *The Industrial Arts Teacher*, Williams wrote the following:

> For a time the true educational concept of industrial arts was lost, and its position was relegated to a secondary place in the scheme of general education. Now, under the pressure of a complex technological society the narrow view of the manual arts concept is fast giving way to a more comprehensive and flexible interpretation of industrial arts or technology. That a crucial need exists for technological literacy is apparent. (p. 1)

In suggesting one course of action, Meyer (1951) recognized that "as teachers of industrial arts, a field yet young in education, we have groped for truth and sought our role in leading youth toward a real and functioning technological literacy" (p. 16). Meyer continued by stating:

> Our problem is not that of substituting something new for something old. It is not to discard the *classics* in the interest of the *technics*—for this will destroy both. Our task is to provide the cultural matrix of the arts, the sciences, and the humanities so that the equally cultural technologies can find their rightful place and make their vast and vital contribution. (p. 16)

The phrase *technological literacy* has since been employed unrelentingly by technology educators, which is appropriate since the development of technological literacy has been identified as a major goal of the discipline. In 1968, DeVore wrote:

> In today's world, when there is a greater need than ever before for technological literacy, we discover the contemporary status of the industrial arts to be one of confusion and perhaps indecision, with a few notable exceptions. Teachers in the profession, however, are becoming increasingly aware that the confusion is the result of our heritage, and indecision the result of inadequate perspective. (p. 1)

In the 1983 *Professional Improvement Plan* of the America Industrial Arts Society, the transition from industrial arts to technology education was described as "a national concern," "a mission for education," and "a stimulus for a new curriculum with new goals directed toward technological literacy" (Starkweather, 1983, p. 8). The plan itself identified three major goals:

I. Pursue the ideal form of industrial arts/technology education to ensure technological literacy of all people.

II. Profit from personnel development exercises developing and nurturing programs that apply technology to societal problems.

III. Exchange ideas and practices within and outside the profession to foster a positive, consistent view of industrial arts/technology education. (AIAA, 1983, p. 4)

According to the goals listed, the leaders of industrial arts education planned to improve the technological literacy of all people through innovative new programs that would involve more of the cognitive and affective content of technology and apply it to solve problems. There was also a successful movement underway to change the name of industrial arts to technology education.

In 1986, Loepp identified the need to increase the technological literacy of our citizenry as "an educational challenge." He described six characteristics that a technologically literate person should exhibit: the ability to recognize and use the appropriate technology in given situations; anticipate undesirable outcomes of the use of technologies; identify alternate courses of action if the technology fails; understand basic mechanical, thermal, fluidic, and electronic principles utilized by technologies; gather and interpret data, or information; and use basic tools, materials, and processes of technology.

An individual who displays such capacities has not only managed to develop fundamental psychomotor skills but also the cognition of many academic disciplines. Values are also important when making decisions regarding the appropriateness and outcomes of the utilization of technologies. Hopefully, in the future, such judgments will be made from well-educated perspectives. Technology education aims to provide learners with the opportunity to develop such capabilities as described above, and therefore contribute to the growth of society.

Conclusion

The CTL has recognized a need that technology educators first identified nearly 50 years ago: Americans need to understand technology and become technologically literate. As the profession has evolved, it has become evident that technology is and has always been the very heart of what we teach.

The CTL also has distinguished a "capability" dimension of technological literacy that justifies the need for psychomotor learning by stating:

> Someone who is knowledgeable about the history of technology and about basic technological principles but who has no hands-on capabilities with even the most common technologies cannot be as technologically literate as someone who has those capabilities. (Pearson & Young, 2002, p. 22)

Technology education has taught about technology, through hands-on experiences, for a long time; most believe that to be the strongest aspect of its heritage. Another of the CTL's conclusions is that education for technological literacy requires a multidisciplinary approach and suggests that technological literacy could be a "thematic unifier for many subjects now taught separately in American schools" (Pearson & Young, 2002, p. 23). Custer (2002), a technology teacher educator and member of the committee stated: "This should not be interpreted in any way as a devaluing of technology education. Rather, the committee clearly came to view technological literacy expansively, as a critical matter of national importance that inherently spans academic disciplines" (p. 6).

American schools are being evaluated constantly and criticized for the quality of education that they provide. Although the majority of graduates do not pursue a postsecondary liberal arts education, almost every American student is prepared as if this were the expectation. The majority of curricula in our schools is based on knowledge we have established over centuries to be "truth." While learning these truths is necessary, understanding how these truths have been applied to our society through technology is also valuable. Maybe there are better ways for students to learn these truths—or to learn them better.

> Perhaps, the field which has been continuously evolving into technology education has always been an essential educational enterprise that links classical knowledge to our culture. If this is true then a broad interdisciplinary approach involving technology education should be considered a natural outcome of general educational practice. (Snyder, 2000, p. 36)

Technology education has evolved to a point where it is uniquely positioned for meeting the aims of the CTL. The CTL itself stated:

"Technology educators are playing an increasingly important role in the development and delivery of technology-related content to students in K-12 classrooms, and technology teachers represent an important resource for attempts to boost U.S. technological literacy" (Pearson & Young, 2002, p. 80). Herein lies an opportunity for technology education to clearly define its role in the American education system. Its strength is its emphasis on the development of students' capabilities through design and problem-solving activities, but it must find its place among a broad interdisciplinary approach and address issues related to how students think about, and act on, technology-related issues. Technology education engenders the academic ideal of developing students who can think, and live, independently. Technology education also prepares students to apply knowledge and introduces new ideas and practices that enable individuals to perpetuate the advancement and development of a strong, safe, well-educated, and technologically literate society.

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References

American Industrial Arts Association. (1983). *Professional improvement plan.* Reston, VA: Author.

Bennett, C. A. (1937). *History of manual and industrial education 1870-1917.* Peoria, IL: The Manual Arts Press.

Buchanan, R. A. (1976). The Promethean revolution: Science, technology and history. In A.R. Hall & N. A. F. Smith (Eds.), *History of technology* (pp. 73-83). London: Mansell.

Chant, C. (1989). Science and technology: Problems of interpretation. In C. Chant (Ed.), *Science, technology, and everyday life 1870-1950* (pp. 40-58). New York: Routledge.

The compact edition of the Oxford English dictionary. (1971). New York: The Oxford University Press.

Crawshaw, F. D., & Varnum, W. H. (1918). *Standards in manual arts, drawing, and design.* Madison: The University of Wisconsin.

Curtis, D. K. (1947, June). The new industrial arts curriculum. *The Industrial Arts Teacher,* pp. 1-3.

Custer, R. (2002, November 1). Unpublished conference proceedings from the Mississippi Valley Conference, St. Louis, MO.

Daumas, M. (1976). The history of technology: Its aims, its limits, its methods. In A. R. Hall & N. Smith (Eds. & Trans.), *History of technology: First annual volume, 1976* (pp. 45-71). London: Mansell. (Reprinted from Revue d'Histoire des Sciences, 1970, 22)

DeVore, P. W. (1968). *Structure and content: Foundations for curriculum development.* Washington, DC: American Industrial Arts Association.

DeVore, P. W. (1980). *Technology: An introduction.* Worcester, MA: Davis Publications.

Ellul, J. (1964). *The technological society* (J. Wilkinson, Trans.). New York: Vintage Books. (Original work published 1954)

Guralnik, D. B. (Ed.). (1980). *Webster's new world dictionary of the English language.* New York: Simon & Schuster.

Hickman, L. A. (1990). *John Dewey's pragmatic technology.* Indianapolis: Indiana University Press.

Johnson, J. R. (1989). *A Project 2061 panel report: Technology.* Washington, DC: American Association for the Advancement of Science.

Latimer, T. G. (1981). William E. Warner: His philosophy and influence on industrial arts. In D. R. Herschbach (Ed.), *Industrial arts: A historical perspective* (pp. 43-50). Reston, VA: American Industrial Arts Association.

Lisensky, R. P., Pfnister, A. O., & Sweet, S. D. (1985). *The new liberal learning: Technology and the liberal arts.* Washington, DC: The Council of Independent Colleges.

Loepp, F. L. (1986). Technological literacy: An educational challenge. In M. Sanders (Ed.), *Technology Education Symposium VIII Proceedings* (pp. 37-40). Blacksburg, VA: Virginia Polytechnic Institute & State University.

Meyer, H. K. (1951, June). Industrial arts–What next? *The Industrial Arts Teacher,* pp. 15-17.

Olson, D. W. (1963). *Industrial arts and technology.* Englewood Cliffs, NJ: Prentice-Hall.

Pearson, G., & Young, A. (Eds.). (2002). Technically speaking: *Why all Americans need to know more about technology.* Washington, DC: National Academy Press.

Price, D. J. de Solla. (1975). *Science since Babylon.* New Haven, CT: Yale University Press.

Savage, E. N., & Sterry, L. (1990). *A conceptual framework for technology education.* Reston, VA: International Technology Education Association.

Snyder, M. (2000). Broadening the interdisciplinary approach of technology education. *Journal of Industrial Teacher Education, 37*(4), 24-38.

Spengler, O. (1960). *Man and technics* (C. F. Atkinson, Trans.). New York: Knopf. (Original work published 1932)

Starkweather, K. N. (1983, May-June). AIAA: Pioneering leadership in industrial arts/technology education. *Man/Society/Technology*, p. 8.

State Committee on Coordination and Development. (1934). *A prospectus for industrial arts in Ohio.* Columbus: Author.

Warner, W. E., Gary, J. E., Gerbracht, C. J., Gilbert, H. G., Lisack, J. P., Kleintjes, P. L., & Phillips, K. (1965). *A curriculum to reflect technology.* Columbus, OH: Epsilon Pi Tau. (Reprint)

Wilber, G. O. (1948). *Industrial arts in general education.* Scranton, PA: International Textbook.

Williams, W. R. (1948, February). Industrial arts faces a new era. *The Industrial Arts Teacher,* pp. 1-3.

Quality-Based Cooperative Technical Teacher Training

By László Kadocsa and Imre Kopp•ny

Hungarian higher education is in transition from the stage of elite training to that of mass education. At the same time, according to monitoring surveys, the output efficiency level of secondary school students has decreased. These aspects, combined with the narrowing resource base due to the worsening demographic conditions, call for the renewal of global higher education and particularly technical teacher training. The authors are hoping for a breakthrough in the following items: quality-based approach in training and the organization, learning-centered philosophy instead of teacher-centered philosophy, new types of study materials and evaluation strategies, modular and credit-based curricula, and cooperative training.

Cooperative Technical Teacher Training

Technical teacher education at polytechnics in Hungary has the specialty, and the advantage, of parallel engineering and teacher training at the same time. This type of dual course work aims at preparing students for two alternative professions: engineer or technical teacher at vocational secondary schools. About three quarters of the total training hours concern engineering subjects, and one quarter of those center on pedagogical subjects. At Dunaujvaros Polytechnic (DP) there is a possibility for students to learn some engineering and pedagogical subjects in English or in German as well. More than half of the graduates work for industrial companies as an engineer. Graduates who have studied professional subjects in mechanical engineering or in information technology in foreign languages at DP are very popular, particularly at multinational firms in Hungary. Cooperative features of the training create a strong link between DP and industrial companies or other enterprises in the practical professional training of the students and between DP and vocational secondary schools in pilot teaching projects run by the students.

At the end of the sixth semester, every student spends a month at an industrial placement as an engineer assistant. In the seventh semester, there is a complex engineering project ended by a written final work and closing exam. This final work is related to the solution of a real industrial problem and is guided by an industrial expert and a supervisor of the academic staff.

Students complete a pilot teaching project in the eighth semester. The project consists of observation and trial teaching, one-month teaching practice in a vocational secondary school, and a teaching presentation. These activities are guided by a senior secondary school instructor and a supervisor of the academic staff. In the curriculum development of the technical teacher training program, theoretical and methodological aspects as follows were taken into account.

Challenge For Higher Education

Global tendencies in higher education are:

- Changing from elite training to mass education.
- Establishing common features in the national higher education systems.
- Strengthening integration and organizational restructuring.
- Gaining a multilevel character or diversification of the training.
- Enforcing institutional autonomies: constraint of the requirement of cost efficiency, development of the interconnection of higher education and research with the industry, change of paradigm in the strategy and methods of teaching and learning, improvement in quality, development of quality assurance systems, etc.

Hungarian higher education needs to follow the international tendencies of development and to adapt some of its important elements (Altbach, 1991). At the same time, in the course of changes, we cannot forget to take into account our national cultural heritage and features to preserve the actual values existing in our higher education.

As for quantitative development, Hungarian higher education has taken a considerable step towards catching up in the end of the 1990s, shown by the doubling of the number of students. Today, 40% of the generation aged between 18 and 23 years, or more than half of the youths leaving secondary school, will enter higher education.

Research studies have shown that the efficiency of students leaving secondary school decreased in our country—mostly in those fields that have an outstanding importance from the point of view of the success of studies in higher education. For instance, primary and secondary schools today prepare their students to a less extent for complex text interpretation exercises (diagrams, tables, instructions of use, etc.), and the output of youths in the field of mathematics and natural sciences is essentially worse than one or two decades before. There is a natural demand in public education to stop this decay of the output level of students and a call for its improvement. However, in itself, this cannot create a solution, as higher education must also enhance the smooth adaptation of students into higher level studies.

Increasing numbers of students combined with a narrowing resource base due to the worsening demographic conditions, the worsening output level of students in public education, and their uncertain career image, urge higher education that was previously arranged for elite training and that has been operating multiple selection mechanisms to undergo radical changes.

We are convinced that within the framework of mass-level higher education, for the sake of maintenance and even improving of quality, it is necessary to transform and renew the vertical structure of the training, as well as the whole technology of teaching and learning.

Change Of Paradigm In The Methodology Of Technology Education

Undergoing rapid changes, there is a demanding need for a new view and paradigm in higher education, which should be student-centered, learner-centered. For this reason, higher education has to change its learning programs. The content, methods, and the practice and means of delivery (teaching and learning) of education should be based upon new partnerships between students and teachers. These new methods of teaching should go together with new types of teaching-learning materials. These new methods must also be connected with the new types of assessment and evaluation, which will enhance the development of not only the memory but also understanding and realizing capacity, as well as creativity and the capacity of doing practical work. The technology-based learning environment and the information and communication technologies as well as the application of open and distant education methods require the reformulation of the content, forms, and full practice of education. These new methods of teaching should go together with new types of teaching-learning materials.

Change Of Concept

The renewal of training should include concept and role changes, both from the part of teachers and students, as well as the renewal of contents and the creation of a study environment. This change of view from the side of teachers requires the creation of a learning, guiding, helping attitude, which can be recognized as the main managing force of the learning process. The active cognitive activity of the students should more and more be emphasized, which, at the same time, also requires the undertaking of a greater responsibility for their own learning activity.

During the renewal of the study material, a balance should be achieved between the wide basis that assures the convertibility of knowledge and the users' ("market") demands that are formulated more and more markedly. Within the transformation of the study environment, the expansion in space and time of the scenes of teaching and learning is well observable (van den Berg, 1996). The individual sites, or those that are suitable for small-group learning, play a significant role in and outside of educational institutions: at media centers, resource centers, computer rooms, libraries, research places, homes, working placements, etc.

The main characteristics of the methodological, didactical changes are:

- The conveying of knowledge is transformed into a cognitive (knowledge-gaining) process.
- Learning to learn plays a decisive role in this process.
- The process has a student-centered character.
- The teacher loses his or her central role.
- The teacher assists the students in the organization of their learning activity.
- The teacher creates the conditions of learning, shows the direction, and gives counsel.
- The teacher explains to the student the essential interrelations, the methods of work, and the rules.
- The teacher evaluates the results.

These, altogether, can result in the achievement of a new type of relationship between teacher and student, the basic change of the structure and contents of training, and the character of teaching and learning.

Development Of Higher Education Curricula

We identify the curriculum as a process plan, a program, that is a thoughtful system of teaching and learning goals, requirements, contents, organizational-methodological-instrumental solutions, evaluations, and conditions. The structure of the curriculum determines the priorities that, at the present date, show more and more a student-centered or learning-centered tendency. In the development of the university and college curricula, the following tendencies can be observed:

1. ***The credit system becomes general:*** The credit serves for the measurement of the time for teaching, or for the measurement of the amount of the total student work necessary for the acquisition of the given subject or module. The great advantage of the credit system lies in its flexibility, which makes possible the satisfaction of the need for free

choice ("determining of the own way of life"), the permeability between the areas of study and the training stages, the reciprocal acknowledgment of the part-trainings and part-studies, the continuing of studies without time losses, the possibility of conferring an international status to the studies (European Commission, 1998).

2. ***The dynamic development of the modular curriculum structure*** (Badley & Marshall, 1995; Burkhart, 1996): The precondition of the optimal functioning of the credit system is modularization, which means the creation of study units, courses, and modules, as well as using them as elements in further building. The module, the unit element of the training (teaching and learning process) that is the basis of the planning and development of the curriculum, includes all the study work (lectures, practical classes, individual learning, assessment and evaluation, school practice, etc.) necessary for the processing and acquisition of a coherent part of the study material (subject or subjects). In fact, the modular curriculum system represents the basis of the credit system. The credit-based modular systems carry in themselves the joint advantages of the credit and modular systems.

3. ***Flexibility:*** The modules can elastically adapt to the many-faceted student community, to the rapid development of the sciences, and to the ever-changing needs of the labor market.

4. ***Motivation:*** The success assured by eligibility, the opportunity of forming an individual path of life, and the effective learning guidance can considerably increase the inner motivation of students, the appearance of a positive attitude, and responsibility towards learning.

5. ***Wide availability:*** With modularization it is possible, on one hand, for preparedness of candidates and the requirements of the study programs to meet. On the other hand, in the measure of the individualization of training and the elaboratedness of the learning guidance procedure and resource systems, it decreases the number of necessary contact hours and increases the ratio of individual learning.

6. ***Adaptivity of curricula:*** The module as a unit element (e.g., the standard module comprises a workload of 90 hours of total learning) can, in principle, be inserted anywhere in the curriculum, or can be changed, transformed, upgraded, etc.

7. ***Enhancement of credit accumulation and transfer:*** Modularized courses are characterized by the fact that the credit is allocated to the module, and the successful accomplishment of a certain module means the acquisition of the allocated credit points (e.g., if one module = 90 hours total learning workload and 1 credit = 30 hours total learning workload then 1 module = 3 credit points). Thus, the credit accumulation is achieved through the accomplishment of the modules, while possibility of the transfer (transferability, accountability) supposes modules with identical (to min. 75%) content among training programs, degree courses, and institutions.

8. ***Cost efficiency:*** As a result of wide availability, the cost efficiency is improving, but the elasticity has its own price. Cost efficiency can be improved if we apply "common" modules in different study programs.

9. ***Promotion of the concept of lifelong learning:*** The knowledge acquired in different training forms, places, and time, as well as the accountability of the practical placement, "requires" the modular and credit-based curricular form because this ensures the superposing of knowledge.

10. ***Open or distant education:*** Distant education is the "traditional" training

form built on modules in the shape of learning packages, which include most of the functions of learning guidance taken over from the teacher, with the assurance of consultation possibilities.

11. ***Spreading of information and communication technologies:*** They promote the re-thinking, re-formulation of the teaching materials and forms of delivery (teaching and learning) connected in most cases with distant education and/or modularization.

12. ***Enhancement of pedagogical innovation:*** Modularization, the development of learning guidance procedures and modern teaching materials, has represented the basis of the pedagogical renewal in higher education throughout the world, which can lead to the achievement of the change of concept and role (change of paradigm).

Active, independent student work is in the center of the process. From among the conditions of the effective achievement of the independent student learning activity, we can point out the following:

- Necessity of the development of learning abilities.
- Elaboration of a system of individual and group study problem solving (literature processing, exercises, projects, etc.).
- Decreasing to reasonable levels the fixed weekly number of hours ("contact hours").
- Working-out of a procedure and device systems for guided learning (learning guidance, additional learning materials, etc.).
- Upgrading of the assessment and self-assessment systems.
- Creation of a modern learning environment (computerized infrastructure, library, laboratories, tutorial system, etc.).

Quality Thinking In Education

A focus of institutional strategic management in higher education includes the demands of the stakeholders: students, staff, employers of graduates, government, and society (Bonstingl, 1997). This new way of thinking of quality in Hungarian higher and public education is characterized by some new programs:

- Hungarian Accreditation Committee organizes the evaluation of training programs and institutions in higher education (started in the mid 1990s).
- COMENIUS 2000 Quality Improvement Program aims at the implementation of the principles and practice of TQM in public education (started in 2000).

Preparation for these tasks is built in the training of technical teachers at DP. The quality development process was supported, among others, by a three-year TEMPUS-JEP project (1996-99).

The project has essentially achieved its objectives:

- The introduction of quality thinking into strategic management.
- The addition of one or more quality subjects in all of the main study areas at DP.
- The development of a new special course, Quality Control, consisting of 12 quality modules in the 3.5 year Technical Manager degree program.
- The development of a quality system at DP as well; the project helped to establish the Quality Assurance Office at DP.

Summary

The experiences of the modular and credit-based curriculum and cooperative training developed and introduced at DP have convincingly proved that, within the conditions of mass education, it is suitable for preserving the quality and, in the case of elaboration of learning guidance methodologies, for improving it. We believe that this pilot program of model value can offer useful experiences for the development of Hungarian higher education.

Meanwhile, the Dunaujvaros and international experiences have also called attention to the fact that the introduction of the modularization and of the credit system is not merely the question of decision, but it is a thoroughly prepared activity that requires a definitely controlled development work lasting many years.

The new type of study materials (learning guide, course textbooks/workbooks, self-evaluation/assessment tests, exercises, electronical study materials, open and distant learning materials, etc.), the alternative approach to the effective teaching-learning methods, the upgrading of the assessment and evaluation strategies, and the learning-centered, student-centered thinking itself require from the teachers the development of new skills instead of the customary traditional teaching activity. This cannot be efficient without a total quality improvement circle of the teaching-learning process.

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References

Altbach, G. P. (1991, Spring). Patterns in higher education development: Towards the year 2000. Review of Higher Education, (14), 190-203.

Badley, G., & Marshall, S. (1995). *53 questions and answers about modules and semesters.*

Bristol, United Kingdom: Technical and Educational Services.

Bonstingl, J. J. (1997). *Schools of quality: The application of total quality management at schools.* Nyíregyháza, Hungary: SCHOOL Bt.

Burkhart, S. (1996). *Vocational training in Europe: Towards a modular form?* (Discussion paper). Thessaloniki, Greece: European Center for the Development of Vocational Training.

European Commision. (1998, March 31). European credit transfer system: ECTS users's guide. Retrieved from http://europa.eu.int/comm/education/socrates/guide.en.dor

van den Berg, M. (1996). *Working on a new learning environment.* Eindhoven, The Netherlands: Pedagogisch Technische Hogeschool Nederland.

Outcomes Assessment: A Pilot Study

By Bill Drake and Douglas Walcerz

Web-Based Continuous Outcomes Assessment: A Pilot Study

Outcomes assessment and continuous improvement are essential elements of educational programs. Emphasis on assessment is based primarily upon the requirements of accrediting agencies, but also on the perceived value of assessment in satisfying the demands for accountability in an increasingly competitive environment. Educational research has shown that measurement of educational outcomes can be used to inform an institution about educational goals that are being satisfied and those that are not. This information can motivate and direct efforts to improve curricula.

In practice, the measurement of educational outcomes is challenging and can be expensive. Results are often ambiguous or statistically unsound. The positive impact of continuous improvement on the curriculum is difficult to prove (Allen, Noel, & Rienzi, 2000). Despite the difficulties and expense, accrediting groups and other agencies have mandated outcome assessment and continuous improvement. Of special note are new criteria by the Accreditation Board for Engineering and Technology (ABET). The new criteria rely extensively on outcome assessment for accreditation, and there is a need for efficient and effective assessment processes to satisfy these requirements. These same outcomes are also applicable to many other programs, including those accredited by the National Association for Industrial Technology (NAIT), North Central Association of Colleges and Schools (NCA), and other accrediting groups. This article describes a pilot study of the implementation of a Web-based (TrueOutcomes©) assessment process in a technology program and examines the effectiveness of the process in terms of student and faculty buy-in and whether the process produces useful data and reports for accreditation and continuous improvement.

We qualitatively measured the following:

- Difficulty of learning the assessment process for instructors and students.
- Quality of the descriptions of educational experiences submitted by students.
- Ability of students to categorize their experiences according to educational outcomes.
- Usefulness and appropriateness of the assessment process and reports.

We quantitatively measured the level of participation of those students who participated.

TrueOutcomes (formerly EnableOA) is a Web-based, software-driven outcomes assessment process that was designed to be consistent with the nine *Principles of Good Practice for Assessing Student Learning*, an online publication by the American Association for Higher Education (AAHE, n.d.), and the *Program Evaluation Standards* developed by The Joint Committee on Standards for Educational Evaluation (1994).

The TrueOutcomes process (Walcerz, 1999a, 1999b) collects both descriptions of educational experiences that instructors intend for their students and descriptions of educational experiences that students perceive they have received from their instructional experiences. Instructors prepare the former and students develop the latter. Every outcome description is associated with one or more of the educational outcomes developed by the instructor. Students are encouraged to attach electronic copies of their actual work (e.g., reports, PowerPoint presentations, CAD files, spreadsheets, programs, digital pictures of design projects, etc.) to support their descriptions. The outcome descriptions submitted by instructors are used to generate a matrix of coursework vs. educational outcomes that can be used in curriculum planning and evaluation. The descriptions that are submitted by students serve two primary purposes:

1. Students develop and maintain a personal electronic portfolio that serves as an extended resume and can be used for professional advancement. The usefulness of this extended electronic resume is the primary motivation for students to participate in the assessment process.
2. The descriptions are aggregated for a specific course or set of courses to see if students perceive and report the instructor's intended educational outcomes.

The Department of Industrial Management at Southwest Missouri State University (SMSU) offers a baccalaureate degree in industrial management (IM) with concentrations in construction and manufacturing management. The IM program enrolls about 300 students. The fall 2000 pilot study was conducted in two courses: Fundamentals of Engineering Drafting (TEC 110) and Industrial Safety (TEC 250). In the spring 2001, courses in Statics and Materials Testing were also piloted.

TEC 110 is a typical freshman-level drafting course in which CAD skills, sketching skills, and orthographic and isometric drawing techniques are practiced. TEC 250 is a sophomore-level course that meets one evening each week for three hours and is populated mainly by young adults with full-time jobs. The course emphasizes management of occupational safety programs.

Three accrediting agencies were associated with this study. Two directly impact SMSU and the third was included because of its impact on the development and application of the software.

Those agencies and their impact are briefly described here.

NAIT accredits the SMSU industrial technology program and has the following requirements with respect to assessment that are taken from the industrial technology accreditation handbook:

> Assessment Plan and Integration: An assessment plan shall be comprised of, but not limited to, the following for each program: (1) program mission statement, (2) the desired program outcomes/student competencies, (3) evidence that the program incorporates these outcomes/student competencies, (4) the assessment measures used to evaluate
> student mastery of the student competencies stated, (5) compilation of the results of the assessment measures, and (6) evidence that these results are used to improve the program. (NAIT, 2000, §§ 5.16 & 6.16)

NCA accredits SMSU as an institution and defines five criteria for accreditation and patterns of evidence to demonstrate the criteria. Statements relating to assessment are:

> Criterion 3: The institution is accomplishing its educational and other purposes.
>
> In determining appropriate patterns of evidence for this criterion, the Commission considers evidence such as:
>
> . . . assessment of appropriate student academic achievement in all its programs, documenting: proficiency in skills and competencies essential for all college-educated adults; mastery of the level of knowledge appropriate to the degree granted; control by the institution's faculty of evaluation of student learning and granting of academic credit.
>
> Criterion 4: The institution can continue to accomplish its purposes and strengthen its educational effectiveness. In determining appropriate patterns of evidence for this criterion, the Commission considers evidence such as:
>
> . . . structured assessment processes that are continuous, that involve a variety of institutional constituencies, and that provide meaningful and useful information to the planning processes as well as to students, faculty, and administration. (NCA, 2000, p. 9)

ABET has the following requirements with respect to assessment taken from criteria for accrediting engineering technology:

> Programs must have written goals that, as a minimum, focus on the student body served, employer expectations, resource allocation, and other factors affecting the program. Programs are required to have plans for continuous improvement and evidence that the results are applied to further development and improvement of the program. Each program is required to demonstrate achievements through various methods including student outcomes assessment and employer feedback. Typical evidence may consist of student portfolios including project work and activity based learning; results of integrated curricula experiences; nationally-normed subject content examinations; recent graduate surveys that demonstrate graduate satisfaction with employment including career development activities, mobility opportunities, and appropriate job title; and employer surveys that demonstrate satisfaction with recent graduates. Programs also must demonstrate that their graduates are readily accepted into the workforce and are prepared for continuing education. (ABET, 2000, Criteria 1 & 6)

ABET developed and has introduced the following objectives as a part of Engineering Technology Criteria 2000 (ET2K). We believe that these objectives are compatible with the NAIT accreditation requirements. Since these outcomes were already developed and ready for use, they were adopted for this pilot study. The ABET objectives for graduates are:

1. Demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines.
2. Apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology.
3. Conduct, analyze, and interpret experiments and apply experimental results to improve processes.

4. Apply creativity in the design of systems, components, or processes appropriate to program objectives.
5. Function effectively on teams.
6. Identify, analyze, and solve technical problems.
7. Communicate effectively.
8. Recognize the need for and possess the ability to pursue lifelong learning.
9. Understand professional, ethical, and social responsibilities.
10. Recognize contemporary professional, societal, and global issues and are aware of and respect diversity.
11. Have a commitment to quality, timeliness, and continuous improvement.(ABET,2002)

In addition to NAIT and NCA, the state legislature, the State Coordinating Board for Higher Education, and the university administration all encourage verifiable assessment.

Implementation

Outcomes Assessment Solutions (formerly Enable Technologies), an application service provider, established an application Web site for SMSU on their Web server. Therefore, the institution did not need to buy hardware or software. Outcomes Assessment Solutions was provided with a spreadsheet containing the names of the courses, the instructor, and rosters of students participating in the pilot study. They then imported this information into the software to establish accounts for all the involved students and the instructor. The 11 pre-existing educational outcomes defined by ABET ET2K were also entered into the software.

Instructor intentions were composed for the fall courses, in consultation with Dr. Walcerz, the service provider representative. In the spring course, intentions were added independently by the instructor. The objectives intended for the students taking the courses were compared with the previously listed ABET-TAC standards. This exercise was found to be helpful in better defining course objectives. This process exposed intended outcomes that had not been well formulated and also revealed that course content was much broader in scope than was initially perceived.

Examples include:

- Intended outcome: Students will learn to utilize computer aided design (CAD) software. This matches Outcome 1: “Demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines.”
- Intended outcome: Students will develop sketching skills, which addresses this same standard.
- Intended outcome: Students will work in small groups to check each other’s drawings before final submission. This matches Outcome 5: “Function effectively in teams.”

The lack of submissions for last outcome emphasized that specific instruction in team building is needed for teamwork to be an outcome.

TEC 250, the industrial safety course, addressed different standards. In one instance we were able to take advantage of the global safety officer for General Electric fractional horsepower motor plants, who had just returned from a visit to a new manufacturing plant in India. We learned from her that their method for transferring concrete is significantly different than the concrete pumps we now find so familiar in the United States. In India women were engaged to transfer concrete by climbing ladders carrying the concrete, balanced in baskets, on their heads. This unintended consequence addressed the ET2K Outcome 8: “Recognize contemporary professional, societal, and global issues and are aware of and respect diversity.”

Working in groups to develop reports and requiring many brief written reaction papers addresses Outcome 7, “Communicate effectively,” as well as Outcome 5, “Function effectively on teams.” Communication with Blackboard software and associated e-mail techniques is another example accomplishing Outcome 1, “Mastering modern tools of their disciplines.”

The process of working through course objectives and comparing them to the outcomes yielded a much better appreciation of how the objectives fit into the overall scheme of developing, to use the campus vernacular, “an educated person." The process of formulating these objectives and associating them with the ET2K standards initially took about one hour for each course. This involved reviewing the course syllabus and text(s) to identify what reasonable outcome objectives might be, creating instructor intended outcomes (word processing software recommended), and copying outcomes into the TrueOutcomes software.

Collecting Student Data

We presented the assessment software to students in two different ways. Because the TEC 110 class is a combination lab/lecture format, we were able to present the software to students as a laboratory exercise. After the first major test, the students were provided a set of instructions that directed them through help menus in the TrueOutcomes software. The students reported that these instructions were easy to follow and, after reading the introductory material, proceeded to make entries. Later analysis revealed that they were not all successful in making entries.

The same instructions used for TEC 110 were distributed to the TEC 250 class via e-mail and the Internet using Blackboard software. Later discussion with an informal sampling of students indicated that the TrueOutcomes "Help" process was easy to follow. However, analysis with the software indicated that only a little over 50% of the students successfully submitted entries. Speculation is that some students had failed to complete the submission process by missing a common last step . . . clicking the Submit Button.

Student Participation in the Assessment Process

A total of 37 students participated in the fall assessment process in two courses. Seventeen students submitted from one to three experiences to their electronic portfolios. In the software a color bar chart, Student Responses, provides data on student participation and indicates the percentage of students submitting experiences as well as the number submitted. In general, about one third of the students did not participate at all; one half submitted a single experience, and one sixth submitted multiple experiences. The apparent lack of participation may have been related to not clicking on the Submit Button as entries were made. This theory is reinforced by the observation that the TEC 110 students who were observed in a lab exercise had lower overall participation than the TEC 250 class.

Quality Analysis of Student Narratives

In order to participate in the assessment process, students had to compose narrative statements of their classroom experiences, focusing on concrete descriptions of what they had done rather than conclusions about what they had learned. This cognitive engagement in the evaluation process is one of the most valuable attributes of this assessment system. A total of 26 narratives were submitted in the fall and analyzed for quality. Good narratives were written in first person, described the student's work in good detail, and dealt with a single experience or a group of thematically related experiences. An example:

> . . . a trip to the . . . plant and I got to observe first hand . . . safety and health procedures on the job. . . . this trip it gave me a[n] understanding on what should be done in order to keep the company you work for safe, and this is what this class is all about understanding what it takes to keep the company you work for safe, so you don't have lost work days, have to pay workerman's [sic]comp, hire a replacement . . . and pay for overtime to catch up for the absents [sic] of a[n] employee. You need to have an understanding of safety and health, on the job, or it could cost the company a lot of money in hidden costs. With the tour . . . I saw a company with good safety procedures, in the employee's working environments . . .

Moderate narratives were written in first person, did not have enough detail, and sometimes included a collection of unrelated experiences. For example:

> Recently we took a tour of a local manufacture[r]. I thought the trip was a good idea and very informative. I It [sic] was well worth the time to do so. It would be great if more such trips were possible.

Poor narratives were either too short (e.g., a single 3-word phrase) or talked about what the student learned instead of what he or she did. Example:

> I feel that TEC 250 is a valuable course and all industrial technology majors should take it or something close to it. Safety should be a huge part in the industry, however it is not always a main priority. I think all managers should be trained in the safety arena.

An analysis of the students' narratives revealed 11 good quality narratives, 10 moderate narratives, and 4 poor narratives. The quality analysis of student narratives showed a substantial variation in quality between courses: TEC 250 had nearly 70% good quality narratives, while the TEC 110 class had nearly 70% medium to poor narratives. TEC 250 had more nontraditional students; therefore, student maturity would be expected to influence narrative quality. The software also provides a graphical display of the quality analysis.

For every experience students submitted, they selected the educational outcome that reflected their individual narrative. Our analysis showed that a majority of students selected too many outcomes; in other words, students selected outcomes such as "an ability to function on teams" when their narrative contained no mention of teamwork at all. A graphic showing Response Appropriateness is also provided. We found nearly 70% selected extraneous outcomes. Clearly more training in the use of the system is indicated. We believe this is consistent with the customary "mark sense" course evaluations where no active thought processes might be engaged. The cognitive engagement potential made available with this system could clearly provide some benefit in assessment.

The TrueOutcomes software automatically generates assessment reports based on the descriptions of experiences that students and instructors submit. A bar-chart presentation is available showing the percentage of students submitting experiences related to each of the 11 outcomes and the number of experiences related to that outcome. According to the data analysis, the percentage of students who perceived and reported at least one significant educational experience demonstrating "an ability to communicate effectively," "an ability to function on teams," "an understanding of professional, ethical, and social responsibility," and "an ability to identify, analyze, and solve technical problems" was 53%, 42%, 42%, and 37%, respectively. If we only consider the students who participated in the assessment process, the percentages are 77%, 62%, 62%, and 54%, respectively. If the quality of the student narratives was moderate or good and the students were able to select appropriate outcomes, then it is patently clear evidence that TEC 250 is developing those four outcomes to a substantial degree and other outcomes to a lesser degree.

The software also allows an instructor to "drill into" any of the outcomes to read the student narratives, review the selected outcomes, view attached documents, and thus to check the validity of the data. As discussed previously, the quality of narratives in TEC 250 was quite good, but the selection of outcomes often included more than the narrative justified. However, the raw evidence, the student narratives and attached documentation, is available to the instructor for assessment purposes.

A standard matrix of technology courses vs. the outcomes they are designed to develop is also available. Across the top of the matrix are the 11 educational outcomes. Down the first column are listed all of the technology courses offered. The cells of the matrix are either blank, which means that the instructor does not intend to develop the associated outcome in that course, or else a 100%, which means that all of the students in the associated course have an instructor intending to develop the associated outcome. TrueOutcomes uses percentages instead of the more common "Xs" because some courses are not uniform across all sections and instructors. For example, one section may have an instructor who uses project teams, thus developing teamwork, while another section of the same course may have an instructor who does not. If there are 60 students in the former section and 40 in the latter, TrueOutcomes will report 60% in the cell associated with teamwork and that course.

When comparing experiences submitted by

students with experiences intended by the instructor, it was clear that the instructor's intentions were fulfilled with respect to the outcomes relating to teamwork, communication, and professional responsibility. The instructor's intentions were partially fulfilled with respect to outcomes relating to knowledge and tools, and commitment to quality. The intended outcomes of global issues and lifelong learning were not being well met. It is interesting to see that a large percentage of students reported developing problem solving, when this was not an intended outcome of the course. This initial analysis must be tempered by the knowledge that most students selected extraneous outcomes, so "drilling into" the reported experiences will be necessary to verify the results until students become more familiar with the process.

The ability to see what was happening as the term progresses is most intriguing. This "real time" access to student perceptions allows adjustments with current students as opposed to the standard end of term evaluation. This is preferable to having input that can only be applied to the next group of students. The fact that students have to be cognitively involved with this process also provides much better insight into evaluations.

Conclusions

The software and process were straightforward to learn and use for both the instructor and students. Student participation and the quality of student submissions were acceptable but not as good as desired. Analytical reports provide meaningful feedback and can be used to document the continuous improvement process for accreditation purposes. The process does not require an excessive time commitment on the part of the instructor. Students can access the software at their convenience in addition to the creation of a portfolio of personal achievements that may be of value in future endeavors.

The effort required to set up the TrueOutcomes program is balanced by the provision of in-depth insight into the educational process. That insight, into the way that activities engage students and address outcomes, provides new opportunity by emphasizing areas where improvements can be made.

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References

Accreditation Board for Engineering and Technology ,Technology Accreditation Commission. (2000). *Criteria for accrediting engineering technology programs.* Retrieved April 2002 from http://www.abet.org/downloads/2000-01_Engineering_Technology_Criteria.pdf (No longer available from this Web Site; http://www.abet.org/criteria.html shows current TAC criteria.)

Allen, M. J., Noel, R. C., & Rienzi, B. M. (Eds.). (2000). *PACT outcomes assessment handbook.* Bakersfield: California State University, Program Assessment Consultation Team.

American Association for Higher Education. (April, 2002). *Principles of good practice for assessing student learning.* Retrieved April 2002 from http://www.aahe.org/assessment/principl.htm

The Joint Committee on Standards for Educational Evaluation. (1994). *The program evaluation standards.* Thousand Oaks, CA: Sage.

National Association of Industrial Technology. (2000). *Industrial technology accreditation handbook.* Retrieved April 2002 from http://www.nait.org/accred/accreditationhandbook.html#1

North Central Association of Colleges and Schools. (2000). *The criteria for accreditation.* Retrieved April 2002 from http://www.ncacihe.org/overview/2001HLCOverview.pdf

Walcerz, D. B. (1999a). *EnableOA: A software-driven outcomes assessment process consistent with the principles of good practice for assessing student learning.* Paper presented at the American Society for Engineering Education Mid-Atlantic Conference. Retrieved April 2002 from http:www.trueoutcomes.com/ASEE%20Monmouth.pdf

Walcerz, D. B. (1999b). *A new, time-efficient, high quality outcomes assessment process.* Paper presented at the American Society for Engineering Education North Central Conference. Retrieved April 2002 from http://www.trueoutcomes.com/ASEE-Erie%204.9.99.pdf

Electronic Course Delivery in Higher Education: Promise and Challenge

By John W. Sinn

Philosophical, political, quality, learning, and instructional challenges are being encountered as higher education institutions respond to pressures and enticements of the World Wide Web and the Internet. My involvement with electronic instruction, almost from the infancy of that process, provides a basis for my views on these challenges. I discuss these under four headings: In Higher Education, Teachers and Learners, Gifts of Electronic Instruction—A Review, and Ensuring Quality.

In Higher Education

Institutional policy, systems, and infrastructure developed over the years to support ongoing programs must change. Not only must traditional efforts be continued, but electronic instruction should be facilitated, governed, and integrated. In doing so, most ongoing activities exemplified by staff meetings, registration, bursar billings, or the bookstore will need to be changed as will virtually every activity of institutional life.

As the reach of instruction is extended outside the university walls, standards, systems, and policies will not only become linked via electronic means but will accommodate new modes of delivery. The university may also find that in order to deliver its instruction beyond its walls, it must understand and work within state, national, and even international laws. New issues of ownership and copyright and security of courses will require more and different sorts of attention and expertise in the new environment (Perley & Tanguay, 1999).

State Governing or Coordinating Boards

As with individual institutions, the state legislators and public higher education governing or controlling boards must consider their policies and attitudes of support or nonsupport for credit and courses offered out of state and the country by constituent universities. Such developments have implications for partnerships between institutions that are distant from one another, which may require state and possibly national government approval.

Many states support their higher education system on some sort of formula system that results in a subsidy to institutions. Electronic instruction introduces issues that need to be carefully and thoroughly investigated, understood, and planned for. There may be a danger in applying a formula used for traditional instruction to support electronic instruction. The flexibility of electronic instruction goes beyond consideration of changes within existing institutions. For example, implications for course loads, up or down, and how to address these in the electronic environment, along with many other questions about the role of faculty, must be assessed in various models. State governing agencies must give heed to the notion that new types of institutions and even entirely new state or proprietary university systems may be on the horizon. These may be based on paradigm shifts influenced by electronic instruction and yield, for example, creative ventures such as transfer credits among two- and four-year institutions, as well as high schools. Since electronic delivery "levels the playing field," in a geographic sense, playing in each other's "back yard," consortial arrangements among different institutions across regional, state, and even national boundaries become physically possible. One example of such an arrangement is the Indiana State University Technology Management Ph.D. Consortium. Involving several universities in various states, the consortium is primarily electronically delivered to focus on several specializations, including the quality systems specialization which the author has been engaged with (Sinn, 2002b).

The Individual University or College

Primarily residential campuses must become concerned with electronic courses, and their institutional mission should address non-traditional electronic delivery issues. The advent of electronic courses delivered anywhere poses serious questions about how to deal with and enable youth to mature and develop the social and intellectual skills that the undergraduate colleges have been providing. Thus, goals of institutions must continue to focus on attracting the best and brightest faculty and students, but also enable them to engage via electronic or traditional methods. The two approaches should not be considered exclusive of one another. On the other hand, blending them into a cohesive, effective university experience may not be a trivial matter. One approach for this is offered in learning communities for our future, both physical and electronic in nature.

Capital Resources

Another consequence of the electronic revolution is determining the flow of resources to affect the best use of bricks and mortar and the electronic infrastructure. Questions about whether buildings and, perhaps more important, the types of buildings that will be needed to support instruction in the future must be addressed.

In this regard, infrastructure shifts must be better anticipated, and future planning must enable rapid implementation and a speed-up of project implementation in order to accommodate the changes that will continue to happen quickly in electronic communications. Thus, institutional planners must acknowledge that technology for electronic delivery will increasingly drive the process. Daniel (1997) noted this situation when he said:

> We are engaged in a battle. The world's universities are in a crisis, assailed by challenges of access, cost, and flexibility. The United States has the world's strongest university system, and the world looks to it for leadership. Yet your system is wedded to teaching technologies that make it difficult for you to successfully respond to the crisis. (p. 17)

Daniel advocated a technology strategy to provide access and flexibility, but at the same time assure integrity in systems.

Hardware/Software

Hardware and software must be in place and configured to seamlessly enroll students in and start up an entire course via the Web. This process should be enabled from any location, without need to be on campus and without major intervention or inconvenience to student or faculty. Because of the importance of supporting courses, institutions need to ensure that servers for that purpose are separate from servers devoted to other administrative and e-mail uses. Doing so recognizes the "bread and butter" nature and appropriate stature of electronic teaching and learning.

Innovative models must be developed that offer faculty incentives to seek out and use new hardware and software delivery systems. Costs, convenience, conformity, and allowance for future change of hard and software must be balanced in light of higher education's limited resources. Economies may be realized in shifts from bricks and mortar to virtual systems and merging traditional institutions and functions to reduce duplication. Other economies may be realized in leasing laptop systems rather than outright purchase and maintaining traditional labs with desktop technology. Costs of providing current desktop technologies per user must be determined and desktop setups reduced, enabling funds to be rolled over toward laptops. Doing this successfully will add flexibility inherent in laptops over the time and place-centered desktops (Waggoner, Sinn, Kennedy, Zargari, Corbett, 1997).

Teachers and Learners

Changes that may be observed in the university are primarily found in redefined roles in teaching and learning. These are reflected in changes in the "presence" of faculty that may occur through real physical presence or through a virtual or electronic presence. Students may become more self-reliant and autonomous, acquire knowledge differently, and be accountable in different ways. Course flexibility and configuration changes occur, and means of student, faculty, and course assessment become different.

Redefined Roles—Faculty as Instructors

Physical presence no longer means a professor standing in front of students to lecture or conduct other traditional classroom activities. The professor's electronic presence is defined and accomplished by the use of various media such as digital documents, chats or video, or camera projection with audio.

Traditional teaching requires a physical presence and direct emotional involvement, whereas electronic delivery provides a detachment in discreet ways. Lectures, exams, structured meetings in one location, and other methods are basic traditions that we have come to accept as the "way things are to be done." We are reminded that in a number of instances the traditional lecture was suggested as being one of the worst methods, despite the reality that most of us have relied heavily on this approach.

Electronic courses demand structure. Although planning and structure have been expected for teaching of traditional courses, it is possible to do a traditional lecture ill prepared and meandering, and even sometimes appear to be well prepared. Electronic instruction demands articulated and integrated preparation. The instructor's presence is in fact the electronic configuration, and it is possible that in such courses the instructor will be able to work at home or in an office rather than in a classroom populated with students, each at his or her desk. Thus the instructor's role becomes redefined. Faculty must organize and facilitate highly structured and orchestrated systems. They must rethink the entire teaching and learning processes. Focus moves from the teacher as a lecturer at the center of attention to that of a facilitator and course designer, almost entirely focused on electronically delivered content and process.

Everything must be digitized or accessible via the Web, and what was done verbally and physically now must be formatted for students to download or interact with in some structured electronic manner. The goal is to have everything navigable in a fairly seamless and articulated manner by disciplined, computer literate learners. This is not a simple matter, and it may be resisted by faculty who dislike writing or who may not wish to carefully think through the design or redesign of a course.

Redefined Roles—Students as Autonomous Learners

Students become knowledge navigators, independently engaged, knowing when and how to "pick up the ball and run with it." Traditions such as skipping classes, whiling away hours trivially, or using courses as social entrees do not apply in the electronic venue where students must navigate well-designed courses. Rather, they must be highly disciplined, focused, and goal oriented, able to work independently and in sometimes ambiguous and nebulous ways. Persons having difficulty working independently, or having a low tolerance for reading carefully and following structured, comprehensive instructions, may have difficulty in this intellectual environment. Properly designed electronic courses may cause those who really do not wish to be engaged intellectually to indicate dissatisfaction with the electronic environment, perhaps due to not being "spoon fed" as they may have been in the traditional classroom. On the other hand, highly motivated, computer literate learners can readily excel in the electronic environment.

Knowledge Acquisition

In Web courses, information and experience as content and process can be posted to provide a portfolio record of progress. Chat transcripts can be recorded and posted, along with conversations in e-mail. Disciplined growth of knowledge actually unfolds in courses, with powerful opportunities to assess teaching and learning, seamlessly documented as portfolios. As students do their work, it becomes streamed together, step-by-step, to clearly show how the thought and intellectual process is formulated. While some may be uncomfortable with how "raw" this is, it cannot be denied that this "electronic dialogue" is the bottom line on when and how knowledge is grown.

Accountability and Assessment of Students, Faculty, and Courses

Traditional accountability systems are less applicable because students do not expect to take "pop quizzes." Attendance taking is automated, and information is manipulated rapidly. Postings can be lost, and savvy computer users may be capable of "borrowing" materials not meant for them; thus, plagiarizing is a possibility. These can be defended against, as in traditional teaching, if the electronic course and systems of delivery are well thought out and changed periodically to correspond to learners' needs and to technologies of delivery. Examinations and tests are dramatically different from the traditional classroom setting as is the entire system of accountability and assessment of the learner and the course. Nontraditional forms of documentation for assessment will become increasingly called upon for accountability of teams and individuals in courses as we diminish traditional forms of test taking based on traditional physical presence. For example, a team of students focused on a project may compile a portfolio of responses to address a technical problem at an industrial firm. The portfolio can document their progress, replacing traditional examinations.

Electronic courses can be rigorous, well designed, and structured. Robust team projects, with reality-based professional requirements, are very achievable in Web-based systems, perhaps even better configured in this way than in traditional courses. Engaging persons external to the academy can be achieved with use of a password. This enables projects and work where the world truly "becomes the lab." Quality is readily measurable due primarily to the highly documented nature of the course in portfolio ways addressed and accessible as presented above. Further underpinnings and illustrations of innovative quality applications in nontraditional lab environments were provided by Olson and Sinn (1999) and Shipman and Sinn (1997). It is suggested that the assessment of courses and instructional quality must become increasingly tied to the "deliverables" produced by students, illustrative of the capacity of the faculty to facilitate and empower emerging student talents, regardless of level, but particularly at the university. This also serves as an excellent illustration to demonstrate that the role of faculty, students, and the entire university is changing as a function of electronic design and delivery of courses.

Gifts of Electronic Instruction—A Review

Electronic delivery brings substantial flexibility and agility to courses that are virtually impossible in other instructional means. No longer do individuals need to be on campus or at the same location. People can be "hooked up" at home, work, virtually anywhere. Class meetings are more flexible in time, space, and location, but if included in a course, electronic chats require a common time and "room location" analogous to traditional time and place of traditional courses. All individuals involved will need properly configured computer systems, with laptops providing the greatest flexibility and agility. Classrooms and their buildings as we know them will decreasingly be required, which will cause serious challenges to institutional planners and administrators. Just as business and industry work innovatively, professional and general university preparation will be increasingly electronic, responding to customer demands for flexible, rapid-moving information.

Electronic delivery may actually enhance teaching and learning, and perhaps the basic criteria for electronic instruction should be how it will improve instructional effectiveness. With electronic instruction and learning, (a) teachers and learners should be better organized and more efficient; (b) teachers and learners should be more dynamic, flexible, and agile; and (c) quality assessment should be enhanced and evidenced more readily. The overall positive effects of electronic delivery may have a significant influence on the evolution of the discipline of technology (Sinn, 1998a).

Systems to connect and encourage research initiatives for "growing knowledge" electronically with our broader communities and customers as part of the academy must be explored. We must better analyze and identify learning attributes assumed prevalent in various levels and types of learners, relationship of maturity, and so on. If we can better understand learners' attributes or behaviors (Sinn 1997, 1998b) and electronic systems' attributes, perhaps we can better match the two with resultant improvement. Faculty and students may wish to be able to select courses and approaches to instruction as they discern what best suits their attributes and behaviors, disallowing those they may wish to avoid. All should be involved, required to experience change, gaining preparation electronically for the future, perhaps transparent, like any other instructional approach (Sinn, 2000).

Ensuring Quality

Assessment and evaluation are important as we determine value added or detracted by technology. Technology can provide opportunities to evaluate and assess traditional and electronic courses and systems. If infrastructure is in place, coursework built as portfolios can be communicated for accreditation, course evaluation by students and faculty, comparisons of electronic and traditional (same) courses, among others. It is possible to accredit, assess, and evaluate from a distance, rather than being on campus, if all are properly configured. As one important example, library resources provide significant institutional questions. Assuring that students have access to quality information beyond (but including) the Internet is key. Facilitating traditional print information available on campus for distance constituents fairly and equitably, engaging students and faculty in evaluating and using information from all sources, is the challenge.

Quality Systems

The existence of a quality system assures quality in electronic delivery. This necessitates a paradigm shift of significant proportions, beyond accreditation and assessment. But, if done properly, the quality system can address essential accreditation and assessment issues, and help build a robust environment for electronic delivery. A viable quality system will recognize the importance of faculty advising, student organization professional involvement, advisory committees, portfolios, alumni surveys, cooperative education experiences, senior projects, and other internal and external mechanisms for assuring quality curriculum, all electronically (Sinn, 2002a).

Do we understand the European Union's role in the International Standards Organization (ISO) global drive for quality standards? What promise do the ISO quality drive (Lamprect, 1992) globally, the Baldridge National Quality Award in America (National Institute of Standards and Technology, 2000), and other traditional quality issues such as Deming principles hold? A university-wide quality system can be the basis from which accreditation and assessment are conducted, all based on emerging standards and guidelines within the ISO context (American Society for Quality, 2000). The challenge may be to practice the Deming principle of placing responsibility for quality at the lowest level possible—in our environment faculty—to provide mechanisms for assessment and accreditation. As a quality system, this is a major paradigm shift that must occur organizationally in order to be competitive in the future. Quality systems must be at the curriculum and course level to achieve goals inherent in assessment and accreditation. Faculty must mesh directly with point of contact connected to our key customer, the student, in the quality system. Recent winners of the first Baldridge awards given in education underscore the depth and importance of the development of quality systems in education at all levels (Daniels, 2002).

Electronic accreditation is being developed by the Council for Higher Education Accreditation (CHEA) with the Western Governors University (WGU), designed to be used and tested at various institutions. Standards may be the same for all institutions, electronic and traditional, and they must be applied uniformly to all (CHEA, 1999). Additional insights were offered by Crow (1999) in an article in the Chronicle of Higher Education. While we may be vague on what the portfolio can do for the overall process, understanding quality suggests a very clear documentation role. Electronic portfolio documentation, driven curricularly by faculty, coupled with data collection, is a key mechanism required for quality, particularly for accreditation and assessment.

The Future

The primary recommendation is to pursue ongoing development of infrastructure and quality electronic delivery of courses. Fundamentally about change, the question is how to equip faculty, students, and staff to work electronically in a high quality manner. We must collectively re-think policy and standards for global quality systems and standards based on ISO and Baldridge quality criteria, as related to electronic delivery of courses. We must also acknowledge that this can greatly benefit our students, particularly by focusing on broad total quality systems institutionally, and link assessment, portfolios, and actual course evaluation and improvement through this quality system.

As a fundamental principle of quality, it is critical that we maintain courses similar to current departmental functions, placing ultimate responsibility for quality where it has always been, and should be, with faculty. This must occur simultaneously while the traditional department and faculty role will change dramatically, along with all that the university is about in the context of process, becoming increasingly electronic as well. Amidst all of the changes, the easy reaction of some may be to seize control of courses from faculty when, in fact, the technology and systems can and must facilitate empowerment.

In all that we do we must strive to improve hardware and software systems, relative to traditional systems, particularly courses and basic services. Technology improperly used can facilitate the addage "garbage in-garbage out," but it also offers many opportunities for improvement if we choose to develop infrastructure carefully and in detailed ways. This ought not be viewed as a trivial or simple task of implementation only, but must be carefully matched alongside faculty perceptions of what is critical to enhanced delivery of teaching and learning, particularly in a process context.

We must better anticipate and plan for change relating to electronic delivery. If we make substantial changes in one area, we will see implications for other areas of our work and environment, and better strategic planning linking all aspects of our work and environment must be accounted for. As the customer base gradually shifts from being physical and present to electronic and virtual, the need for enhanced planning systems will be increasingly critical. This must begin with changes in how states perceive their role in the educational process, and consortial connections in broader infrastructure, globally, to take better advantage of collective resources and "best practices" at the local level.

As part of the change process, we must intentionally build increasingly robust models to optimize all that we are about via technologies of course delivery, relating how we work, growing human capital and knowledge, ongoing improvement systems to solve technical problems, and embracing classrooms well beyond traditional brick and mortar precepts and traditions. This must also include designing, structuring, and administering objective tests and experiments, as assessments, of both electronic and traditional teaching and learning scenarios to assist all in better understanding where and how to use all systems for best advantage.

Finally, changes should be done to improve all that we do, not simply for the sake of change. The immediate electronic delivery opportunities that beckon must be pursued, but only with careful and prudent consideration. This challenges us to objectively use our knowledge and experience to assess potential electronic delivery changes as positive and value adding. Change must occur, based on substantive evidence evolutionarily pointing toward improvements. Conventional wisdom suggests that electronic delivery, while not applicable to all we do, must be pursued for our future, but primarily based on evidence of improvement.

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References

American Society for Quality. (2000). Draft standard: Guidelines for education (BSR/ASQ-Z1.11-2000). Milwaukee, WI: Author.

Council on Higher Education for Accreditation. (1999). *CHEA update number 2: Distance learning in higher education.* Washington, DC: Author.

Crow, S. (1999, October 29). Virtual universities can meet high standards. *Chronicle of Higher Education, 66*, B5-B6.

Daniel, J. (1997). Why universities need technology strategies. Change. *83*, 11-17.

Daniels, S. (2002). First to the top. *Quality Progress*, *35*(5), 41-53.

Lamprecht, J. (1992). *ISO 9000: Preparing for registration.* Milwaukee, WI: American Society for Quality Press.

National Institute of Standards and Technology. (2000). National quality program. Retrieved April 2001 from http://www.baldridge.org

Olson, D., & Sinn, J. (1999). Update on applied quality science at BGSU, student-based research for technology transfer: Critical element for technologists. *Journal of Industrial Technology, 15*(4). Retrieved March 2001 from http://www.nait.org

Perley, J., & Tanguay, D. M. (1999 October 29). Accrediting on-line institutions diminishes higher education. *Chronicle of Higher Education*, *66*, B4-B5.

Shipman, M., & Sinn, J. (1997). Technology transfer, CQMA, and the future. *Journal of Industrial Technology*, *13*(1), 40-45.

Sinn, J. (1997). Universal performance behaviors: What ought to be the technologist's toolkit? *Journal of Technology Studies*, *23*(2), 58-60.

Sinn, J. (1998a). Content to achieve industrial technologist performance behaviors. *Journal of Technology Studies*, *24*(1), 38-41.

Sinn, J. (1998b). Discipline, research, future conversations with friends: Can we move quickly to determine core knowledge? *Journal of Industrial Technology*, *14*(4), 11-14.

Sinn, J. (2000). Proposal for taking the profession to the next level: Assessing core knowledge through online methods. *Journal of Industrial Technology*, *17*(1). Retrieved April 2001 from http://www.nait.org

Sinn, J. (2002a). Education and the future of quality. *Quality Progress, 35*(7), 69-73.

Sinn, J. (2002b). A quality major. *Quality Progress, 35*(10), 24-29.

Waggoner, T. C., Sinn, J., Kennedy, E., Zargari, A., & Corbett, R. (1997). Automating a liberal education technology course: Preliminary foundation for redesign. *Journal of Industrial Technology*, *13*(1), 35-39.

Factors Influencing Participation in Technology Education Graduate Studies

By George E. Rogers and Phillip L. Cardon

Higher education has initiated a variety of educational reforms in an attempt to improve the effectiveness of teacher education over the last two decades. A major focus of the reform movement has been professionalization of schools that prepare educators. Metcalf-Turner and Fischetti (1996) indicated that traditional university approaches to teacher education were inadequate primarily because of disengagement between theory and practice. The need for context-rich educational experiences in teacher preparation is important in all teacher education, but is imperative in the field of technology education. Technology education demands a co-mingling of theory and principles with practice. Morris, Armstrong, and Price (1997) stated that the present teacher education system fails to equip preservice teachers for the realities of the classrooms they will enter. The challenge for technology teacher educators is to embrace reform initiatives that bridge pedagogy by encouraging the profession's best teachers to enter the teacher education faculty ranks, thus keeping technology teacher education theory current with classroom practice.

A key component of this educational reform is technology teacher education faculty versed in both practice and theory. To assist in facilitating these changes, Brown (2002) noted that 64% of the technology teacher education programs surveyed indicated that they would increase their faculty by one or more positions over the next five years. However, Brown also indicated that the field would be short an average of 25 qualified faculty candidates per year and that these positions could go unfilled. Without qualified technology teacher education faculty, it will be very difficult for these education reform efforts to succeed.

Graduate-level technology teacher education has not kept pace with the need for qualified faculty. The number of individuals pursuing graduate studies in technology education, focusing on teacher education, is at its lowest level in five decades (Bell, 2001; Buffer, 1979; Erekson & McAlister, 1988). According to Brown (2002), the technology teacher education profession is in short supply of qualified faculty. Hill (2003) further noted that a shrinking pool of faculty is compromising leadership for the profession. Based on these trends, Volk (1997) predicted that "the demise of technology teacher preparation programs will occur around the year 2005" (p. 69).

Statement of the Problem

Since 1975, there has been a steady decrease in the number of technology teacher education graduates (Volk, 1997). This decrease has been compounded by a significant increase in the number of technology education teachers needed across the nation (Weston, 1997). A survey of technology education leaders rated insufficient quantities of technology education teachers and the elimination of technology teacher education programs at the university level as two of the most critical issues facing the profession (Wicklein, 1993).

Volk (1997) noted that one factor in the decline of university technology teacher education programs has been the lack of graduate-level prepared faculty to serve as technology teacher education professors. Buffer (1979) found that between 1955 and 1977 over 2,500 individuals received a doctoral degree with emphasis in industrial education, the predecessor of technology education. A survey of the *Industrial Teacher Education Directory* (Dennis, 1995, 1996; Bell, 1997, 1998, 1999, 2000) noted there were only 127 technology education doctoral degrees awarded between 1994 and 1999. Buffer (1979) further noted that there were 2,507 master's degrees awarded during the 1976-1977 academic year. This number pales in comparison to the 6,700 master's degrees awarded in 1938 (Buffer, 1979). Furthermore, an examination of the *Industrial Teacher Education Directory* indicated that only 209 master's degrees in technology education were earned in 1999.

Currently, there is a lack of information as to the causes in the decline in technology educators pursuing an advanced degree. Without increasing the number of graduate degrees in technology teacher education, the baccalaureate degree major of technology education may vanish and, consequently, technology education courses will no longer be provided to the nation's middle school and high school students. This research was an attempt to address one of the major problems facing the technology education profession: the lack of graduate prepared teacher education faculty.

Significance of the Problem

According to the International Technology Education Association (2000), technology education teachers prepare the nation's middle school and high school students with core technological knowledge and skills. Secondary technology education is a hands-on program of study that provides an opportunity for students to learn about communication, construction, design, manufacturing, power-energy, and transportation. Technological literacy benefits students from all fields, but especially those who choose technical careers, such as engineering, architecture, industrial design, manufacturing, and construction. Theoretically, a shortage of secondary technology education teachers could have an impact on the quality and quantity of students entering university engineering and technology programs.

The number of technology teacher education graduates from the nation's universities has reached a critical stage. As Volk (1997) noted, "if we do not address the issues, soon we will be going … going … gone" (p. 70). Volk further stated that "the corresponding decrease in doctoral degrees granted and diminished new professional opportunities in technology education teacher preparation programs does not afford the incentive or opportunity for new ideas to be promoted" (p. 69).

Purpose of the Study

The purpose of this research was to identify the factors that influence enrollment in technology teacher education graduate programs, both doctoral and master's levels. This study examined both positive factors, those that influence technology education teachers to enroll in graduate education, and negative factors, barriers that deter teachers from entering either a doctoral or master's degree program. The following research questions were developed for examination:

1. What factors do graduate education program graduates identify as providing the greatest positive influence for their enrollment into a graduate program?
2. What factors do technology education teachers indicate would provide the greatest incentive to enroll in a graduate education program?
3. What factors do graduate education program graduates identify that provided the strongest barriers to their enrollment in a graduate program?
4. What factors do technology education teachers identify as providing the strongest barriers to their enrollment in a graduate education program?

Methodology

This study utilized a modified Delphi technique as noted by Paige, Dugger, and Wolansky (1996) and Wicklien (1993) to identify and analyze what factors led individuals to enter both doctoral programs and master's degree programs focusing on technology teacher education. Additionally, the factors that deter individuals from entering doctoral and master's degree programs were identified.

Population

Two pairs of Delphi panels were established: one pair for examination of the doctoral programs and the other pair of panels to study the master's degree programs. The first doctoral group consisted of recent doctoral graduates (1994 -1999) whose degrees were in technology education focusing on teacher education as indicated in the *Industrial Teacher Education Directory* (Dennis, 1995, 1996; Bell, 1997, 1998, 1999). The directory noted that 127 doctoral degrees were granted during this five-year timeframe. Institutions that had graduated five or more doctorates during the five-year time span were contacted and asked to provide the names and address of their technology education doctoral graduates. This resulted in a population of 15 doctoral graduates whose location could be identified. These 15 individuals comprised the population for one panel of this modified Delphi study. From this population, nine doctoral graduates agreed to serve on the Delphi panel.

The second doctoral panel consisted of practicing technology education teachers. Technology education directors from six states were asked to identify five technology education teachers who currently hold a master's degree and whom the director would categorize as "an outstanding candidate for doctoral studies." This second doctoral population consisted of 30 technology education teachers having earned a master's degree and identified by their state director as a leader in the profession. From this population, 16 teachers agreed to serve on the Delphi panel.

The first master's degree panel consisted of technology education teachers who had earned a master's degree from 1994 through 1999. This panel was randomly drawn from an identified population of 209 technology education teachers who had earned a master's degree. From this sample, 19 teachers agreed to serve on the Delphi panel. The second master's degree panel consisted of 18 teachers without an advanced degree and who agreed to serve on the Delphi panel. These pre-master's program teachers were selected from a population of technology education teachers identified by state technology education directors.

Procedure

The first round of this modified Delphi study consisted of an open-ended survey mailed to all participants, doctoral graduates, master's degree graduates, and both sets of technology education teachers. Doctoral and master's degree graduates were asked to identify the factors that positively influenced their decision to enter and complete a graduate education program and to list those barriers that they were able to overcome in order to earn an advanced degree. The two non-advance degree panels were asked to list the factors that would positively influence them to enter either a doctoral program or a master's degree program. These two pairs of panels were also asked to identify the barriers that have deterred them from entering either a doctoral program or a master's degree program.

First round responses were then categorized into similar factor groupings for the second round review. Each panel's listings, doctoral graduates, master's degree graduates, and both sets of non-advance degree technology education teachers, were grouped into 10 common factors for both positive influences and barriers. Each Delphi panel was then mailed a set of second round instruments on which the participants were asked to rank-order the 10 factors from 1 (*greatest*) to 10 (*weakest*). Each participant received two ranking surveys, one noting positive influences and the other instrument listing barriers. The findings from the study's second round of responses were then compiled for a third Delphi round. Top rank-ordered items were selected to be used as the factors listed in the study's final round.

During the third and final Delphi round, participants were asked to rate each positive influence and each barrier on a 1 to 5 Likert-type scale (1 = *weak influence*, 3 = *absence of influence*, and 5 = *very strong influence*).

Findings

Master's degree graduates rated their personal goal and desire as the top influence for pursuing a graduate degree (M = 4.74, SD = 0.56; see Table 1), whereas technology education teachers without a master's degree rated their personal goal and desire at a lower level (M = 4.00, SD = 1.14). Doctoral graduates also rated their personal goals and desire as the top positive influence in enrolling and completing a doctoral program in technology education (M = 4.63, SD = 0.70; see Table 2). Technology education teachers from the doctoral Delphi panel who had completed a master's degree also noted that their personal goals and desire would provide them the most positive influence for entering a doctoral program (M = 4.63, SD = 0.78).

The university's geographical location was indicated as a positive influence by both master's degree graduates (M= 4.37, SD = 0.68) and their cohort of technology education teachers (M = 4.28, SD = 1.02). The positive influence of the university's location was also noted by the teachers with a master's degree from the doctoral panel (M = 4.25, SD = 1.09). However, the positive influence of geographical location was not shared by doctoral graduates (M = 2.38, SD = 1.58). The difference in doctoral panel members with regard to the university's geographical location was also noted in the barriers section by the master's degree Delphi panelists (see Table 3). The pre-master's teachers rated the university's location as a significant barrier to enrolling in a master's degree program when compared to their master's degree graduate counterparts (M = 3.50, SD = 1.58; M = 2.16, SD = 1.30, respectively).

Doctoral graduates rated the doctoral program's quality and reputation along with its faculty's quality and reputation as positive influences (M = 4.00, SD = 0.71; M = 4.00, SD = 0.87). Technology education teachers, from the doctoral panel, rated the quality and reputation of the program and faculty lower (M = 3.63, SD = 0.70; M = 3.56, SD = 1.06). Technology education teachers without a master's degree rated the quality and reputation of the university as their strongest positive influence (M = 4.56, SD = 0.51), whereas the master's degree graduates from this panel rated that item lower (M = 3.84, SD = 1.01).

Both groups from the doctoral Delphi panel indicated that time commitment was a substantial barrier that hindered their enrollment into a doctoral program (M = 4.00, SD = 1.12; M = 4.38, SD = 0.86; see Table 4). Both groups of technology education teachers from the master's degree panel also ranked time commitment as a barrier (M = 3.58, SD = 1.35; M = 3.28, SD = 1.32). Program residency requirements and a lack of quality programs did not appear to provide barriers to either pair of panels.

Table 1. Positive Influences for Enrolling in a Master's Program

	Master's Graduates (n = 19)		Pre-Master's Teachers (n = 18)	
Factor	***M***	***SD***	***M***	***SD***
Personal goal/desire	4.74	0.56	4.00	1.14
University's geographical location	4.37	0.68	4.28	1.02
Pay increase	4.05	1.27	4.22	0.73
Quality and reputation of university	3.84	1.01	4.56	0.51
Financial support/assistantships	2.26	1.59	3.17	1.65

Table 2. Positive Influences for Enrolling in a Doctoral Program

	Doctoral Graduates (n = 9)		Non-Doctoral Teachers (n = 16)	
Factor	***M***	***SD***	***M***	***SD***
Personal goal/desire	4.63	0.70	4.63	0.78
Financial support/assistantships	4.13	0.93	4.44	0.70
Quality and reputation of university	4.00	0.71	3.63	0.70
Quality and reputation of the faculty	4.00	0.87	3.56	1.06
Support of advisor/faculty	4.00	0.87	3.81	0.73
Support of family	4.00	1.22	4.38	0.60
Direct communication with advisor	3.88	1.05	3.81	0.81
Flexibility of the program	3.25	0.97	4.50	0.71
Interest in research	3.13	1.62	3.13	0.99
Credit for prior coursework	2.63	1.58	4.63	0.70
Short residency period	2.38	0.99	4.50	0.71
University's geographic location	2.38	1.58	4.25	1.09
Distance education offerings	1.63	0.99	4.25	1.20

Table 3. Barriers to Enrollment in a Master's Program

Factor	Master's Graduates (n = 19)		Pre-Master's Teachers (n = 18)	
	M	*SD*	*M*	*SD*
Time commitment	3.58	1.35	3.28	1.32
Financial	3.37	1.26	3.17	1.47
Lack of flexibility in the program	3.11	1.20	3.78	1.00
Lack of quality master's program	2.83	1.15	3.56	1.42
University's geographic location	2.16	1.30	3.50	1.58

Table 4. Barriers to Enrollment in a Doctoral Program

Factor	Doctoral Graduates (n = 9)		Non-Doctoral Teachers (n = 16)	
	M	*SD*	*M*	*SD*
Time commitment	4.00	1.12	4.38	0.86
Financial	3.75	0.97	3.81	0.88
Family responsibilities	3.50	1.22	4.38	0.70
Lack of flexibility in the program	3.38	1.73	3.44	1.41
Geographic location of university	3.00	1.22	3.88	1.50
Lack of quality doctoral programs	2.88	1.36	3.88	1.96
Program's residency requirement	2.75	1.09	3.69	1.45

Discussion

As with other studies using a modified Delphi technique (Clark & Wenig, 1999; Wicklein, 1993), discrepancies may occur in the gathering of data. During the process of this research, not all participants contributed to all three panels. Some respondents did not participate in the first panel but did participate in either the second or third round. However, their responses were deemed valuable and included in this research.

The purpose of this research was to determine the factors that influence or deter technology education teachers' decisions to enroll in graduate level technology teacher education programs. From the four questions, there were six influencing factors and two barriers that were ranked highest for influencing the decision of technology education teachers to enroll in graduate programs. The participants were in agreement as to the primary influencing factors.

According to the respondents, technology education teachers entering a doctoral program and graduates of both master's and doctoral programs identified their personal goals and desires as the most important factor influencing them to enter or complete a graduate program. Pre-master's technology education teachers viewed their personal goals and desire to be a less important influencing factor. Although the university's geographical location was not rated highly as an influencing factor for doctoral graduates, it was very important for the other three groups. It should be noted that the pre-master's technology education teachers indicated that the quality and reputation of the university was influential in their decision to enter a master's program, whereas the doctoral graduates said the program and faculty quality and reputation were important for entering and completing a doctoral program.

The factor that was determined to be the strongest barrier to the enrollment of both pre-master's and master's technology education teachers in a master's degree program was the university geographical location. The second barrier that was shared by all four groups was the time commitment involved in a graduate program. It was interesting to note that program residency and the lack of quality programs were not determined to be barriers to enrollment, even though the doctoral graduates indicated the program quality to be an important influencing factor in their decision to enroll.

Other factors influencing enrollment in technology teacher education graduate programs were also noted but were not as significant as those previously discussed. One factor indicated to influence pre-master's technology education teachers to enroll in a master's program was pay increase. Two factors that were determined to influence non-doctoral technology education teachers to enroll in a doctoral program included flexibility of the program and credit for prior course work.

There were several barriers to enrollment that did not have consensus from more than two groups but were significant. The pre-master's technology education teachers indicated that the lack of flexibility and lack of quality in master's programs were barriers to enrollment. Both doctoral panels indicated that family responsibilities and financial commitments were key barriers to their enrollment in a doctoral program.

In summary, it appears that several influencing factors and barriers are shared among several groups. The influencing factors include personal goals and desires and the university's geographical location. The barriers include the university geographical location and time commitment. While some of these factors are difficult to adjust, such as the university's geographic location, other factors such as personal goals and desires, time commitment, and program and faculty quality are flexible.

Recommendations

The information gained from this research is provided as a foundation for future research and program development. Through periodic evaluation of influencing factors and barriers to technology education teacher enrollment in graduate programs, the technology education field can make the necessary changes to improve program quality and increase enrollment.

Based on the information from this research, we recommend the following to graduate program coordinators:

1. Promote the quality of the university, the program, and its faculty. This can be performed by integrating the *Standards for Technological Literacy: Content for the Study of Technology* (International Technology Education Association, 2000) into the program and encouraging faculty to become active in local, state, and national technology education organizations and conferences. Include information about the quality of the program in brochures and advertisements.
2. Capitalize on the technology education teacher's personal goals and desires to recruit qualified individuals into graduate education programs. When recruiting or interviewing, discuss the goals and desires of the teacher and indicate how your technology education graduate program can help the teacher fulfill those goals and desires.
3. Promote the location of the university and the cultural aspects of the community. Let the technology education teacher know that the program and university are in a great location for families, schools, spouse employment, etc.
4. Inform technology education teachers that time commitment is a requirement of graduate education and that there will be benefits to obtaining a graduate degree.

The following are recommendations for further study:

1. Periodic studies should be conducted to determine consistencies and changes to the influences and barriers indicated by technology education teachers regarding their enrollment in technology education graduate programs.
2. Research should be conducted to determine the factors that make a successful technology teacher education graduate program.

As noted by Paige et al. (1996),

> doctoral-granting institutions must provide the leadership. This leadership must come in the form of providing programs that have a research focus directed toward contributing to the body of knowledge and

> that are aimed at developing and providing future leaders with the background and experiences that are needed to move the profession forward into the 21st century. (p. 20)

If the universities do not increase their production of advanced degrees in technology education focusing on teacher education, Volk's (1997) doomsday prediction will be reality.

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References

Bell, T. (1997-2001). *Industrial teacher education directory*. South Holland, IL: Goodhart-Wilcox.

Brown, D. (2002). Supply and demand analysis of industrial teacher education faculty. *Journal of Industrial Teacher Education, 40*(1), 60-73.

Buffer, J. J. (1979). Graduate education in industrial arts. In G. E. Martin (Ed.), *Industrial arts education retrospect, prospect* (American Council on Industrial Arts Teacher Education: 28th Yearbook). Bloomington, IL: McKnight.

Clark, A. C., & Wenig, R. E. (1999). Identification of quality characteristics for technology education programs: A North Carolina case study. *Journal of Technology Education, 11*(1), 18-26.

Dennis, E. A. (1995-1996). *Industrial teacher education directory.* South Holland, IL: Goodhart-Wilcox.

Erekson, T. L., & McAlister, B. K. (1988). *Supply and demand for university technology faculty: 1986-87 position vacancy and search results analysis* (Research in Technology Education Series-Report #2. (ERIC Documentation Reproduction Service No. ED312459)

Hill, R. B. (2003). Does NAITTE have a future? A third generation decision. *Journal of Industrial Teacher Education*, *40*(2), 86-91.

International Technology Education Association. (2000). *Standards for technological literacy: Content for the study of technology.* Reston, VA: Author.

Metcalf-Turner, P., & Fischetti, J. (1996). Professional development schools: Persisting questions and lessons learned. *Journal of Teacher Education*, *47*(4), 292-299.

Morris, J., Armstrong, D., & Price, M. A. (1997). Teacher educators for today's diverse learners: A model for the preparation of interprofessional clinical faculty. *Action in Teacher Education, 19*(1), 55-63.

Paige, W. D., Dugger, J. C., & Wolansky, W. D. (1996). Essential components of doctoral program for industrial technology education. *Journal of Technology Studies, 22*(2), 15-20.

Weston, S. (1997). Teacher shortage: Supply and demand. *The Technology Teacher, 57*(1), 6-9.

Wicklien, R. C. (1993). Identifying crucial issues and problems in technology education using a modified-Delphi technique. *Journal of Technology Education, 5*(1), 54-71.

Volk, K. S. (1997). Going, going, gone? Recent trends in technology teacher education programs. *Journal of Technology Education, 8*(2), 67-71.

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Thinking About Technology Effects on Higher Education

By Mohammed F. Fahmy

Technology today extends over many fields and is very complicated in nature. Learning to "do" technology is an important way to understand and to learn what technology really means. In academia, this implies a needed change in our teaching methods and the design of new applied teaching methods to explain the processes resulting in the development of technology in the "real" world. Explanations of such processes are sought and are taught in new lab/classroom instructional settings that enhance the teaching of problem-solving skills. In a recent publication of the International Technology Education Association (ITEA, 2002), it was cited that "recent research on learning finds that many students learn best in experiential ways by doing, rather than only by seeing or hearing" (p. 5).

It is no wonder that in recent years a new wave of "experiential learning" has flooded academia. At the national level many universities, particularly publicly supported institutions, were required to develop and implement experiential learning methods across all of their disciplines and in their curricula. To encourage such practices, funds were made available from several state and federal sources. The resources allocated for this new methodology were, as usual, meager and not enough to achieve the stated goals. Some colleges, in pursuit of such funds, established what they called experiential learning classrooms as their main application of such newly encouraged teaching methods just to continue to benefit from the newly allocated funds. Continuous funding of these new experiential learning efforts to establish the infrastructure and to acquire needed equipment and hardware was, as usual, not adequately allocated or provided for, resulting in a long and laborious process in implementing such worthy efforts in academia. Students today not only need to learn how to do technology, they also need to learn how to live in today's world, which has become one that is buzzing with information and misinformation. Students need to know how to collect, sift through, and organize the information made available to them to augment and assess their own learning process. Ehrmann (1999) emphasized the value of technology by stating that "technology (in the broadest sense of that term) is providing a foundation for the reorganization of higher learning" (p. 42).

Technology and Change

To fully realize how technology and change are related, I will first define change and then discuss some factors such as need for change, importance of change, and resources needed to implement change in this section.

First what does *change* mean? The 1940 edition of the *Winston Dictionary* lists some of the definitions of the word change as: "to alter as, to change one's habit; to vary; to undergo alteration; to pass from one place to another." A more recent 1997 *Merriam-Webster Dictionary* cites some of the definitions of change as: "to make or become different, alter; to replace with another; ...etc; (n) the act, process, or result of changing; etc," which is almost the same as that cited in the 1940 edition of the *Winston Dictionary* above.

Need for Change

Should we implement *every* new technological discovery in all professional fields once we know about it? Obviously the answer is no, we should not, at least until we understand the ramifications of such implementation. Next, what should we look for before even thinking of changing our established ways or procedures? Common sense necessitates that we should study the new technological phenomenon, decide whether it relates to our existing practices, and then study the possibility of its implementation. In other words, we must be sure that we understand the new technology and whether it would be a better fit of what we already have or not. Moreover, would it really benefit the organization if it is implemented? Or, at least be aware of the downside of its applications, especially if the new technology has not been studied and understood well enough yet.

Importance of Change

Once the new process, or technological phenomenon, has been carefully studied, we need to identify the areas and personnel that it will have direct impact on when fully implemented. Next, we need to convince those involved that the sought-after change will bring positive results both to the individual and general levels. In other words, explain why the organization will be in better shape and list the benefits, which will be brought about as a result of implementing this new technology or change. People can only be "champions of the cause" if they understand the consequences of its implementation on their personal lives and the organization as a whole.

Resources

Allocation of resources to bring about and to implement the new technology or practices is a very important and essential factor if any change is to be instituted. Such resources are needed for (a) feasibility and pilot studies; (b) training, re-training, or hiring of new trained personnel; (c) building the infrastructure (i.e., acquiring the new equipment or hardware needed for the full implementation of the new processes); and (d) continued assessment of the implementation of the process.

This factor (allocation of resources) could be viewed as the most important one in the process of change. Two sectors of our economy that might be viewed as the most successful in implementing new technologies because of readily available resources are *industry* and the *military*.

The military branch of the government, which may be viewed as the boldest in the implementation of new technologies, has proven to be at the forefront of technology applications. Its hierarchal structure and leadership structure—coupled with the generous resources made available for its development and annual operational cost, and other such factors as clear vision, willingness to try, ability to recognize value, impact on the success of mission, etc.—are believed to be the direct reasons as to why the military is way ahead of civilian organizations in the implementation of new technologies. The nature of the military as well as the fact that the mere survival of its members depends vastly on the new applications mandates that it must be at the cutting edge of technology use and implementation.

On the other hand, many industries have realized that their own success and survival in a globally competitive arena depends greatly on their ability to implement new, relevant technologies to stay ahead of their competition, not only nationally, but also at the global level. Unlike the military, the industrial sector—even though it is willing to apply new technologies—is not as bold. There are other factors that private industry has to consider. At the forefront of such factors is the margin of profit. There has to be a very delicate balance between what the private sector is willing to spend on new technology applications and the margin of profit it has identified for itself to stay competitive. Another factor in the implementation of new technologies is the fear of the ramifications if the technology has not been fully understood yet. In the private sector, such failures may bring losses as a result of lawsuits and compensations for a failed product.

A third sector that may be involved in technology applications and the changes they bring about is the public sector, whose funding depends mainly on allocated funds by public institutions (e.g., local government, etc.). Public educational institutions fall under this category. Usually the progress such institutions achieve in the arena of technological applications and the changes they bring about is very slow compared to the other two sectors discussed above. The key factor here, again, is simply resources. Public academic institutions are, for the most part, governed by the resources made available to them more so than their ingenuity and willingness to implement new technologies. In their quest to apply new technologies needed for their ultimate survival and to stay competitive, public institutions are always compensated by meager allocations of funds controlled by their governing bodies. Such funds are often not enough to cover the needed changes. Many of these institutions, however, have stayed very close, if not at the cutting edge, by seeking external funds from a variety of sources such as other more fortunate government agencies (e.g., the military, the National Science Foundation, the Department of Energy, etc.), industrial partnerships, or private foundations. The degree of success in finding external organizations willing to fund such efforts in higher education depends on many factors, including:

- Classification of the academic institution (land grant, research, comprehensive, etc.).
- Reputation of institution (public relations and marketing, previous dealings).
- Infrastructure of institution.
- Influence of institution on local or national government (pork monies allocations).
- Willingness of faculty and their ability to market their ideas and to make a convincing case for the funding organization to buy into their vision.

Recent Changes in Academe

Ehrmann (1999) described the three main revolutions that have taken place in education. The major transformation (or the first revolution) took place 2,500 years ago when the "oral exchange" between teachers and students was augmented by reading and writing. In his characterization, Ehrmann stated that "the rigidities of memorization were replaced by the even-stiffer rigidity of the written word and, later, the printed page" (p. 44). The second revolution, according to Ehrmann, started when students and teachers shared the same facilities (libraries, laboratories, etc.), which was the beginning of the educational community and campus life. This brought financial resources, not previously available, which caused the creation of a very complex environment (instructors, administrators, technicians, staff, students, publishers, etc.). The third revolution identified by Ehrmann is the one "made possible by computing, video, and telecommunication" (p. 42). One can safely term this third revolution as the technology revolution, which has brought about more learners and an inevitable change in the way higher education delivers its services. Even though this change is certain, its character "is not yet clear" (p. 46) according to Ehrmann.

The Future of Academe

What does the future hold for academe has been the recent topic of many researchers and academicians. While there is not one single model that identifies clearly how all the researchers see the future of academe, there is a common vision of many of the anticipated elements of change. In the sections below, some of such elements are shared and discussed.

Technology and the Classroom

Carlson (2000) cited the issue of integrating technology with instruction as the single most important issue facing higher education. Other factors, which were identified in the same study as of less priority, were replacing outdated hardware or software, providing user support, providing online distance education, and integrating e-commerce into college and university Web sites and all other institutional services. While only 10% of college courses used electronic mail as a tool for instruction in 1994, Carlson cited that over 60% of courses in 2000 used this tool. According to him, 7% of courses had Web sites in 1994, whereas in 2000 the number was more than 30%. The report by the National Commission on the Cost of Higher Education (1998) concurred with these findings and noted that institutions were faced with the need to provide new equipment and infrastructure to accommodate this type of offerings. To meet the cost of such technology implementation, the report stated that institutions mandated computer/instructional technology fees ranging from $55 to $140 per student, hence passing some of such costs on to the students and their families. It is strongly believed that this trend will continue in the future to enable higher education institutions to update their classrooms and laboratories with the needed contemporary infrastructure required to deliver instruction to their students whether on campus or at a distance over newly established networks.

Other Technology Applications

According to Carlson (2000), academe is still lagging behind society at large in the application of some technology trends such as personal digital assistance devices (e.g., Palm Pilot) that campuses have not been able to integrate into their campus networks. E-commerce services is another area that shows academe far behind the private sector in application and use. Only 18.8% of the institutions surveyed, according to Carlson, have set up e-commerce services (e.g., to pay tuition with credit cards) on their Web sites. The majority of colleges (80%) still do not see e-commerce applications as a service that should be allowed on campus Web sites. Like e-commerce, there are new e-learning companies such as Quisic 2000 (chronicle.quisic.com), which advertises that it believes that asking the right questions and learning new ways to answer them is essential. Further, the company claims to offer e-learning solutions for business education to help students and faculty achieve important goals. CollegeNet (www.corp.collegenet.com), another new e-company, has announced that its services are designed "to turn your school's homepage into an engine for web commerce as streamlining commerce with the new generation." Furthermore, Pelline (1997) and Kyrnin (2002) described a new technology, the "push technology," made available by the commercial Internet providers, as a phenomenon that is inevitable. Push technology describes efforts to make local information available to all users linked to the institution's network, hence pushing information to users rather than waiting for them to seek it. This way, push technology becomes a tool for educators to deliver instruction over a wider network.

As can be seen from the foregoing discussion, higher education institutions will be faced with more demands to cope with the fast-changing technologies and will be required to implement changes to accommodate such applications in order to deliver services in a manner that satisfies their clientele and to stay competitive at the same time.

Academe and the Information Society

Educators and society perceive the industrial revolution in general as a major reason for the shaping of our societies today. Many professionals and intellectuals believe a new revolution started recently, namely, the information/communication revolution, which will shape our future. This revolution in the exchange of information has been mainly caused by the great and rapid advances in technology. Levine (2000) identified new technologies as the major forces that have the power to change our university and college systems and the way they deliver their services as we know it now. Other forces cited in his article were shifting demographics, the entrance of commercial organizations into higher education, the changing relationships between colleges and the federal and state governments, and the move from an industrial to an information society. He further listed nine major changes in higher education as inevitable changes that should not be ignored:

1. The creation of numerous and diverse "higher-education providers" that are global and more technologically advanced institutions. Such institutions will change the current practices and will necessitate a much faster response to an international student body, due to their ability to deliver instruction globally, if they are to stay successful and competitive.
2. The three types of higher education providers will be either brick universities (i.e., the traditional residential campus as we know it now), click universities currently known as virtual universities, or brick and click universities, which is a combination of both types that he predicts to be the most successful and competitive ones in the future. Gregory C. Farrington, president of Lehigh University, stated, "residential colleges might band together to share courses using the Internet" (as cited in Young, 2000,1) to provide their students with highly specialized courses and hence cutting their cost of delivery. Ehrmann (1999) added to these shared efforts among universities online libraries so that physical and virtual campuses complement one another and provide more services to their "customers" at a much lower cost. As a result, new entities in higher education, consortia, partnerships, etc., will emerge.
3. More individualized higher education in which students set the educational agenda due to their diverse backgrounds. In this case, institutions will react to customer needs rather than setting the educational agenda as they traditionally have done. Education will be provided

wherever and whenever students decide to receive it: at home, in the office, in the car, or on campus. This will simply be achievable because of the new emerging technologies.

4. A shift of focus of higher education from teaching to learning. In other words, instead of a certain number of credits to measure student achievements, a competency-based education in which student outcomes are measured and assessed will be used.
5. The current triangle of teaching-scholarship-service that describes the activities of most of today's universities will become predominantly focused on teaching as dictated by for-profit and other new providers in higher education.
6. The creation of a new rock-star professor in which the name of the professor, not that of the institution, will be the most important in bringing in business for the university. In other words, professors will become increasingly more independent of colleges and universities. Young (2000) cited a new book that predicts that institutions will market lectures of their superstar professors and place them on a World Wide Web site, replacing outdated traditional lecture delivery.
7. Degrees will be replaced by a transcript in which students' competencies delineate the level of their skills and knowledge. Students no longer have to reside on any specific campus to obtain a degree; rather, they can move around and accumulate more recognized skills and competencies.
8. Educational portfolios, or "educational passports," will have to be created and maintained to identify students' achievements wherever and whenever they were gained.
9. Public and private support will be directed to students rather than to educational institutions.

Whether we agree that the future holds some or all of the above listed changes, many recent articles have listed many such changes in the future of academe. Young (2000) cited a new book whose authors concluded that both technology and market forces can "improve university teaching, streamline offerings, and bring education to more students than ever" (p. 1).

Faculty Security and the Tenure Process

Another recent shift in higher education and university practices involves the process of tenure. Wilson (1998) discussed the issue of tenure and its future. He argued that colleges that have abolished the tenure process and now hire new faculty on an "annual contract" basis are increasing in numbers. He further stated that there are currently 40 institutions in the United States hiring professors on contract appointments, hence increasing the percentage of such institutions from 19% in 1979 to 28% in 1998. Even though such news is not readily announced, the phenomenon of hiring more adjunct professors has risen from 22% in 1970 to a new high of 42% and has attracted the attention of many educators. According to Wilson, this new trend will result in professors hired on contract to be either focused on teaching or research, but not both. He further explained that new titles of such professors will commonly be known as lecturers, research scientists, instructors, or clinical faculty and that they will not be considered voting faculty on many campuses. Changes in the tenure process have been long anticipated by many in academe. An overhaul of that process in the next few years will not surprise many at all.

Impact of Technology/Change on Other Areas of Academe

The impact of technology and the resulting changes on nonacademics of higher education is cited by Ault, Hainline, and Abunawass (1999). Areas and personnel affected by technology in academe include:

- Staff and the way they provide their services.
- Academic offices.
- Training of personnel and technicians and quality of performance.
- Bargaining and the changes in the workplace.
- Ability of institutions to "market" themselves.

Such areas that are impacted by the technological changes will, undoubtedly, need a process of re-evaluation so we can get the best services to the students who are, after all, impacted by all the services provided by or depending on the above listed areas.

Conclusion

Technology and technological applications are, indeed, a continuous process that dates way back in our human history. Every time a new technology comes around, a process of change accompanies its implementation. Higher education, like any other sector in our society, is affected by technology applications and always races to institute the necessary changes to implement it. As a matter of fact, many of the new technological applications were discovered and developed into prototypes, which were tested and modified on many campuses. However, the full implementation, which needed resources beyond academe's reach, was always a long and laborious process.

If higher education and academe are to improve the rate of change that technological applications bring, they need to find new ways to fund such efforts. Educational institutions started to seek partnerships with industry, government, and the private sector as means of providing part or most of the costs associated with the implementation of such new technologies. It is believed that it is through such partnerships that the process of change will be accelerated better than it is today.

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References

Ault, K. P., Hainline, F. C., & Abunawass, A. M. (1999). Emerging issues in collective bargaining: Technological expectations for support staff. *Universities 21.* Retrieved (October, 2000) from http://www.upi4100.org/univ21/AultHainline.html

Carlson, S. (2000, October 27). Campus survey finds that adding technology to teaching is a top issue. *The Chronicle of Higher Education*, p A46.

Ehrmann, S. C. (1999, September). Technology's grand challenges in academe. *Bulletin of the American Association of University Professors,* pp. 42-46.

International Technology Education Association. (2000), Standards for technological literacy: Content for the study of technology. RetrievedOctober 2000 from URL: , http://www.iteawww.org.

Levine, A. E. (2000, October 27) The future of colleges: 9 inevitable changes. *The Chronicle of Higher Education,* pp. B10-B11.

The National Commission on the Cost of Higher Education (1998, January). Straight talk about college costs and prices. *The Chronicle of Higher Education.* Retrieved October 2000 from http://chronicle.com/data/focus.dir/data.dir/0121.98/costreport.htm

Young, J. R. (2000, October). New book from EDUCAUSE talks up technology's value to academe. Retrieved October 2000 from www.apa.org/ed/educause.html

Wilson, R. (1998, June 12). Contracts replace the tenure track for growing number of professors. *The Chronicle of Higher Education*, pp. A12-A14.

Leadership Knowledge and Skill: An Enabler for Success as a Technology Education Teacher-Leader

By Robert E. Wenig

Introduction

While our technological society has rapidly moved into the digital-information age leadership has emerged as even more distinctive and essential for success (Reich, 2000). Experience teaches us that leadership can be exercised through noble uplifting pursuits or driven by corrupting repressive power. Leadership when positive creates a stimulating environment that builds a thriving organization but, when negative, it fosters a woefully oppressive and debilitation atmosphere which chokes performance. Historically, Americans love Washington, Jefferson, and Lincoln, but despised Hitler types who are autocratic tyrants. Research tells us that leaders are not born but emerge through a complex sociological process to satisfy some demanding need or want (Clark and Clark, 1996).

We are all familiar with the story of Winston Churchill, who during World War I was charged with poor military decisions ending in extensive lost of life. For nearly twenty years fame was derailed and influence ceased. Churchill referred to this time in his life as the wilderness years. Fortunately for England, Churchill took the advice of Benjamin Disraeli, who said, "The secret of success in life is for a man to be ready for his time when it comes." Certainly, it was Churchill time when he was elected Prime Minister of England in 1939 at the beginning of WW II. He more then anyone else rallied the English people through inspiring speeches and endless work to achieve eventual victory. Today, England, and others, consider Churchill, the greatest Englishman who ever lived. Similarly, great teachers rise to the challenge by becoming successful classroom leader through a combination of ever increasing knowledge and elevating experiences (Walling, 1994)

Purpose

The purpose of this article is to share the value of leadership knowledge and skill for enhancing the survival and performance of teachers and leaders.

Leadership and Performance

When performance of an individual, organization, or event is discussed leadership becomes the dominant subject. Recently a cartoon appeared in the Wall Street Journal where two men were having a heated discussion about leadership. Finally, one turned to the other and said, "Yes, we need leadership, but also we need someone to tell us what to do." Most people have difficulty attempting to understand or appropriately use leadership (Peters, 1992 and Drucker, 1993). They see it as hazy, confusing, or a distant abstraction.

Nevertheless, most people can comprehend the behaviors of great leaders and teachers when they can personally relate to their actions. Let me illustrate. Recently I visited an art museum displaying works of some of the worlds most famous artists. There were paintings by Monet, Picasso, van Gogh, Renoir and many others on display. The paintings I enjoyed the most were those that gave a clear depiction of something I am familiar with, such as a serene lake, a gathering of flowers, or people easily recognized as humans. There were other paintings on display that portrayed distorted figures, and blurred shapes and colors that defy description. Certainly, these too, are valued works of art that were carefully selected to represent the variety of creative expression, but the distant abstraction left me with a feeling of emptiness or even confusion. Similarly, the omnipotence or great secret of highly effective leaders and teachers is achieved when they cut confusion and haziness to relate and build understanding. An example of transforming from a hazy-confusing leaderless environment to a clearly functioning leadership process can be found in the small book, *The Leaders Compass* (2003) by Ruggero and Hailey. This is a must read by the beginning leader.

Clark and Clark, (1997) state, that with effective leadership any organization can increase its performance by at least 20-25 percent. Further, educational literature suggests that an effective teacher-leader can also raise the learning level of his/her students by 15-25 percent. Accordingly, the relationship between gifted teachers and gifted leaders is very similar as Williams (2001) found in her dissertation that compared award winning local school technology teachers and their use of effective leadership practices. Hasting, (1991) agreed in her article, Teachers as Leaders" saying, "teachers as leaders model the way or influencing their students to follow" (p.24.).

Leadership Defined

Bennis and Nanus, (1985), stated in their award winning book, *Leaders*, "Decades of academic analysis have givens more than 350 definitions of leadership"(p. 4). Even today, the quest continues to specifically define just what is leadership. One stirring and profound definition of leadership that is well accepted by noted experts is Burns' (1978) "transformational leadership" which is described in his classic and award winning book, *Leadership*. He defined a transformational leader as one who creates a vigorous and magnetic environment in which the leader and his/her followers raise each other to higher and higher levels of motivation and morality.

It happens when a leader can harness and focus an organizational member's energy into a collective force resulting in a powerful empowering process that transforms both the individual and organization to higher and higher levels of performance. The best leadership thinking today (Covey, 1992; Kanter, 2001; Kotter, 1996; Reich, 2001; Senge et. al, 1999) about how to gain the highest level of organizational performance continues to include a leader who successfully uses transformational leadership. Again, transformational leader-teacher creates an environment that releases human potential then reinforces it by giving recognition and the opportunities for continuous personal growth (Walling, 1994; & Wenig, 1995).

Finally, after years of concerned involvement in leadership theory and application, I believe that it is more important to define leadership by what it "does" rather than by what it "is". At first glace, what a transformational leader does seems so simple, yet it possess that overwhelming powerful human propellant called "hope". Accordingly, top leaders and teachers are a "merchant of hope" those who elevate the meaning and aspiration of others to form an organization under pinned by hope. Hope can be germinated by leaders-teachers who propel others-students to rise to higher and higher levels of success. Leadership then, when practiced at its positive best, produces hope, that propels individuals and organizations that transform dreams into visions and visions into actions - - "a vision community" (Barker, 1994). The leader-teacher who applies the powerful spirit and tenor of "hope", establishes transformational leadership in the classroom/boardroom, the magical key ingredient to gaining a dynamic and fruitful future for all involved. Debbie Kennedy, (June, 1991) perhaps expresses the significance of hope in the following poem tilted, "Our Dreams In Action":

Dreams give us hope.

Hope ignites passion.

Passion leads us to envision success.

Recognition of opportunities inspires far-reaching possibilities

Far-reaching possibilities help us enlist support from others.

Support from others keeps us focused and committed.

Focus and commitment foster action.

Action results in progress.

Progress leads to achievement.

Achievement inspires dreams.

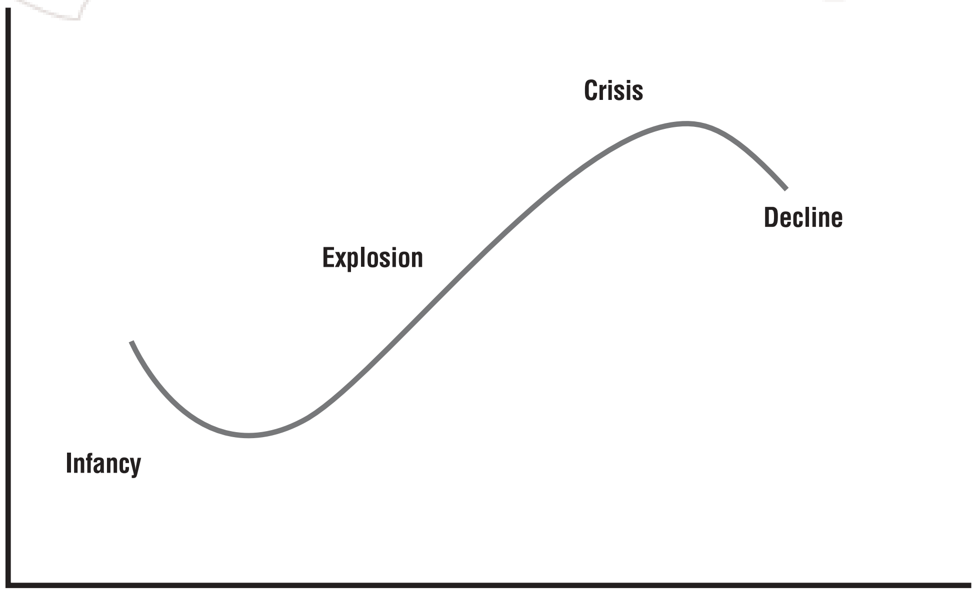
Dreams give us hope.

Perhaps Warren Bennis (2003 & 2003) ship expert, stated it best about *hope* when he stated, leadership involves creating larger visions and engaging people's imagination in pursuit of them.

Leadership Knowledge for Survival

Rip Van Winkle went to sleep for twenty years. When he awakened, the American landscape had changed dramatically, and his bones creaked with age. The world around him was no longer one he understood or in which he could function well. Will history someday see that

Figure 1. ***The "S" Curve: The Life Cycle of An Organization.***



classic story as a parable for leadership in American public and private organizations? George Santayana, the noted anthropologist, once observed that in our changing world we no longer salute our ancestors but bid them farewell. The world constantly searches for new knowledge and wisdom to answer very complex problems with simplicity. Let me illustrate. There is old parable about the grasshopper that decided to consult the hoary consultant of the animal kingdom, the owl, about a personal problem. The problems concerned the fact that the grasshopper suffered each winter from severe pains due to the savage temperature. After a number of these painful winters, in which all of the grasshopper's known remedies were of no avail, he presented his case to the venerable and wise owl. The owl, after patiently listening to the grasshopper's misery, so the story goes prescribed a simple solution. Simply turn your self into a cricket, and hibernate during the winter." The grasshopper jumped joyously away, profusely thanking the owl for his wise advice. Later, however, after discovering that this important knowledge could not be transformed into action, the grasshopper returned to the owl and asked how he could perform this metamorphosis. The owl replied rather curtly, "Look, I gave you the principle, it's up to you to work out the details!"

All parables, supposedly, contain a moral, and the moral here is that even if knowledge is provided survival is linked to actually performing the metamorphous. Again, transformational leadership elevates performance of individuals from the boardroom to the classroom. Leadership knowledge is paramount to change (Kotter, 1996), and change is the key to organizational survival (Senge, 1999).

The present-day "S" Curve (see Figure 1) evolved in the early part of the twenty-century from the work of Russian economist Nikolai Kondratieff and was popularized in America by Joseph Schumpeter in 1939. It represents the typical life cycle of an organization that last beyond infancy. Through dynamic and creative leadership, the opportunity for an organization to experience explosive growth is possible. However, over time things change; competition increases, cost rises, new technology suddenly appears, economic down-turn occurs, product demand falls, management falters, or whatever happens to trigger decline eventually ending in failure. When reviewing super successful surviving organizations (e.g., Ford, IBM, Johnson and Johnson, and 3 M) one finds a core ideology of visionary leadership one that that has a passion for learning to stay competitive. Accordingly, organizations that are built to last (Collins & Porras, 1997) feverously keep informed (knowledgeable) about the future which enables them to constantly plan and execute critical intervention strategies (see Figure 2) at key times to avoid stagnation and decline to propel continuous rebirth and growth.

There is a significant example of not staying competitive (realizing the "S" Curve) as found in American public schools. The word competition was foreign to the public educational system. Many thought that no outside force could or would attempt to provide K-12 education. Over time, public schools failed to implement key intervention strategies to meet their greatest challenge parent dissatisfaction with public school performance. Certainly, lack of parent confidence has triggered the advent of home schooling, charter schools, vouchers, and yes, even private businesses schooling children. All are pursuing a replacement to the traditional public school system.

Research has consistently said that the difference between model and poorly run schools is the "Whoever be chief among you let him be your servant principal's leadership performance (Clark and Clark, 1997). It is obvious that TED can significantly benefit from possessing leadership knowledge and skills because the future belongs to the informed (Collins & Porras, 1997 & Peters, 1994). In time of drastic change, the learners inherit the future. The learned find them equipped to live in a world that no longer exists (Reich, 2001 & Senge et. al., 1999).

Finally, Servant-Teacher-Leader

Historically, the Bible reveals through endless stories examples of individual servant leadership, especially those in the New Testament. In 1966, Queen Elizabeth II, the present Queen of England, placed a large carved plaque in Westminster Abby which stated, "Whoever be chief among you let him be your servant." "The term servant-leadership was first coined in the United States in a 1977 essay by Robert K. Greenleaf entitled, *The Servant First Leader* (Spears, 1995 P.2) Question. If the leader's overwhelming desire is to serve when or how does the leader lead? Leading and Serving seems rather contradictory, or is it? Another perplexing question, does a leader lead first by serving or serving first then lead? To answer these questions, Greenleaf wrote:

> "Servant-leader begins with the natural feeling that one wants to serve, to serve first. Then conscious choice brings one to aspire to lead. The difference manifests itself in the care taken by the servant—first to make sure that other people's highest-priority needs are being served. The best test is: Do those served grow as persons; do they, while being served, become healthier, wiser, freer, more autonomous, more likely themselves to become servants? …At the core, servant-leadership is a long-term, transformational approach to life and work…a way of being that has the potential to create positive change throughout our society" (Spears 1995, p.4).

Greenleaf went on to say, "When I started to write on the servant-leader theme, I was trying to communicate a basis of [hope]—not just for students but for everybody" (Spears, 1995 p.21). Hope or servant-leadership, then, provides a most powerful pronouncement again for the operational behavior followed by the best teachers and leaders.

Historically, we have some understanding of where the idea of servant came from, but what triggered Greenleaf at add servant to leader or leadership? Greenleaf (1984) stated that he conceptualizes and coined the term servant-leadership after Eventually; he comes to realize that it was his servant, Leo, who held him and his group together. After many years of wondering, the director finds Leo again, who as it turns out, is the head of the spiritual community that the director was seeking all along. Reading on it becomes more and more clear that the director is actually Hesse, himself, an autobiographical character. After Hesse (A Nobel Prize for Literature in 1946) was initiated in the spiritual order Leo and Hesse are talking and they are holding a small transparent sculpture of two figures joined together. One is Leo and other is Hesse who realized that his image was in the process of adding and flowing into Leo's nourishment and strengthening. Reading the story about Hermann Hesse's (1956-2003) *Journal to the East*. The story is about a party of seekers searching for enlightenment in the form of a particular secret spiritual order. Leo, a servant, attends to their needs and does menial chores. Throughout the journey, the group is sustained by Leo's "spirit and his song." Leo eventually disappears. The party gets completely lost and gives up on the search. The party director carries on but suffers immense emotional and physical stress.

Peter Senge (1995), after reading the *Journey to the East*, "I knew that this man [Greenleaf) understood something, something we have lost in our modern transactional society, where 'what's in it for me' is the assumed bedrock of all actions." To make it very clear, servant-teacher-leader grand design focuses on serving others by adding and flowing together to achieve one image using nourishment and strength. Robert Frost said, "All great things are done for their sake." Senge adds, to think that this reorientation of spirit might be a foundation for true leadership stunned me.

The significance of the servant-leadership concept has led to the establishment of the Robert K. Greenleaf Center for Servant-Leadership. Further, the 1995 publication, *Reflections on Leadership* also includes the writings of Greenleaf with companion reflections about Greenleaf works. The importance of the Greenleaf's was given further credence in the "Indianapolis Business Journal" which stated, "Servant leadership has emerged as one of the dominant philosophies being discussed in the world today (Spears, L. C, *Reflections on Leadership* 1995).

Summary

History has shown us that leadership can either be positive or negative. When positive and of the highest quality it can enhance performance, whether in the classroom or boardroom, remarkably by 20-25%. The master teacher who seems to draw us out has thrilled us all. These same high qualities are also found in top leaders. The teacher-leader makes a difference—a big difference for they model the way to influence our lives. Through an examination of the literature and research, the author attempts to discover what makes leadership such a powerful force. The first research question dealt with how to gain and inspire support. The challenges and possible opportunities facing TED are also discussed.. Second question reviewed the research on effective TED teaching. The findings indicated that innovative teachers are professionally involved in their associations, have greater school support, use different instructional methods and are very creative.

The third research question provided information on how TED could apply the dynamics of leadership to sell its benefits. These processes include: developing communication power, applying various leadership development models, bringing about effective change, using visioning technology to set the course, and the need of research to apply the teacher-leader model for developing Technology Education for American youth.

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References

Barker, J. A. (1994). *The power of vision*. (Video Tape) Burnsville, MN: Charthouse International Learning Corporation.

Bennis, W. (2003). *On becoming a leader* (Revised). Perseus.

Bennis, W, & Goldsmith, J. (2003). ***Learning to lead***. New York: Basic Books.

Bennis, W. G. , & Nanus, B. (1985). *Leaders: strategies for taking charge*. New York: Harper & Row.

Burns, 3. M. (1978). ***Leadership***. New York: Harper & Row Campbell, D. (1984). If I'm in charge here why is everybody laughing. Greensboro, NC: Center of Creative Leadership.

Clark, K. E. , & Clark, M. B. (1997) *Choosing to lead*. Greensboro, N C: Leadership Press Limited.

Clark & M. B. Clark (Eds.), *Measures of Leadership*. West Orange, NJ: Leadership Library of America.

Covey, S. R. (1992) *Principle centered leadership*. Simon & Schuster.

Drucker, P. F. (1993). *The post capitalist society*. New York: Harper & Row

Greenleaf, R. K. (1977). *Servant leadership* . New York: Paulist Press.

Hasting,S. C. (1991). *Teachers as leaders*. Learnig 2001 Carlson Learning Company Journal. Vol.2, No.3.

Hesse, H. (1956-2003) *The journey to the east*. New York: Picador.

Kanter, R. M. (2001). *Evolve: succeeding in the digital culture of tomorrow*. Harvard Business Review Press.

Kennedy, D. (June, 1991). *Our dreams in action.* Burnsville, MN: Charthouse International Learning Corporation.

Kotter, J. P. (1996). *Leading change*. Boston: Harvard Businesa School.

Peters, T. (1992). *Liberation management.* New York: Alfred A. Knopf.

Peter, T. (1994). *The Tom Peters seminar: Crazy time call for crazy organizations.* New York: Vintage Books.

Spears, L. C. (1995). *Reflections on Leadership*. John Wiley & Sons.

Reich, R. B. (2000). *The future of success*. Random House.

Ruggero, E., & Hailey, D. F. (2003). *The leaders compass*. King of Prussia, PA: Academy Leadership.

Senge, S. M. (1999). *The dance of change*. Doubleday.

Walling, D. (Ed.). (1994). *Teachers as leaders.* Bloomington: Phi Delta Kappa.

Wenig, R. E. (1995) Technology education leadership. In G. Eugene Martin (Ed), *Foundations of technology education*, *44th Yearbook of the Council on Technology Education.* Peoria, Ill: Glenco Division, Macmillan/McGraw-Hill.

Williams, R. (2001) *An analysis of award winning local school technology education teachers and their use of effective leadership practices.* Raleigh, NC: An unpublished dissertation, North Carolina State University.

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