

2009

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Ritz, John M., "A New Generation of Goals for Technology Education" (2009). *STEMPS Faculty Publications*. 23.
http://digitalcommons.odu.edu/stemps_fac_pubs/23

Original Publication Citation

Ritz, J. M. (2009). A new generation of goals for technology education. *Journal of Technology Education*, 20(2), 50-64. doi: 10.21061/jte.v20i2.a.4

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A New Generation of Goals for Technology Education

John M. Ritz

Introduction

To develop meaningful instructional programs for technology education, goals need to be in place to direct the outcomes of curriculum development and teaching. Goals are program terminal outcomes that focus curriculum writers or teachers who structure content for learners. Goals provide direction so content can be delivered for long-term impact to students who study the subject. They go beyond everyday teaching objectives; they are directed at long-term learning and programmatic outcomes.

Goals are arrived at through at least three different sources: empirical, philosophical, or subject matter (Zais, 1976). Empirical goals are usually developed by surveying the members of society and using this analysis to determine the directions of education. Examples include improving the economic condition of a society, focusing the role of citizenship or parenthood, or establishing the cornerstones of democracy.

Philosophical sources of educational goals are derived from the thoughts of the great thinkers of the time and their beliefs of what schooling should be. For those of us who work at the university level, some academics try to influence the entire institution through the directions that they feel the general liberal arts curriculum should take. This would also include the federal government's view of setting goals that all learners need to meet.

Subject matter sources for curriculum goals are commonly used by professions to structure the importance of their subject to the greater education of all. Some criticize using the motives of subject matter specialists since they often become narrow and technical. For our profession, we must look beyond the development of engineers, industrial technologists, or craft workers. We must seek goals that take curriculum designers and teachers beyond the limits of these specific professions toward the goal of technological literacy for all. As Tyler (1950) stated, "what can a particular subject contribute to the education of young people" (p. 26).

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Review of Literature

Clear goals for technological literacy instruction are very important to our profession in that they provide direction for teachers to structure instruction. Goals are also important guide posts as the profession and its members to help decide if technology education should continue to have a technological literacy prospective, or if we should direct our instructional efforts on STEM (science, technology, engineering, and mathematics) education, industry certificate preparation, pre-engineering, or some other focus.

If educators only use content derived from, for example, the *Standards for Technological Literacy* (ITEA, 2000), the result might be learners who know a lot about technological content, the engineering design process, and how to perform a number of technical processes, but they would have little ability to apply this knowledge to the technological challenges and decisions they will make in everyday life.

Aims are related to goals and influence the processes of curriculum design and delivery. Unlike goals, aims are focused on very long-range outcomes and they guide the direction of schooling and society. In other words, they are the expected life outcomes from education. One set of aims that have been influential in shaping the curriculum of American schools is the *Cardinal Principles of Secondary Education* established by the Commission on the Reorganization of Secondary Education (1918). This Commission based their aims for education on the important life principles and citizenship. Thus, they would be considered as empirical sources (Zais, 1976). They were:

Health

Command of fundamental processes [basic literacy]

Worthy home membership

Vocational education

Civic education

Worthy use of leisure

Ethical character (pp. 11-16)

Whereas aims provide a broad direction for schooling, goals are more focused on the outcomes of schools. They include, for example, graduation requirements and literacy rates.

During the 1980s, U. S. politicians began observing that students in other developed nations of the world were performing better than U.S. students. These observations spawned many studies during the ensuing decade. Consequently, the U.S. was determined to be a *Nation at Risk* (NCEE, 1983). As a result, President George Bush, the 31st President, assembled the U.S. Governors in 1988 to devise a plan to improve the schooling of American youth. The plan, *America 2000*, set educational strategies to make the U.S. the best educated nation in the world (U. S. Department of Education, 1991). Ten years were set to achieve certain goals that were based on empirical sources. They included:

- All children in America will start school ready to learn.
- The high school graduation rate will increase to at least 90 percent.

- American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.
- U.S. students will be first in the world in science and mathematics achievement.
- Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.
- Every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning (U. S. Department of Education, 1991, p. 3).

As one might see from these statements of outcome, the American Governors used goals as tools to guide the improvement of U.S. schooling. Although not specifically mentioned, technology education fits very nicely into Goal 5 and could significantly support Goal 3.

Historically, technology education professionals have used goals to guide curriculum and instructional plans. If one were to review technology education curricula over the years, coherence would be found between what was specified by the goals and the content to be taught and the corresponding instructional activities.

As school subject leaders began to examine their effectiveness in preparing future generations after the launching of Sputnik I, so did leaders in industrial arts. The U.S. Office of Education reported in *Industrial Arts* (1961) that the predominate purpose of the field was to provide instruction based on trade and job analysis (USOE, 1961). In an attempt to redirect the profession toward general education, the USOE, in conjunction with the leaders of the profession, published a document titled *Improving Industrial Art Teaching* (1962). Through this publication, a more encompassing mission for industrial arts was proposed. This document was the result of professional meetings designed to redirect the efforts of industrial arts teachers to develop instructional programs around the following four goals:

1. To develop in each student an insight and understanding of industry and its place in our culture.
2. To discover and develop talents of students in the technical fields and applied sciences.
3. To develop technical problem-solving skills related to materials and processes.
4. To develop in each student a measure of skill in the use of the common tools and machines (USOE, 1962, pp. 19-20).

During the following decades, much research and development was undertaken to improve industrial arts/technology education by embracing these

broad goals. Over the years, surveys of teachers and school administrators were conducted, including benchmark studies by Schmitt and Pelley (1966), Dugger et al. (1980), and Sanders (2001). In the Schmitt and Pelley (1966) study, the priority rankings of purposes of industrial arts were to develop tool and machine skills, creative abilities, worthy use of leisure, and technical skills. Dugger et al. (1979) found that teachers believed the intentions of industrial arts teaching were to develop tool/machine skills, technical skills, creative abilities, and worthy use of leisure. Sanders (2001) found that technology education teachers sought to teach problem solving, the use of technology to solve problems, making education and occupation decisions, and the application of science and mathematics. In all three of these national studies, the researchers asked the respondents to rank order purposes.

As the profession moved from industrial arts to technology education, new lists of goals were developed. For many of the new curriculum plans that emerged, the goals that they promoted became their most important contribution. Examples include the American Industry project (1965), the Industrial Arts Curriculum Project (1968), the Maryland Plan (1973), and Technology as a Discipline (1972).

One of the significant research efforts in changing the profession to a study of technology was the *Jackson's Mill Industrial Arts Curriculum Theory* (Snyder & Hales, 1981). This panel of professionals and the document they produced outlined the content for technology education programs with a focus on the technological systems of communication, construction, manufacturing, and transportation. It also provided guidance for curriculum development by setting forth the following goals (Snyder & Hales, 1981, p. 42):

- To understand and appreciate the evolution and relationships of society and technical means;
- To establish beliefs and values based upon the impact of technology and how it alters environments;
- To develop attitudes and abilities in the proper use of tools, techniques and resources of technical and industrial systems;
- To develop creative solutions to present and future societal problems using technical means;
- To explore and develop human potentials related to responsible work, leisure, and citizenship roles in a technological society.

The authors of the Jackson's Mill work felt that the history of technology, impacts of technology, abilities to use technology, problem solving, and work and citizenship were important outcomes for all technology education students.

Following this work, the International Technology Education Association developed *Technology Education: A Perspective on Implementation* (1985) to help the profession understand why it was changing its content-base from industry to technology and cited examples of how such programs might be implemented. In this work, the authors proposed goals for technology education for the elementary, middle, and high school levels. They included:

- Know and appreciate the importance of technology
- Apply tools, materials, processes, and technical concepts safely and efficiently
- Uncover and develop individual talents
- Apply problem-solving techniques
- Apply other school subjects
- Apply creative abilities
- Deal with forces that influence the future
- Adjust to the changing environment
- Become a wise consumer
- Make informed career choices

In 1990, ITEA further refined its position for teaching technology education through *A Conceptual Framework for Technology Education* (ITEA, 1990). This document proposed the following goals for technology education:

- Utilize technology to solve problems or meet opportunities to satisfy human needs and wants.
- Recognize problems and opportunities exist that relate to and often can be addressed by technology.
- Identify, select, and use resources to create technology for human purposes.
- Identify, select, and efficiently use appropriate technological knowledge, resources, and processes to satisfy human wants and needs.
- Evaluate technological ventures according to their positive and negative, planned and unplanned, and immediate and delayed consequences.

As the profession continued to study its school subject area, it worked to establish a sound foundation for the school study of technology. In the *Rationale and Structure for Technology Education* (ITEA, 1996), ITEA listed the goals for technological literacy to include:

- Evaluate technology's capabilities, uses, and consequences on individuals, society, and the environment
- Employ the resources of technology to analyze the behavior of technological systems
- Apply design concepts to solve problems and extend human capability
- Apply scientific principles, engineering concepts, and technological systems in the solution of everyday problems
- Develop personal interests and abilities related to careers in technology

With the development of the *Standards for Technological Literacy* (ITEA, 2000), content took precedent over goals. The profession sought to identify the content that needed to be understood and/or mastered for one to become

technologically literate. The research of the ITEA Standards Project (2000), headed by William E. Dugger, produced standards and benchmarks for the study of technology. ITEA chose to follow the templates for standards developed by other disciplines such as science and mathematics. By making these choices, it could be implied that the “standards movement” and its identification of specific content (standards and benchmarks) became more important than establishing and following goals in curriculum design. Correspondingly, assessment would be much easier to accomplish if the attainment of content benchmarks was measured rather than the extent to which broader goals were reached (Pellegrino, Chudowsky, & Glaser, 2001; NAE, 2002).

Content, though, has always been the primary emphasis of technology education and its predecessors. During the industrial arts era one of the goals was to “develop skill in using tools and machines” (Schmitt & Pelley, 1966). For this reason, much instruction was directed at the identification of tools and machines, their parts, and their safe and proper usage. Students were engaged in activities designed to develop skills in using equipment to perform processes using a variety of materials of industry. The goal-content dilemma relative to the *Standards for Technological Literacy* is what motivated this researcher to conduct the study reported herein.

Rationale

As the above chronology reported, the intent of technology education has changed in many ways and yet remained the same in many other ways. This study was intended to generate a new set of goals in line with the profession’s current emphasis on technological literacy. Since the release of the *Standards*, there has been an ongoing curriculum development effort by the International Technology Education Association (ITEA) and its Center to Advance the Teaching of Technology and Science (CATTs). It is important for the association that the goals of the profession drive the products that it develops. The intent of this study was to regenerate goals for technological literacy to guide curriculum efforts at the elementary, middle, and high school levels. Clear program focus cannot be achieved without goals. If standards and benchmarks are used in the absence of goals, there will not be a unification of purpose and assessments will result in “teaching to the test” rather than assessing the extent to which the overarching goals were reached. This has already happened in the core academic subjects. If it were to occur in technology education, the result would be graduates who have specific knowledge about selected technologies, but who lack an understanding of the broader notion of how technology is a part of the lives of all.

Method

The purpose of this study was to generate a set of goals to guide curriculum development and instruction for technological literacy, K-12. A four round modified Delphi methodology was used among the leadership boards of the

International Technology Education Association (ITEA). The board memberships included the International Technology Education Association Board of Directors and the executive committees of the Council on Technology Teacher Education, the Council of Supervisors, the Technology Education Collegiate Association, and the Technology Education Council for Children. This constituted a population of 33 leaders from the technology education profession. Since the boards are composed of classroom teachers (elementary and secondary), pre-service teachers, local and state level supervisory personnel, and college professors, this gave representation for all educational levels of professionals. The study was approved by the ITEA Executive Board.

To begin the study, an email was sent to each board member notifying them that the study would commence. The board members were told that their participation would be voluntary. To begin data collection, a letter and white paper was sent to the board members. The letter encouraged participation and explained the process to be used to collect data, exclusively through email. The white paper was a short essay about educational goals and a description of some goals that had been used in prior eras to guide instruction in industrial arts and technology education. It also explained how the profession had moved from using goals to using standards in curriculum development. Once this information had been received by the respondents and they agreed to participate, then Round 1 of the study began. In this round, participants were asked to email the researcher two to five goals they thought were important to guide instruction for K-12 technological literacy. No suggestion was made that any of the goals from past studies should be included by the participants.

Findings

Fifty-five percent (18) of the participants responded to Round 1 and from them 32 potential goal statements were identified. As expected, some goals were stated by more than one participant. A study panel integrated these 32 statements into 21 statements by combining redundant statements in the process. See Table 1.

In Round 2 of the study, the list of 21 potential goals for K-12 technological literacy programs was sent to the 33 board members and asked them to decide if each of the goal statements should be retained or dropped from the list. They were also given the opportunity to reword or modify the goal statements. Ten members (30%) of the participants responded to Round 2. This round resulted in a list of 12 goal statements. The statements are presented in Table 2.

In Round 3 of the study, the list of the 12 goal statements from Round 2 was sent to the original population of 33 board members. The Round 3 instrument included a five point, Likert-type scale for each of the items with 5 indicating strongly agree, 4 agree, 3 uncertain, 2 disagree, and 1 strongly disagree. This enabled the participants to indicate the extent to which they agreed with the statements.

Seventeen of the 33 members (52%) participated in Round 3 of the Delphi study process. Based on the mean values, the participants strongly agreed with

five of the 12 goals. However, seven goals also had high rankings of agreement. Table 3 reports the ratings of the proposed goals for guiding curriculum development and instruction in technological literacy, K-12.

Table 1
Round 1 goal statements

Goal Statement	
1. Explain how technological systems and devices work.	12. Solve problems using technology.
2. Describe how technological systems and devices are used to assist humans.	13. Extend creative abilities using technology.
3. Explain how to troubleshoot and repair technological systems and devices.	14. Deal with the influence of technology.
4. Explain that technology can have unforeseen consequences.	15. Make informed career choices related to fields of technology.
5. Explain that technological design and innovation are tools used to improve the human condition.	16. Describe the nature of technology.
6. Know the scope of technology and how to differentiate between science, engineering, and computers.	17. Assess the interactions between technology, society, and the environment.
7. Become educated consumers of technology for personal, civil, and work usage.	18. Apply design principles that solve technological problems and extend human potential.
8. Understand that there are ethical and environmental impacts associated with the use of technology.	19. Develop abilities to live in a technological world.
9. Develop an appreciation for the role technology has played in human development.	20. Describe the designed world that has resulted from the application of technology.
10. Develop skills to use tools and designs to solve technological problems.	21. Describe the relationships between technology and other areas of knowledge.
11. Appreciate the importance of technology.	

Table 2*Round 2 goal statement results*

1. Use technological systems and devices.	7. Extend creative abilities using technology.
2. Troubleshoot and repair technological systems and devices.	8. Make informed career choices related to the designed world.
3. Become educated consumers of technology for personal, professional, and societal usages.	9. Describe the nature of technology.
4. Describe social, ethical, and environmental impacts associated with the use of technology.	10. Apply design principles that solve engineering and technological problems and extend human potential.
5. Develop an appreciation for the role technology has played in the designed world.	11. Develop abilities to live in a technological world.
6. Use technology to solve problems.	12. Describe the relationship between technology and other areas of knowledge.

Table 3*Round 3 ranking of goals for technological literacy*

Goal Statement	M	Ran k
Become educated consumers of technology for personal, professional, and societal use.	4.76	1
Describe social, ethical, and environmental impacts associated with the use of technology.	4.70	2
Apply design principles that solve engineering and technological problems that extend human potential.	4.65	3
Use technological systems and devices.	4.64	4
Use technology to solve problems.	4.59	5
Develop abilities to live in a technological world.	4.41	6
Extend creative abilities using technology.	4.35	7
Describe relationships between technology and other areas of knowledge.	4.24	8
Develop an appreciation for the role technology plays in the designed world.	4.18	9
Troubleshoot and repair technological systems and devices.	4.00	10
Make informed career choices related to the designed world.	4.00	11
Describe the nature of technology.	3.88	12

When the initial study was planned, the researcher knew from literature and experiences with curriculum design that the fewer and more succinct goal statements are, the better it is for the learners and teachers. Today, this is especially important in assessing student progress toward attainment of the goals. For this reason, a fourth round of the modified Delphi study was planned for this analysis. In this round, the idea was to have only the Board of Directors of the International Technology Education Association participate in the study. There were 16 participants in this group. This was a representative group since each of the four affiliated councils has a seat on the board.

In Round 4 the participants were provided a rank-ordered list of the 12 goal statements from Round 3, as well as the mean values that indicated the extent of agreement. They were asked to review each goal statement and categorize it either as a “must have” or “not essential” goal. The request of the participants occurred just prior to the 2008 ITEA Conference. Fifteen of the 16 board members responded (93.75%).

Table 4*Selection of essential goals for technological literacy programs*

Goal Statement	“Must Have”
Describe social, ethical, and environmental impacts associated with the use of technology.	93.3%
Become educated consumers of technology for personal, professional, and societal use.	86.7%
Apply design principles that solve engineering and technological problems.	86.7%
Use technological systems and devices.	86.7%
Use technology to solve problems.	86.7%
Describe relationships between technology and other areas of knowledge.	73.3%
Develop abilities to live in a technological world.	66.7%
Develop an appreciation for the role technology plays in the designed world.	53.3%
Troubleshoot and repair technological systems and devices.	53.3%
Make informed career choices related to the designed world.	53.3%
Describe the nature of technology.	53.3%
Extend creative abilities using technology.	33.3%

Before starting Round 4, the researcher set a criterion that 80% of the participants must indicate “must have” in order for a goal statement to remain in the final list. This process is consistent with cut-rates reported in other educational research studies such as Lewis, Green, Mitzel, Baum, and Patz (1996) and Mitzel, Lewis, Patz, and Green (2001). Using this 80% selection criterion for inclusion as a goal, five statements were identified. Table 4 reports the proportion of participants that felt that a goal statement fell into the “must have” category.

Discussion

The modified Delphi research methodology was a way to draw consensus among the elected leaders who represent the membership of the International Technology Education Association and its affiliated councils regarding the goals for the field. This resulted in five goal statements that should be used to guide curriculum and instructional development in K-12 programs in technology education and possibly at higher grade levels.

The goal ranked as most important by the professional leadership was *Describe social, ethical, and environmental impacts associated with the use of technology*. Over 93% of the leaders felt that this goal was essential. This indicates that when designing curriculum and instruction for technology education, it is important that the content taught include this social constructivist outcome. There is a significant amount of content suggested in the *Standards for Technological Literacy* (ITEA, 2000) in the area of technology and society, elementary through high school. There are many objectives and activities that could be included such as the creation and elimination of jobs, the outsourcing of work, the building of urban centers, the loss of non-English languages, and country economic status. The same holds true about the ethical impacts of technology. Ideas for content could include the use of animals to test experimental drugs or consumer products, raising the price of fossil fuels after climatic disasters such as hurricanes and floods, and ingredients in food products that can make children and animals ill such as plastic compounds in milk and dog food. Finally, the environmental impacts of technology are topics that have been viable since Earth Day was established in the early 1970s. Although technology can make for a better life, it can also destroy the earth if its impacts are not assessed.

The goal *Become educated consumers of technology for personal, professional, and societal use* was believed to be essential by the vast majority of respondents (86.7%). This goal statement indicates that students ought to become literate about the products they and society as a whole purchase and use. Consistent with this goal would be learning from what materials products are made, what materials are recyclable and how they are recycled (green technology), and what are the health and safety risks of using cell phones and text messaging. At different times in our profession, consumerism has arisen as an important part of the field. Whether one is teaching a general course on

technological literacy or one that develops higher levels of technological capabilities, consumerism should be included.

A high proportion of the respondents (86.7% - same as previous goal statement) felt that students should be able to *Apply design principles that solve engineering and technological problems*. Learning to design in order to solve technological problems should be a key part of the program. The days of having students do technology activities in which they all come up with the same solution to a problem are gone. Gone as well are tracing patterns and cutting materials so that everyone in the class has the same product to take home. Design means that students develop some technical knowledge and skill, understand the impacts of their actions, and then use this knowledge and their creative abilities to solve problems through engineering and technological means. This is what some professionals intend with STEM (Science, Technology, Engineering, and Mathematics) education. This current thrust in U.S. education is to increase student knowledge and capabilities in the STEM subjects, so that they can apply it in the workforce. It is believed that with STEM experiences there will be an increase in the number of school and college completers who are better prepared to design and build innovative products to keep the U.S. economy moving forward. The profession has a long way to go in figuring out how to imbed the STEM concept into K-12 programs. It is the author's belief that STEM efforts will not be successful without the full involvement of technology education and technology education teachers. Technology educators have the unique knowledge and skill necessary to design programs that are goal-based and can show students at all levels how their science and mathematics skills can be applied in designing solutions to engineering and technological problems.

The vast majority of respondents (86.7%, like the previous two goals) felt that the ability to *Use technological systems and devices* is essential. We live in a technological society that uses both low-level tools such as screwdrivers and hammers, as well as high-level tools such as digital electronic devices, for our daily activities. Students need to learn about the basic principles and operation of these tools and related systems and it is our unique responsibility to teach students how to use them. Our classrooms and labs provide an ideal environment for students to learn these skills, particularly consumer skills, so that they can safely replace a battery in their future automobiles or sketch a diagram of a home problem that they or a service technician can help them solve. This exploration will cause some to determine the career that they may wish to pursue. They can then seek further education after graduation or as part of their life-long learning.

One must assure that our study of technology uses the tools that are school appropriate. However, we must not limit the experiences we provide to our students to the tools, machines, and systems that the school systems purchase for our laboratories. This is often the observation and criticism of professionals, including other educators, engineers, or even the comedians on late night television. They see technology education as teachers teaching students to use

tools and little more. The profession needs to keep this in mind when they re-design school programs for technological literacy and base them upon the goals derived in this study.

The vast majority of respondents (87.6%, like the previous three goal statements) believe that it is essential to teach students to *Use technology to solve problems*. Not all problems are technological, but many can be solved through the use of technology. Technology requires an infrastructure such as lighting, transportation, food, etc. Students need to study real world problems in their technology programs. When designing curriculum, the enjoyable part is to have activities that reinforce the knowledge being studied with applications that are age appropriate. Sometimes themes work well while in other situations design briefs are useful. The key again to make these learning experiences successful is to engage students in activities that have multiple correct answers, not just the single answer that the teacher or curriculum designer intended. Moreover, the problems in which the students are engaged need to be changed to keep up with the technology of the times and to peak the interest of the learners.

Reflection

During the 1980s and 1990s, the Input-Process-Output Model for technological systems was very popular in curriculum design. With the goals discussed above this model is probably not as appropriate as it once was. Learners need to be more involved in developing knowledge that will change as the technology and related social issues change. The knowledge that we teach should be transferable. It should be able to be manipulated in a learner's mind and transferred to other applications.

In a technical problem-solving environment, one needs to be aware of the constraints created by society, the economy, and the systems of technology. Technological literacy programs need to study more than just the technical side, or context, of technology. Programs continue to need to develop knowledge that will enable learners to understand the socio-cultural side of technology. This context has been well reviewed in technology education literature. The *Standards for Technological Literacy* (ITEA, 2000) includes four standards that set benchmarks for K-12 students related to technology and culture. They must become an integral part of the programs we design.

Equally important is providing educational experiences to the students we serve that increase their analytical, or the problem solving, capabilities. Most people who work with technology have superior analytical skills. There is no other program in the school curriculum that can better provide these knowledge and skills than technology education. Using the goals identified in this study will lead all programs in this direction.

Conclusions

The leadership of the technology education profession has projected what they believe should be the goals to guide program development and instruction in the field. Coupling these goals with the *Standards for Technological Literacy* (ITEA, 2000) can result in the design and delivery of meaningful educational programs. The International Technology Education Association, through its Center to Advance the Teaching of Technology and Science, has continued to develop and test courses that meet these standards and at the same time integrate standards from science and mathematics. It is time for all technology education professionals to rework their curriculum and instructional practices so they are in line with the goals identified herein and the *Standards*. This will better assure that the completers of our programs are technologically literate.

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