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Technological Literacy

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It's a commonplace today that technology—or good or ill—will play an ever larger role in our lives at home, at work, and in the community. There is also some consensus, in an era of educational reform and standards, on the need for technological literacy and the definition of it. Recently developed standards for technological literacy identify knowledge, skills, and attitudes all students need to use and judge technology intelligently and responsibly. This Digest provides information to K-12 educators about the need and standards for technological literacy and the steps necessary to implement those standards.

Definitions and Rationale

What is technology? A definition of *technology literacy* might well begin with a definition of *technology*. Technology consists of all the modifications humans have made in the natural environment for their own purposes (Dugger 2001)—inventions, innovations, and changes intended to meet our wants and needs, to live longer, more productive lives. Such a broad definition of *technology* includes a broad spectrum of artifacts, ranging from the age-old (flint tools, wheels, levers) to the high-tech (computers, multimedia, biotechnologies). In short, if humans thought of it and made it, it's technology.

Two important points need to made about such a broad definition of technology. First, although some writers address only computer and communications technology (e.g., Selfe 1999), technology is usually defined to include far more than instructional or communications technology (Custer 1999). Computers, e-mail, and Web TV are only one part of the array of devices and procedures we encounter in day-to-day life—everything from digitized kitchen appliances to transportation systems and integrated manufacturing. Second, science and technology, although closely related, are different (Sanders 1999). Science generates knowledge for its own sake, proposing and testing explanations. Technology, on the other hand, develops human-made solutions to real-world problems. Of course, science uses technology to generate knowledge and technology uses scientific knowledge to generate solutions, so the two are integrally connected; but they are different fields driven by different concepts and processes (Bybee 2000).

What is technological literacy? Just as technology involves more than computers and the Internet, technological literacy involves more than hands-on skill in using technology (Bugliarello 2000). Certainly, knowing how to use information technology is increasingly important in our knowledge society, whether we are looking for a job, marketing a service, or shopping for a product. We must also be able to use other devices, like microwaves, copying machines, and self-service gas pumps, that have become part of everyday life at home, at work, or in the community. However, the ability to use technology is only one part of technological literacy. What are the other parts?

Interpreting a large body of work on technological literacy from a variety of fields, Gagel (1997) suggested common elements of an enduring, inherent technological literacy that can last through the fast, continuous changes in technology. This type of technological literacy would include knowledge about the details of individual technologies and about the process of technology development. It would also include a holistic understanding of the historical and cultural context of technology and adaptability based on initiative and resourceful thinking. Finally, enduring, inherent technological literacy would include four generalized competencies: "(a) accommodate and cope with rapid and continuous technological change, (b) generate creative and innovative solutions for technological problems, (c) act through technological knowledge both effectively and efficiently, and (d) assess technology and its involvement with the human lifeworld judiciously" (p. 25).

These elements are mirrored in other descriptions of technological literacy. Prime (1998) characterizes technological literacy as consisting of knowledge and skills. Broad knowledge areas include problems that might be solved with technology, important technologies, social and cultural effects of technology, prerequisite knowledge from other disciplines (e.g., math), and the form or structure of technological knowledge. Skills include both manipulative and cognitive skills (e.g., evaluation, analytical thinking, creativity, problem solving, research, analysis, design). Affective skills include the capacity to act for the right reason and exhibit concern for moral and ethical implications of technological choice, as well as attitudes such as independence and interdependence, caring, environmental concern, social responsibility, and positive work habits.

Why is technological literacy so broad? There is wide agreement that *technological literacy* should be defined very broadly, for two reasons (International Technology Education Association [ITEA] 2000). The range of technology available today is very broad, as is the range of human problems that technology might solve; creation of new technologies and extension of old technologies will only increase the ranges of both. As a result, individuals need more than just knowledge of current technology and skills in using it; they also need an additional set of knowledge and skills to accommodate and use the new and changed technologies of tomorrow. This additional set of knowledge and skills includes learning-to-learn skills—information, inquiry, independent learning, media, and group skills (Potter et al. 2000).

Just as important, however, are the knowledge and skills all will need for informed, responsible decision making as workers, consumers, and citizens (Bugliarello 2000; Gilberti 1999). Responsible decision making requires an understanding of the relationship between technology, humans, and the environment and of the limits of science and technology; the ability to distinguish between fact and conjecture, to examine the values associated with technology, and to develop one's own values; and some experience in applying technology to solve problems. For example, chlorofluorocarbons are great as refrigerants and foam-blowing agents but they also damage the ozone (ITEA 2000). And we know the Internet can affect how people interact and communicate, do business, and entertain themselves, but we don't know what its long-term effect will be.

Some educators are particularly concerned about the articulated belief system that links literacy and technology, the "grand narrative...[that] *science + technology + democracy* (*+ capitalism*) + *education = progress + literate citizenry*" (Selfe 1999, pp. 122-123). Will the powerful, common-sense appeal of such a belief system lead us to accept without question both its assumptions and its conclusions? Has the equation of technology with progress blinded us to the fact that technology may simply reproduce social problems? Great concern is expressed about unequal access--at home, in the workplace, and in school--to online telecommunications and technology for women, minorities, and the poor. Equally, concern is expressed about affluent, highly educated nontechnologists who are estranged from technology and prefer to leave it to the technologists, abdicating their own responsibilities as informed citizens, consumers, and workers (ibid.).

Standards for Technological Literacy

These concerns are reflected in ***Standards for Technological Literacy: Content for the Study of Technology*** (ITEA 2000). The product of lengthy and careful collaboration among educators, engineers, and scientists conducted by ITEA's Technology for All Americans Project (TfAAP), 20 cognitive and process standards are grouped in 5 categories:

- **The Nature of Technology**—characteristics and scope of technology; core concepts of technology; the relationships among technologies and connections between technology and other fields
- **Technology and Society**—cultural, social, economic, and political effects of technology; effects of technology on the environment; role of society in the development and use of technology; influence of technology on history
- **Design**—attributes of design; engineering design; role of troubleshooting, research and development, invention and innovation, experimentation in problem solving
- **Abilities for a Technological World**—apply the design process; use and maintain technological products and systems; assess the impact of products and systems
- **The Designed World**—medical technologies; agricultural and related biotechnologies; energy and power technologies; information and communication technologies; transportation technologies; manufacturing technologies; construction technologies

Specific, developmentally appropriate benchmarks define precise student outcomes for four clustered grade levels (K-2, 3-5, 6-8, and 9-12). Extensive additional narrative provides fuller explanations of the intent of standards and examples and details of grade-level benchmarks; vignettes illustrate instructional activities and experiences to implement benchmarked standards.

ITEA calls for technology education for all students, from kindergarten through high school, with attention to gender, minority, and equity issues. The association recommends that standards be included in curricula for both technology education and other subject areas and applied in conjunction with other national, state, or local standards for technological literacy and other subject areas.

Implementing the Standards

TfAAP has begun development of three sets of related standards critical to implementation (Dugger 2000-2001): assessment standards (good practice in measuring student learning for formative and summative purposes); professional development standards (for inservice and preservice teacher preparation); and program standards (framework for a consistent, articulated, coordinated K-12 technology program).

Another essential step toward implementing the standards is curriculum development. One statewide effort has developed a model K-12 standards-based technology education curriculum based on state K-12 technology education standards and correlated with ITEA standards (Mino et al. 2001). TfAAP's ongoing summer implementation workshop provided valuable clarification in developing teacher tasks, student activities, and student work examples based on the standards. Future plans include Internet dissemination and district-level professional development; a website will contain a relational database of classroom activities, searchable by standard or grade level, with examples of student work correlated to level of competency, as well as model curriculum and implementation plans for all state standard content areas.

With or without a model curriculum, individual teachers will play a major role in incorporating ITEA standards into existing programs (Sumner 2001). Teachers must compare ITEA standards to state, district, program, and course standards, outcomes, objectives, or goals to determine whether current materials and activities fit ITEA standards. If existing components fit ITEA standards, they can be used without modification; a partial fit can be rectified by modifying existing components. New components need to be developed for ITEA standards that are not currently addressed.

Teacher education must also play a role in implementing ITEA standards for technological literacy (Reeve 2001). Courses in technology education should at least identify which standards for technological literacy they cover. Eventually, upper-level curriculum and teaching methods courses must provide detailed knowledge about standards and give students the opportunity to develop curriculum materials and activities to implement the standards.

In the end, implementing the standards for technological literacy will depend on leadership and partnership. Teachers, curriculum specialists, and administrators can and must provide leadership to the educational community; developing a cadre of leaders is one of the first steps in nationwide implementation (Dugger 2000-2001). Ultimately, meeting the challenge of providing the study of technology to all students at all levels will require a partnership of all parties interested in improving levels of technological literacy--teachers, principals, superintendents, state supervisors, teacher educators, students, parents, educational equipment providers and publishers, engineers, scientists, mathematicians, technologists, and the community at large (ITEA 2000). And meeting that challenge will require careful attention to issues of equity and access so that all segments of society can enjoy the benefits of technological literacy.

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