Interdisciplinary Approaches to Teaching Technology Education

Chapter 5

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Hail to the Skillful, cunning hand!
Hail to the cultured mind!
Contending for the world's command,
Here let them be combined.
 —Calvin Woodward, 1887 (cited in Barlow, 1967, p. 36)

INTRODUCTION

As Woodward's axiom implies, it is counterintuitive for the study of technology to be segregated from the rest of the school curriculum, because technology is intertwined with nearly every aspect of our lives. At best, this practice is illogical. At worst, it perpetuates misconceptions about our technological world. With the study of technology rapidly becoming a significant component of science, social studies, and other school curricula, the profession has an unprecedented opportunity to explore and implement interdisciplinary instructional strategies appropriate to the study of technology.

The segregation of technology from other school subjects is grounded in cultural values placed on knowing and doing, dating to antiquity. Plato and Aristotle postulated that knowledge was separate from—and to be held at some higher level than experience—a cultural bias that remains to this day. But the idea of integrating praxis—the doing of technological activity—with *academic* subjects has been at the heart of educational experiments throughout the past century, and has been increasingly embraced over the past few decades.

Noted philosopher John Dewey was explicit in denouncing the separation of knowing and doing. In *Democracy and Education*, Dewey (1917) reasoned:

> The most direct blow at the traditional separation of doing and knowing . . . has been given by the progress of experimental science. . . . There is no such thing as genuine knowledge and fruitful understanding except as the offspring of doing. . . . Knowledge and power of

explanation . . . cannot be attained purely mentally—just inside the head. Men have to do something to the things when they wish to find out something. (Chapter 20)

In the latter half of the 20th century, many of those who thought deeply about and experimented with the teaching/learning process have formulated learning theories that promote *contextualizing* ideas by grounding them in meaningful experiences. The theories of constructivism, situated learning, and experiential learning, for example, are widely accepted and support the idea of integrating relatively abstract ideas with technological problem-solving experiences. Constructivist theory suggests schema and mental models lend meaning and organization to ideas (Bruner, 1966). Constructivists believe students build their understandings of the world through active information processing. Situated learning theory (e.g., Brown, Collins, & Duguid, 1989; Greeno, 1988; and Lave & Wenger, 1990) holds that knowledge must be presented in an authentic context. Experiential learning theorists such as Rogers (1969) suggested learning occurs through direct confrontation with practical, social, personal, or research problems, and the most effective learning occurs when subject matter is self-initiated and deemed relevant by the student.

The ideals of these now-popular learning theories—that learning is best accomplished in the presence of mental models, schema for understanding, active information processing, authentic contexts, practical real-world problems, and personal relevance—are all attributes of the *technological problem-solving method* common in contemporary technological studies. Thus, contemporary learning theory strongly supports the implementation of interdisciplinary instructional approaches to technological studies.

PURPOSE

The purpose of this chapter is to discuss the instructional strategy of the interdisciplinary approach to teaching. The development of education has resulted in a separation of subjects in the school setting. Technology is not a "stand-alone" entity but rather is intertwined with nearly every aspect of our lives. Thus, an interdisciplinary approach to the study of technology is more logical than a segregated approach.

EARLY INTERDISCIPLINARY CURRICULUM MODELS IN THE PROFESSION

Throughout most of the last century, noted industrial arts/technology educators borrowed from these educational philosophies and learning theories in designing curricula that connected praxis and academics via an interdisciplinary instructional approach. Bonser and Mossman (1923) proposed an interdisciplinary industrial arts elementary school model in which hands-on activities were situated in a social/cultural context. Maley (1959) argued the point with a question: "Where else in the school is there the possibility for the integration and application of the mathematical, scientific, creative, and manipulative abilities of youngsters to be applied in an atmosphere of references, resources, materials, tools, and equipment so closely resembling the society outside school?" (p. 12). In formulating a curriculum model he called *The Maryland Plan*, Maley (1973) combined his ideas of interdisciplinary instruction with his belief that industrial arts activities should be developmentally appropriate. In describing the "culture complex," Olson (1973) suggested the industrial arts curriculum should explore—among others—the historical, economic, social, aesthetic, political, environmental, scientific, and industrial aspects of technology. In describing these terms, he wrote: "These are an invitation to integrated, correlated, and articulated study with other disciplines" (p. 10). DeVore's (1972) "Sphere of Universal Technological Endeavors" model depicted the interrelationships of technology with "social cultural elements" (p. 33). Savage and Sterry's (1990) "Interaction of the Domains of Knowledge and Human Adaptive Systems" model illustrates interactions among technology, science, humanities, formal knowledge, and natural environments (p. 10).

EDUCATIONAL REFORM AND NATIONAL STANDARDS

The incorporation of technological content into the school curriculum became a significant thrust of educational reform efforts of the 1990s. *Science for All Americans* (AAAS, 1989) catapulted technology into the mainstream of educational reform. Its chapters on "Science and Technology" and "The Designed World" legitimized the study of technology within the context of science and became a rationale for all future

curriculum efforts that sought to connect the study of science and technology.

Concurrently, the national standards developed for science, mathematics, social studies, and technology education explicitly addressed the study of technology in an interdisciplinary context. "Content Standard E: Science and Technology" of the *National Science Education Standards* (NSES) for example, advocates that students develop "Abilities of Technological Design" (NRC, 1996). This section of these *science standards* describes a process very familiar to technology educators:

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design. (pp. 165–166)

Similarly, "Thematic Standard #8: Science, Technology, and Society," of the *National Standards for Social Studies Teachers* (NCSS, 1997) stressed the importance of technological study in the *social studies* curriculum. Specifically, it says social studies teachers should "possess the knowledge, capabilities, and dispositions to organize and provide instruction. . . for the study of science, technology, and society" (Par. 1). It encourages students to trace the impact of science and technology in "agriculture, manufacturing, the production and distribution of goods and services, the use of energy, communication, transportation, information processing, medicine and health care, and warfare" so that they might understand "the way science and technology have influenced and have been influenced by individuals, societies, and cultures" (Par. 2). This *social studies* standard is eerily reminiscent of technology education literature when it proclaims the following: "By examining questions and issues raised historically and contemporaneously resulting from scientific inquiry and technological applications, learners can be better prepared to make informed decisions as citizens about individual choices and policy alternatives that face society" (Par. 3).

The *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000) reiterated what these earlier standards documents had already begun to make clear—technological study should be integrated with other disciplines and school subjects. Specifically, Standards #4—The Cultural, Social, Economic, and Political Effects of

Technology, #5—The Effects of Technology on the Environment, #6—The Role of Society in the Development and Use of Technology, and #7—The Influence of Technology on History, set the stage for interdisciplinary instructional strategies that connect technology education with the science and social studies curricula.

RELATED RESEARCH FINDINGS

Over the past four decades, researchers in industrial arts/technology education have identified various benefits of integrating technological content with other subject areas (Brusic, 1991; Champion, 1966; Childress, 1996; Downs, 1969; Ingram, 1966; Korwin & Jones, 1990; LaPorte & Sanders, 1995; Logan, 1973; Pershern, 1967). Likewise, hands-on activities in science education have been shown to enhance the learning process (Brooks, 1988; Cotton & Savard, 1992; Glasson, 1989; Mattheis & Nakayama, 1988; Roth, 1991, 1992, and 1993; Saunders & Shepardson, 1984).

International comparisons of mathematics and science education suggest the current approach to these subjects in the United States is not as effective as it might be. Of the 38 countries studied, the U.S. ranked 19th in achievement in 8th grade mathematics and 18th in achievement in 8th grade science (U.S. Department of Education, 1996). These and similar earlier findings prompted the National Science Foundation (NSF) to fund research and development projects that integrated technology education content and method with science and mathematics. These NSF projects included "Phys-Ma-Tech" (Scarborough, 1993); the "Technology, Science, Mathematics Integration Project" (LaPorte & Sanders, 1993, 1996); "Project UpDATE" (Todd, 1994); "Integrated Mathematics, Science, and Technology" (Loepp, 1999); and the "Children Designing and Engineering Project" (Hutchinson, 1999). Each of these projects resulted in curriculum and/or teacher in-service materials, most of which are described later in this chapter.

CONCEPTUALIZING INTERDISCIPLINARY INSTRUCTION

Those working to develop and implement an interdisciplinary approach to technology education should consider the different ways of conceptualizing interdisciplinary instruction. Jacobs (1989) provided a

helpful set of "design options for an integrated curriculum" in which she described 10 different interdisciplinary curriculum models. Fogarty (1991, cited in Lake, 2002) extrapolated the following interdisciplinary instructional approaches from Jacobs' work:

Fragmented. The traditional model of separate and distinct disciplines, which fragments the subject areas.

Connected. Within each subject area, course content is connected topic-to-topic, concept-to-concept, one year's work to the next, and relates idea(s) explicitly.

Nested. Within each subject area, the teacher targets multiple skills: a social skill, a thinking skill, and a content-specific skill.

Sequenced. Topics or units of study are rearranged and sequenced to coincide with one another. Similar ideas are taught in concert while remaining separate subjects.

Shared. Shared planning and teaching take place in two disciplines in which overlapping concepts or ideas emerge as organizing elements.

Webbed. A fertile theme is webbed to curriculum contents and disciplines; subjects use the theme to sift out appropriate concepts, topics, and ideas.

Threaded. The meta-curricular approach threads thinking skills, social skills, multiple intelligences, technology, and study skills through various disciplines.

Integrated. This interdisciplinary instructional approach matches subjects for overlaps in topics and concepts with some team teaching in an authentic integrated model.

Immersed. The disciplines become part of the learner's lens of expertise; the learner filters all content through this lens and becomes immersed in his or her own experiences.

Networked. The learner filters all learning through the expert's eye and makes internal connections that lead to external networks of experts in related fields.

The work of Jacobs (1989) and Fogarty (1991, cited in Lake, 2002) points to the many options, nuances, and attending complexities—some obvious, others less so—that really must be considered when designing or implementing an interdisciplinary instructional approach to technology education. Technology educators and curriculum developers should identify an approach or a combination of approaches that they deem suitable for their situation and plan accordingly.

PLANNING INTERDISCIPLINARY INSTRUCTION

Whether the integration of content takes place only in the technology education course, or is orchestrated among several courses/teachers, careful planning is the key to successful implementation of integrated instruction. Administrative support is also critically important, particularly for those strategies that include more than one school subject/ teacher. Teacher "teams" need common planning time, as well, which is typically scheduled by a school administrator. If no common planning times are provided during school hours, teachers on the "team" *will* need to meet before or after regular school hours to coordinate efforts. It is impossible to ignore the need to plan interdisciplinary instruction when teams are involved.

As noted earlier, considerable resources have been invested over the past decade—particularly by the National Science Foundation—to develop instructional materials that integrate technological content and method with other school subjects. Individuals and/or school systems need not—nor can they afford to—reinvent integrated instructional units. Rather, those planning to implement an interdisciplinary approach to technology education should begin by reviewing as many of the existing materials as possible. To assist with this process, a number of projects are briefly described in the "Approaches to Interdisciplinary Technology Education" section, along with information about where to locate the materials described. Teachers/schools may use these materials "as-is" or adapt them as they see fit—thus saving considerable time and resources.

While existing materials can provide a framework, specific instructional strategies will need to be agreed upon by all teachers involved. Success will depend largely on the commitment of all teachers involved. Alternatively, a single teacher (e.g., technology education teacher) may tackle an interdisciplinary instructional unit, but doing so successfully requires considerable creativity, knowledge, and careful planning.

ASSESSING INTERDISCIPLINARY INSTRUCTION

As should be the case for any assessment strategy, assessments of interdisciplinary instructional models should be predicated upon the initial

goals and objectives identified. Too often, scores on pre-existing standardized achievement tests have been used to assess innovative instructional approaches. If the goal of a new interdisciplinary instructional unit were to improve achievement on such standardized tests, student scores on these tests would be an appropriate measure. However, since the goals of newly developed interdisciplinary instruction are likely to be different from those measured by pre-existing standardized tests, one should expect such ill-conceived assessments to yield indifferent or even negative results. In other words, it is critical that the validity of the assessment is established.

Most of the instructional materials developed for integrating technology education with other school subjects engage students in researching, designing, constructing, and evaluating solutions to technological problems. One might, therefore, assess the interdisciplinary instructional approach by examining student performance on those constructs (researching, designing, etc.). But other intended outcomes exist, as well. "Problem-solving ability," for example, is an often-stated goal of this type of instruction. The solutions (physical artifacts) developed by students may be helpful in assessing problem-solving ability, but using a "product" to evaluate a "process" is tricky business riddled with pitfalls. Student "portfolios" that document their ideation throughout the problem-solving process are helpful in evaluating problem-solving ability and could provide a means for assessing this aspect of the interdisciplinary instruction. Portfolios might also be helpful in assessing the extent to which the interdisciplinary instruction causes students to incorporate principles from other subjects such as science and mathematics.

Indeed, the assessment of innovative instructional strategies in general—and the integration of technology education with other school subjects in particular—have only recently begun to garner the attention they deserve. Because far more questions arise than answers, technology education teacher educators and researchers should assess new interdisciplinary instructional strategies with cautious determination.

APPROACHES TO INTERDISCIPLINARY TECHNOLOGY EDUCATION

No single best way to approach interdisciplinary technology education exists. The fact that the philosophies and structures of elementary, middle, and high schools vary considerably necessitates very different

approaches at each of these three levels. Beyond that, the work of those such as Jacobs (1989), Fogarty (1991, cited in Lake, 2002), discussed earlier encourages the need for a variety of different approaches to interdisciplinary technology education.

In addition to "conventional" instructional materials, careful consideration should be given to the many state/national "technology" competitions that are held each year throughout the United States. Many of the most successful teachers use state/national competitions to motivate students. While most of these competitions are designed to be extracurricular, the unique flexibility of technology education programs often allows technology teachers to incorporate these competitions as a component of the regular curriculum. Chapter 12 further introduces competitions as a viable instructional strategy.

The limited space herein does not allow for thorough descriptions of the many interdisciplinary instructional approaches that have been implemented in the profession. What follows, therefore, is an annotated list of many of the interdisciplinary projects that have been conducted in the field, particularly those with published curriculum materials that the reader may obtain. Materials on the accompanying Web sites should be extremely useful to those planning to implement interdisciplinary instructional approaches to the study of technology. The following list is structured by school level—elementary, middle, and high school. For some additional listings, particularly for specific interdisciplinary technology education activities, see the ITEA Monograph, *Integrating Technology Education Across the Curriculum* (Sanders & Binderup, 2000).

Elementary-Level Approaches/Projects

Although elementary technology education is still sparse in the U.S., the K–5 standards in *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000) provide insight into what interdisciplinary technology education at the elementary school level might become. Indeed, the elementary school provides one of the best opportunities for interdisciplinary work, since many elementary teachers routinely work in this mode. Obstacles include insufficient technology education backgrounds among most elementary teachers and their principals, as well as a curriculum that is already overflowing with content. That said, some of the most exciting interdisciplinary work in technology education is currently taking place at the elementary grade levels.

Project UpDATE developed 12 K–6 curriculum packages known as "Contextual Learning Units" (CLUs) for teaching integrated mathematics, science, and technology. The materials, which each relate to common elementary level readings, focus on design, technology, and problem-solving approaches. For example, *The Three Little Pigs* provides the context for a CLU on house construction in which students build models of houses to experiment with different construction materials/techniques (Todd, 1994).

Children Designing and Engineering developed instructional units for grades K–5 known as *TechEdge Topics*. These units apply a design and technology approach to real-world activities. They are intended to increase the scientific and technological literacy, capability, and responsibility of all students. *TechEdge Topics* are based upon subject matter from business and industrial settings (e.g., transportation, food, safety, and utilities) that young learners find particularly interesting and relevant. Each unit includes a guided portfolio, a technology education topic book, and a teacher's guide (Hutchinson, 1999). For more information on the World Wide Web, go to http://www.tcnj.edu/~cde/.

Craftsman/NSTA Young Inventors Awards Program challenges students in grades 2–5 to use their imaginations along with science, technology, and mechanical ability to invent or modify a tool. The tool, which students design/construct on their own, must perform a practical function. The two national winners (one from each grade level competition) receive a $10,000 U.S. Savings Bond each and the 10 finalists (five from each grade level) receive a $5,000 U.S. Savings Bond each (NSTA, 2002). For more information on the World Wide Web, go to http://www.nsta.org/programs/craftsman/.

Toshiba/NSTA ExploraVision Awards Program is a national competition for students in grades K–12 (in four divisions: K–3, 4–6, 7–9, and 10–12) that encourages students to "combine their imaginations with the tools of science to create and explore a vision of a future technology" (Par. 1). Students, working in small groups, select a technological device; explore what it does; how it works; and how, when, and why it was invented. They then project what that technology might be like in 20 years and convey their projections to others in writing and via a Web site (Toshiba, 2002). For more information on the World Wide Web go to: http://www.toshiba.com/tai/exploravision.

Middle-School Level Projects

In some ways, middle schools are best prepared for interdisciplinary instruction, since the vision for middle schools was predicated upon integrated subject matter and teaching teams (Vars, 1987). Middle school teaching "teams" are almost universally comprised of the "academic" teachers only (planning time is created when students are collectively scheduled into elective subjects during a single class period). Thus, one of the real keys to interdisciplinary technological studies at the middle school level is to convince school administrators to include technology teachers in the "teams." This is perhaps the most critical prerequisite for planning and implementing interdisciplinary instruction. The following project materials and competitions facilitate interdisciplinary technology education in the middle school.

Learning by Design developed learning modules built around engineering and design problems that promote the learning of essential concepts and processes in mathematics, science, and technology education. Based upon complex design problems, the modules integrate content from the different disciplines, focus on collaborative learning and doing, and foster reflection. Computer support provides an interactive problem-solving environment, information resources, and scaffolding for teachers. Diversity issues are addressed through the relevant realistic problems that are solved through cooperation and communication. For more information on the World Wide Web, go to http://www.cc.gatech.edu/edutech/projects/lbdview.html.

DESIGNS consists of six modules based on engineering projects intended as an alternative to traditional and discovery-based experiments for introductory physical science courses. Each challenge begins with student construction of a standard device (e.g., batteries, bridges, electromagnets, solar heating, and a gravity car). Students are challenged to optimize the performance of a variable that has a large range. Construction of the solutions takes relatively little time and the outcome is tested publicly. Students are asked to predict results of trials and explain the outcomes. The six modules are available from Kendall/Hunt Publishing Company under the title *Challenges in Physical Science* (Harvard-Smithsonian Center for Astrophysics, 2002). For more information on the World Wide Web, go to http://cfa-www.harvard.edu/cfa/sed/projects/designsinfo.html. and http://www.kendallhunt.com/.

World in Motion II is a multi-disciplinary curriculum for grades seven and eight. Over the course of eight weeks, students work together in engineering design teams through a six-phase design process, which includes setting goals; building knowledge; designing; building and testing; finalizing the model; and presenting the results. Students become engaged in an intense exploration of hands-on materials as they investigate the relationship between force and motion, the effects of weight and lift on a glider, data analysis and variable manipulation, and the importance of understanding consumer demands. Volunteers share their professional experiences in engineering, science, math, marketing, oral communications, and/or consumer research (Society of Automotive Engineers, 2002). For more information on the World Wide Web, go to http://www.sae.org/students/awimii.htm.

Integrated Mathematics, Science, and Technology is a two-year, middle school curriculum designed to facilitate the attainment of national mathematics and science standards. Students are expected to spend at least 40 minutes per day in each of the disciplines of math, science, and technology. The 7th grade modules are titled Wellness, Food Production, Waste Management, Energy Transformations, Manufacturing, and Forecasting. The 8th grade includes modules on the themes of Animal Habitats, Human Settlements, Systems, and Communication Pathways. Each module includes objectives; hands-on learning activities in math, science, and technology; readings; and assessment activities. IMaST modules are available from Glencoe/McGraw-Hill. (Center for Mathematics, Science, and Technology, 2002) For more information on the World Wide Web, go to http://www.ilstu.edu/depts/cemast/imast/imasthome.htm.

The **Technology, Science, Mathematics Connection Activities** is a collection of six detailed activities that integrate technology education, science, and mathematics in the middle school. These engineering-like activities challenge students to design, construct, and evaluate solutions to real-world problems of interest to them. The activities encourage technology, science, and mathematics teachers to work together as a team. Each activity includes detailed information for science, mathematics, and technology teachers. The *Technology, Science, Mathematics Connection Activities* are available from Glencoe/McGraw-Hill (LaPorte & Sanders, 1996). For more information on the World Wide Web, go to http://teched.vt.edu/TechEd/HTML/Research/TSMOverview1.html.

Science and Technology: Investigating Human Dimensions is a three-year activity-based program for students in grades 5–9. Students explore science and technology by doing investigations and reading about how science and technology relate to their lives. Student books and teacher guides accompany units on patterns of change, limits and diversity, and equilibrium. The program encourages the participation of female, minority, and disabled students, emphasizes reasoning and critical thinking, and illustrates careers. These materials are available from the Kendall/Hunt Publishing Company as the *Middle School Science and Technology* textbook series (BSCS, 1999). For more information on the World Wide Web, go to http://www.kendallhunt.com/elhi/.

FIRST Jr. Robotics (LEGO League) is a national competition sponsored by the FIRST™ organization, for students age 9–14. A challenge designed around a LEGO robotics kit is presented in the fall. Students have 10 weeks to research, design, and build a robot that can "solve" the challenge. Their solution may then be entered in a one-day local and (if successful) state tournament (FIRST, 2002a). For more information on the World Wide Web, go to http://www.usfirst.org/jrobtcs/flego.htm.

Craftsman/NSTA Young Inventors Awards Program is a national competition that includes a middle school division (see description in the section entitled Elementary-Level Approaches/Projects mentioned earlier).

Toshiba/NSTA ExploraVision Awards Program is a national competition that includes a middle school division (see description in the section entitled Elementary-Level Approaches/Projects mentioned earlier).

High School Level Projects

High schools present a unique set of challenges for interdisciplinary instruction. The goal of preparing students to meet college entrance requirements and perform well on standardized tests encourages high schools in the United States to teach conventional courses in conventional ways. Nevertheless, the increasing sophistication of the high school technology education curriculum—especially in the realm of digital technologies—and ubiquitous electronic communication capabilities provide new opportunities for interdisciplinary instructional approaches in high schools. The following resources provide a starting place for those embarking on interdisciplinary instruction at the high school level.

Science that Counts in the Workplace is a full-year physical science course for 11th- and 12th-grade students embedded in the context of

workplaces/fields such as engineering, manufacturing, maintenance and repair, transportation, architecture, and construction. The course is targeted to students who have not thrived in conventional science courses. It is particularly appropriate for use in career academies and high schools organized by career clusters (Technology Education Research Center, 2002b). For more information on the World Wide Web, go to http://www.terc.edu/TEMPLATE/projects/item.cfm?ProjectID=30.

Science by Design is a series of four texts that integrate science and technology through design-and-build projects entitled *Construct-a-Boat, Construct-a-Greenhouse, Construct-a-Glove,* and *Construct-a-Catapult.* These units provide students with a hands-on approach to the physics of product design. They blend biology, physical science, physics, and earth science with technology education processes and topics. The materials focus on selected process skills: communicating, designing and building, testing, planning and conducting experiments, analyzing data, and modeling (Technology Education Research Center, 2002a). For more information on the World Wide Web, go to http://www.terc.edu/TEMPLATE/products/item.cfm?ProductID=3.

National Super-mileage Competition provides high school students an opportunity to engage in a rich, safe, and authentic research and development experience. This competition challenges students to design, construct, and enter a high-mileage vehicle competition hosted by the Minnesota Technology Education Association (MTEA). Some participants reach over 800 miles per gallon in the sleek vehicles they have designed and built. Three classes comprise the competition: (1) Stock—which uses a 3.5 hp Briggs and Stratton engine with no modifications; (2) Modified—which uses a 3.5 hp Briggs and Stratton modified engine where the base construction remains Briggs and Stratton; and (3) Concept—which uses any engine that burns gasoline (MTEA, 2002). For more information on the World Wide Web, go to http://www.mtea.net.

FIRST Robotics is a high school competition sponsored by FIRST™, a non-profit organization whose mission is to generate an interest in science and engineering among today's youth (the acronym stands for "For Inspiration and Recognition of Science and Technology"). In the FIRST Robotics competition, kids, teachers, and engineers work together in creating robotic devices with which they compete in local, state, and national tournaments (FIRST, 2002b). For more information on the World Wide Web, go to http://www.usfirst.org/robotics/index.html.

National Engineering Design Challenge (NEDC) is a high school program sponsored by the Junior Engineering Technical Society (JETS) in which teams of students design, build, and demonstrate a working solution to a societal need. NEDC challenges students to apply mathematics, science, and technology to a real-world engineering situation. Solutions developed should be usable by people with or without disabilities. Each team must work with an advising engineer who provides general information about engineering design principles and technical information about project specifics, verifies the safety of the project, teaches the team research methods, and serves as a resource link between the team and the community (Junior Engineering Technical Society, 2002). For more information on the World Wide Web, go to http://www. engineeringnet.org/nedc.htm.

Winston Solar Challenge is designed to teach high school students the physics and technology associated with a roadworthy solar car. Its objective is to encourage student interest in science, engineering, and solar technology. Emphasis is placed on the sharing of knowledge and the development of new friendships rather than on the intensity of competition. The major components of the vehicle must be designed and constructed completely by the students, though they may seek the advice of engineers or other design consultants. In even-numbered years, the competition is a three-day closed-track race at the Texas Motor Speedway. In odd-numbered years, it is a three-day cross-country race (Winston Solar Challenge, 2002). For more information on the World Wide Web, go to http://www.winstonsolar.org/dhtml/.

Toshiba/NSTA ExploraVision Awards Program is a national competition that includes a high school division (see description in the section entitled Elementary-Level Approaches/Projects mentioned earlier).

SUMMARY

Many compelling reasons encourage those developing technological studies curricula to consider interdisciplinary instructional strategies. Were it not for the fact that school subject matter has been "compartmentalized" throughout the last century, an interdisciplinary instructional approach to the study of technology might already be commonplace. Technology is not a "stand-alone" entity but rather is intertwined with nearly every aspect of our lives. Thus, an interdisciplinary approach to the study of technology is more logical than a segregated approach.

The "technological problem-solving" method, in which students are challenged to design, construct, and evaluate solutions to problems, has been embraced not only by technology education, but by innovative science teachers, social studies teachers, and elementary educators as well. Many National Science Foundation projects, arguably among the most innovative of all science educational materials, are grounded in the "technological problem-solving" method.

Research from a variety of disciplines suggests "chunking" abstract facts with practical experience—a common byproduct of the "technological problem-solving" method—is sound pedagogy. Not surprisingly, the sourcebooks for educational reform in America of the last two decades and many of the national standards that followed—particularly the science, social studies, and technology education standards—call for the implementation of interdisciplinary instructional strategies to technology education.

Just recently, the National Academy of Engineering (NAE) and National Research Council (NRC)—which enjoy considerable political clout—released a book titled *Technically Speaking: Why Every American Should Know More About Technology* (Pearson & Young, 2002). *Technically Speaking* is the report of two years of study by the Committee on Technological Literacy established by the National Academy of Engineering. This book—more than any that preceded it—promotes an interdisciplinary approach to the study of technology as the preferred means for achieving technological literacy in America. Specifically, their recommendations include the following:

Recommendation 1. Federal and state agencies that help set education policy should encourage the integration of technology content into K–12 standards, curricula, instructional materials, and student assessments in non-technology subject areas.

Recommendation 2. The states should better align their K–12 standards, curriculum frameworks, and student assessment in the sciences, mathematics, history, social studies, civics, the arts, and language arts with national educational standards that stress the connections between these subjects and technology. The National Science Foundation (NSF) and Department of Education (DoEd)-funded instructional materials and informal-education initiatives should also stress these connections.

For those wishing to pursue an interdisciplinary instructional approach to technology education, good news awaits. The education

reform efforts of the last two decades, the national standards documents of the 1990s, and the politics of the 21st century support this approach to the study of technology. Moreover, a wealth of existing curriculum material is available to those embarking on the journey. And, while interdisciplinary technology education remains the exception rather than the rule, a growing body of anecdotal evidence points to the benefits derived when the study of technology cuts across traditional boundaries in education.

DISCUSSION QUESTIONS

1. Why is the concept of interdisciplinary instruction so important to consider in the technology education classroom?

2. What are some of the challenges to overcome as technology education teachers begin to incorporate interdisciplinary instructional strategies in the classroom?

3. Which of the interdisciplinary instructional approaches from Fogarty's and Jacob's work seem most appropriate for your philosophy of technology education?

4. Why has it taken so long to incorporate interdisciplinary instructional strategies into our educational system?

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