Incorporating Experimental Technologies in the Middle Level Technology Education Classroom

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The International Technology Education Association (ITEA) in its *Standards for Technological Literacy and Content for the Study of Technology* (2000) broadly defined technology as "the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human wants and needs" (p. 2). Implied in this definition is the concept that technology education is a constantly changing and evolving discipline. Therefore there is a need for teachers of technology education to avoid stagnation and to stay abreast of the latest technologies, including those deemed experimental.

Along with up-to-the-minute knowledge of their field, technology education teachers should possess the ability to successfully integrate experimental technologies into their classrooms and laboratories. Technology education teachers must also be prepared to lead discussions about how emerging technologies may affect society, both positively and negatively. Indeed, ITEA goals require that students of technology understand the impact of technology on the economy, on the environment, and on society (ITEA, 2000). Technology education teachers may find discussions with students on these topics difficult as the discussions will inevitably delve into deep rooted socio-political beliefs. However, the issues raised by students are also those that must be answered by society. Although discussions of the ramifications of experimental technologies are deemed important by the ITEA, specifics are not offered on how

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such topics can be integrated into the curriculum. This paper offers some concrete ideas and suggestions for incorporating discussions of experimental technologies in the middle level technology education classroom.

Incorporating Technology in the Classroom

Middle school technology education programs across the United States run a gamut from those that have changed very little since the curriculum was known as industrial arts to the very new and experimental. Teaching experimental technologies and devising methods of incorporating them into the classroom curriculum share the common requirement of a well versed technology education teacher. It is less important what experimental technology topic the technology education teacher focuses on than it is that he or she establishes a knowledge base on which students are able to comprehend the processes involved in developing experimental technologies. If the students fail to understand the process—its consequences and its benefits—it is unlikely they will appreciate the value of learning from experimental technologies.

Certainly there are many technology education teachers already incorporating ideas about experimental technology in their classrooms, just as certainly as there are others who resist the idea. Those who are resistant may view the study of experimental technologies as pointless since these technologies often disappear or become obsolete as newer, more improved technologies advance and replace them. However, progress is the nature of technology, and technology education teachers should enlighten their students as to its ever changing nature. The ITEA (2000) made this argument when it asked teachers not to focus on the outputs, but rather on the processes of technology.

Integrating a topic that requires cutting edge technological skills with socio-political ramifications might not be easy, but it can be accomplished. A prime example of an experimental technology topic that incorporates all of these ideas and can be readily presented in a middle level technology education classroom is the use of innovative energy technologies, such as those used in hybrid vehicles. It is true that while hybrid vehicles are no longer experimental, they are certainly not yet the

norm. As the technologies used in hybrids evolve, the technology education teacher must be willing to alter his or her lesson plan to incorporate other new or emerging technologies such as fuel cells, hydrogen vehicles, or other not-as-yet foreseen technologies. All the while the teacher must ensure that the material presented is technically accurate as well as relevant to the economic, environmental, and cultural impact of the technologies.

The facts of hybrid vehicles are easily documented. The number of hybrid vehicles in the United States in 2010 is expected to be in the range of 500,000 to 3,500,000, depending on various factors and on which agency is conducting the survey (Rechtin, 2005 a). The production is led by Toyota, which expects worldwide sales near 300,000 vehicles in 2006. As a percentage of the 16.9 million vehicles on the road, hybrids are still a very small proportion (Rechtin, 2005 a).

The technology education teacher can show students how the numbers of hybrids have grown since the introduction of the first hybrid, the Honda Insight (American Honda Motor Company, n.d.). In the technology education classroom the teacher might present such statistics in pie or bar chart form on a PowerPoint presentation. Not only is this activity easily accomplished, it also lends itself to interdisciplinary study aligned with math classes. The technology education teacher can further interest students by showing them pictures of the vehicles and illustrations of how hybrid engines operate. Should the teacher choose to delve further into experimental technologies, General Motors Corporation (n.d.) offers to teachers an online resource that explains in great detail how the fuel cells work and how they can be used. These and many similar resources make it easier for technology education teachers to stay aware of technologies as they emerge. In the classroom, over the course of a unit, such information will take no more than a few minutes each day to integrate into the lesson.

The example of hybrid vehicles also enables the teacher to apply the ITEA (2000) standards of informing the students of the impact experimental technology has on the environment, the economy and society. The teacher can point out that 16.9 million vehicles are on the road (Rechtin, 2005 a) in the United States, virtually all of which use fossil fuel as their primary source of

power. The teacher might discuss with students the fact that fossil fuels represent a finite source of energy and show the students basic facts concerning the costs of and the pollution generated by fossil-fuel-powered vehicles. A resource for this is www.fueleconomy.gov (United States Department of Energy, Energy Efficiency, and Renewable Energy & United States Environmental Protections Agency, n.d.). This Web site gives the miles per gallon rating of cars in the United States, along with their estimated operating cost for one year. After a brief overview, the technology education teacher might spend 10-15 minutes of classroom time to have students compare the fuel economy of two or three cars and then ask groups of students to compare the benefits and drawbacks of certain cars. Returning to the economical factors discussed earlier, the teacher can demonstrate both the economical and environmental advantage of technologies used in hybrid vehicles.

To foster critical thinking skills among students the teacher might introduce current controversial topics that seem to pit technology against the environment. After presenting both sides of the issues, the teacher can allow the students a few minutes to summarize their opinions on the wisdom of these uses of technology. Those students who believe the technology is not used wisely should be encouraged to pose alternative solutions. By fostering open discussion the teacher invites students to think critically about the ethical burdens, that the use of experimental technologies places upon humans as well as on the entire natural environment.

To address how technologies impact cultures and interactions between cultures, the technology education teacher can introduce historical facts about hybrid vehicles, their origin, and their primary manufacturers (Rechtin, 2005 b). The teacher should ask students to list reasons why this technology developed, and why it is more prevalent in Japan than in the United States. By engaging students in this activity the teacher is exposing the students to the critical issues and values of an unfamiliar culture.

Teachers might further engage students in discussions of the role that technology plays in issues between societies by dispersing facts about United States oil consumption. From 1973 to 2003 the average cost of a gallon of gasoline has risen from

$.039 to $1.59 (United States Energy Information Administration [EIA], 2003). Also during this time the dollar value of imported crude oil entering the United States has risen from 5 billion dollars to over 46 billion dollars, the majority (just under 50%) of that coming from OPEC nations (EIA). These facts about the usage of finite resources lend themselves to political discussions. Certainly this last point is a very contentious issue, but the teacher has the responsibility (ITEA, 2000) to make students aware of how technologies affect cultural relations. While controversial, such discussions present an opportunity for students to consider and discuss options concerning experimental technology, such as when a specific technology will they become economically viable, and what other socio-political factors may aid or hinder its development. As long as the technology education teacher remains neutral and allows students to discuss their opinions in an open, respectful format, such discussions can be a thought provoking and valid part of the lesson.

The hybrid vehicle is just one example of an experimental technology topic that can be presented in the middle level classroom. There are any number of experimental technologies that require the same economical, environmental, and cultural cost/benefit analysis, any of which might be added to a technology education lesson with minimal additional work required from the teacher. By bringing these topics to the classroom, the teacher demonstrates to the students that technologies now deemed experimental may in time affect a profound change in world politics and the world economy. In spite of—and perhaps because of—differing personal opinions, through these discussions students become more aware of the world around them as they become aware of both the positive and negative consequences that experimental technologies present. It is possible that through such discussions a student whose interest is peaked might pursue further study of the experimental technology involved. Even those students who do not pursue further studies of technology have become, at least at the basic level, better informed consumers and have been encouraged to think critically on a given topic, both of which are goals set forth by the ITEA (2000).

Incorporating Technology in the Laboratory

Technology education is a discipline that necessarily incorporates theoretical as well as applied knowledge, and the teaching of any experimental technology topic at any level must engage students both in the classroom and in the laboratory. In addition to researching and discussing experimental technologies in the classroom, it is imperative that students have the opportunity to solidify these topics in the laboratory. The ITEA (2000) noted, "recent research on learning finds that many students learn best in experimental ways – by doing, rather than only be seeing or hearing – and the study of technology emphasizes and capitalizes on such active learning" (p. 5). Given this fact, incorporating experimental technologies into the middle level curriculum should extend beyond the classroom and into the hands-on experience of the laboratory.

The study of experimental technologies, such as the investigation of hybrid cars, is easily integrated into the classroom curriculum, but is it possible to demonstrate the use of such technologies in the laboratory? Exact duplication may not be possible, but it can be simulated. For example, Pitsco Incorporated (2004), in its *Ideas and Solutions 2004 Big Book*, offers numerous kits that utilize experimental technologies such as photovoltaic solar panels and fuel cells. With lab materials consisting of a balsa wood base, wheels, axles, a photovoltaic cell, a small electric motor, battery, wiring, and a phototransistor, the middle level technology education teacher can create a laboratory activity that allows students to brainstorm, design, and ultimately build and test a scale model car capable of running off the photovoltaic cell in the sunlight, but then switching to battery power in the dark. Such an activity allows students to utilize vital technical and problem solving skills while it also demonstrates laboratory applications of classroom discussions. The Project Lead The Way (PLTW) Gateway to Technology (GTT) program offers other suggestions for topics appropriate for middle level technology education classrooms and laboratories. For example, one of the core areas of the GTT program is the "Magic of Electrons." This unit includes such topics as input devices and circuit logic (PLTW, n.d. b), and the activities described meet many, if not all, of the ITEA standards.

Drawing on the applied side of experimental technologies begins to involve a higher level of technical skill and may lead students to investigations beyond the middle level setting, most likely in high schools and beyond. High schools have the ability to offer more focused classes, such as Project Lead The Way (PLTW) classes, which are directed specifically at emerging technologies. The goal of PLTW is to educate the future technicians and engineers of the United States. In fact, PLTW has, in the planning stages, a class entitled Energy and Environment (PLTW, n.d. a). In a class such as this it would be possible for students to develop technical knowledge and skill concerning many experimental energy sources. Students can develop their creative and problem solving skills as they brainstorm their own solutions to potential future energy problems. A unit similar to the one described above, in which students research and build hybrid cars, could be readily integrated into a PLTW program.

Conclusion

Technology education students should be aware of experimental technologies. They should understand the ramifications of items such as hybrid vehicles, photovoltaic solar panels, biometrics, nanotechnology, biological engineering, and hydrogen vehicles. Nonetheless, the focus of the middle level technology classroom should not be on any specific experimental technology. Instead the focus should be on preparing students to think in a logical manner, comprehend the needs of society, solve problems (even those which may not exist at the current time), consider what technological skills society must develop in order to solve those problems, and understand how to use technology ethically. By fully engaging students in the use of experimental technologies at the middle level, technology education teachers make students active stakeholders in experimental technologies. Perhaps the ITEA (2000) offers the best advice to teachers as they begin the task of implementing the teaching of experimental technologies in their classroom and laboratories:

> Because technology is so fluid, teachers of technology tend to spend less time on specific details and more on concepts and principles. The goal is to produce students with more conceptual understanding of technology and its place in

society, who can thus grasp and evaluate new bits of technology that they might never have seen before. (p. 4)

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