EnviroTech: Enhancing Environmental Literacy and Technology Assessment Skills

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It is no coincidence that many of the *Grand Challenges for Engineering* (National Academy of Engineering, 2007-2010)—such as carbon sequestration—address environmental problems that were precipitated by human inventiveness and engineering achievements. Although we recognize our dependence upon environmental processes to provide essential resources and ecosystem services, such as food and air purification, our understanding of the interconnections between the environment and our technological activities has often been insufficient to predict technological impacts upon the environment. As evidence mounts that our technological actions threaten the viability of ecosystems and public health (e.g. U.S.EPA, 2010a), it is imperative that all citizens improve their environmental literacy and technology assessment skills if we are to break this untenable cycle and make progress toward sustainability.

As characterized by *Excellence in Environmental Education: Guidelines for Learning (K-12)*, a standards project of the North American Association for Environmental Education (NAAEE, 2010), environmental *literacy* refers to a unique combination of knowledge and skills that enables informed decision-making. These essential attributes include knowledge of environmental processes and the environmental consequences of human action, inquiry and analysis skills, and an ability and commitment to act. Technological literacy—"the ability to use, manage, assess, and understand technology" (ITEA, 2000) — is the explicit mission of technology education programs in the U.S.. As articulated within *Standards for Technological Literacy* (ITEA, 2000), two content standards and their associated benchmarks mutually support environmental education guidelines (NAAEE, 2010), including:

5. Students will develop an understanding of the effects of technology on the environment.
13. Students will develop the abilities to assess the impact of products and systems. (ITEA, 2000)

Without interdisciplinary understandings and assessment skills that stress the interconnectedness of the human-built and natural environments, teachers and students of technology will not be able to understand or assess how these systems interact and influence each other.

Including the aforementioned standards within *Standards for Technological Literacy* (STL) marked new content for technology education (TE) curriculum. Daughtery's (2005) study of technology teacher educators indicates widespread support for these standards and some graduate programs have included relevant coursework (e.g., Rose & Flowers, 2008). As with most curricular change

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initiatives, the most critical need rests with the estimated 26-36,000 practicing technology teachers (Dugger, 2007) who may not have had formal education related to these standards.

Unfortunately, practicing technology teachers have had few opportunities to build sophisticated levels of environmental literacy, especially within their formal science coursework. McAlister's (2005) survey of 24 technology teacher preparation programs in the U.S. indicated that preservice technology teachers take an average of 8 credits of science (range = 6 to 13) with physics (10 of 24) being the most commonly reported requirement, followed by chemistry (4), and biology (3). Only single occurrences of environmental, life, natural science, and biotechnology were evident in these survey results. This combined evidence suggests that practicing technology educators need professional development opportunities to enhance both their environmental and technological literacy. The EnviroTech Project, made possible by a grant by the United States Environmental protection Agency and Ball State University, aimed to address this need.

EnviroTech Mission and Goals

EnviroTech was a web-enabled professional development project, which occurred in the spring of 2009. This document describes the results of EnviroTech in terms of the impact it had upon a cohort of 19 practicing technology teachers. The mission of EnviroTech was to develop (1) understandings of environmental processes and systems; (2) skills for identifying, analyzing, and assessing the impacts of technology upon the environment; and (3) skills in the use of guided inquiry, an instructional strategy where teachers structure and scaffold the examination of problems and gaps in knowledge. The semester-long project facilitated guided inquiry into two essential questions:

- How might replacing incandescent lamps with compact fluorescent lamps (CFL) impact the environment and society?
- What strategies might individuals and communities use to reduce the negative impacts of replacing incandescents with CFLs?

The adoption of CFLs is a fruitful technology assessment theme because it is conceptually rich in terms of the environment, timely (Energy Independence and Security Act, 2007), accessible to students, relevant to personal health and safety, and relevant to civic responsibility. It is the mercury within CFLs—an average of 4 mg per bulb (Energy Star, 2008)—and the emissions of mercury from coal-fired electricity production—an estimated 0.012 mg/kWh (Energy Star, 2008) —that has the greatest potential for impacting the environment and human health. Mercury, like carbon, naturally cycles through the atmosphere to the soils and water through a process known as mercury deposition. Once back on earth, mercury can be transformed to methylmercury through microbial activity and bioaccumulate in fish and the animals that eat fish, including humans (U.S.EPA, 2010b).

These results may inform professional development providers about the efficacy of this distributed model and provide practicing teachers with instructional models that simultaneously address environmental and technological literacy goals.

Methods

As described below, the one-year EnviroTech project included four distinct phases.

Planning, Recruiting, and Developing

During the fall semester of 2008, project staff planned five web-based seminars, recruited teachers, and developed a web-based portal (http://envirotech.iweb.bsu.edu), evaluation instruments, and teaching and learning resources. Several instructional materials—an instructional guide and a web-based tool for generating a force field analysis—were developed and provided to participating teachers. The instructional guide, *Impacts of Technology on the Environment: Resources for Decision Making* (Rose, 2009), employs life cycle assessment as a framework for teaching and learning. The document is arranged into background information for the teacher, 10 activity sheets for students, and worked examples.

A call for participation generated 26 applications from interested technology teachers; 19 teachers, including 6 females, completed the semester-long project. Teachers resided in nine different states, located within the Eastern Seaboard/Mid-Atlantic (7) and Midwest (7) regions, followed by the South (4) and West (1). The average teaching experience was 15 years (range = 2-34 years). Fifty-three percent (n = 10) were middle school teachers who taught introductory technology courses (e.g., Inventions and Innovations or Technology Today); high school teachers (32%) and an elementary teacher (5%) also participated in the project. Most teachers (74%) had never taken an ecology or environmental studies course. On a 3-point scale from no competence (1) to extremely competent (3), the average rating for teaching others about environmental impacts of technology was 1.8, interpreted as less than competent. However, 18 of 19 teachers reported having formal educational experiences addressing technology assessment; the average competence rating regarding technology assessment was 2.2, interpreted as competent.

Webinars

During the spring of 2009, teachers met once per month for five virtual webinars using *IHETS Interactive*, a technology service of Indiana Higher Education Telecommunication System based upon Adobe Connect web conferencing software. These 70-80 minute webinars enabled synchronous audio and video communications among the hosting instructor, participating teachers, and three guest speakers who were experts in solid waste, environmental education, mercury pollution, and technology assessment. Webinar topics included life cycle assessment, guided inquiry, the mercury deposition cycle, recycling of lamps, hazardous waste collection systems, and forecasting.

Guiding Student Inquiry

All participating teachers planned and implemented a guided inquiry experience with their students, which also addressed the aforementioned essential questions. Sometime between April and June of 2009, about 420 students from 26 separate classrooms participated in EnviroTech inquiry activities. As indicated in Table 1, the largest group of participants was the 10 teachers who delivered instruction to 244 middle school students (6-8th graders).

Table 1. *Teachers and Students by School Level, Sex, and Courses*

Level	Teachers			Students #	Courses
	Male	Female	TOTAL	(%)	
High School	7	1	8 (42%)	136 (32%)	Engineering Processes Engineering Applications Geospatial Technology Digital Electronics Technological Design Technological Issues Foundations of Technology
Middle School	5	5	10 (53%)	244 (58%)	Inventions and Innovations Technology Today Introduction to Technology Computer Technology The Environment and You Communications Systems
Elementary	1		1 (5%)	40 (10%)	Technology
TOTALS	13 (68%)	6 (32%)	19 (100%)	420 (100%)	

As one would expect from an inquiry approach to instruction, the nature of these teacher-planned instructional experiences was quite varied. A content analysis of teachers' end-of-project teaching portfolios was conducted to identify the types of analytical strategies they integrated into instruction. Teachers guided students through experiments with lamps (68%), calculations of the efficiency of lamps (32%), and the analysis of data using graphs and charts (32%) and life cycle analysis (26%). Only two teachers (11%) explicitly noted the use of force field analysis or forecasting as it applied to predicting the potential mercury released into the environment from coal-generated electrical power. Some classes documented their inquiry by producing videos or developing posters about the proper way to dispose of CFLs. Others conducted a home or school inventory of lamps or surveyed parents, neighbors, and custodians to discover the disposal practices for mercury-containing lamps. Teachers invited guest speakers (a lamp recycler and a physician) into their classrooms or took students on a field trip to a fish hatchery to highlight mercury deposition and bioaccumulation in fish. In one instance, a school's Technology Student Association chapter entered their CFL inquiry activity in the Environmental Challenge competition at the state level and took first place.

Insights from the Evaluation Study

Evidence from pretests provides insight into how EnviroTech teachers supported environmental literacy within their classrooms. Comparison of pre- and post-tests also helped gauge the impact of the EnviroTech project upon teachers' knowledge, instructional practices, attitudes, and behaviors. Data were analyzed using SPSS 16.0 and Wilcoxon Matched-Pairs Signed-Rank test, a nonparametric procedure for repeated measures that does not make assumptions about the normality of distributions.

Impact on Teachers: Knowledge Changes

The knowledge assessments, including 18 multiple-choice items, examined teachers' understandings of environmental processes, technological concepts, and technology assessment. Pretest percentages indicated low preexisting understandings on environmental and technology items, including items related to the transformation of mercury into methyl mercury, mercury deposition, retorting, energy efficiency of lamps, and the reason for replacing incandescents with CFLs. In contrast, teachers' knowledge of disposal issues related to mercury-containing lamps was high. For example, over 80% of teachers classified CFLs as household hazardous waste, indicated how to properly dispose of mercury-containing lamps, and correctly identified when mercury was likely to be released into the environment.

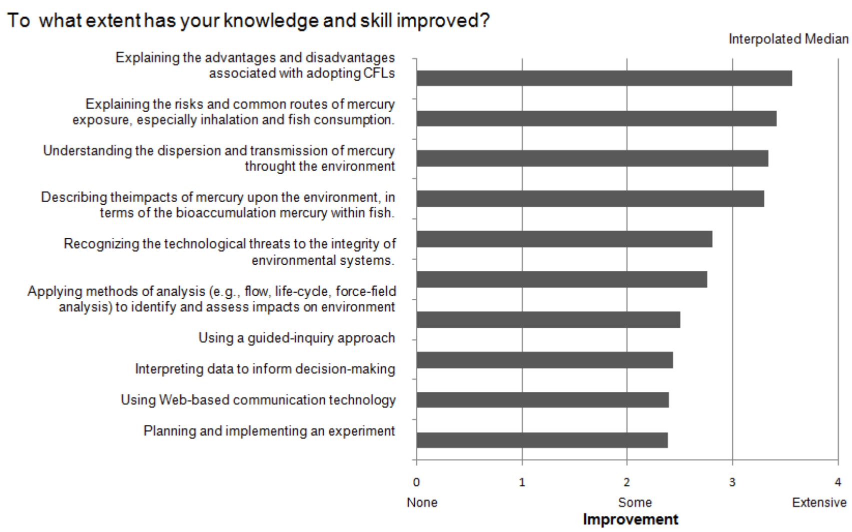
When all knowledge items were aggregated, a Wilcoxon Signed-Rank test indicated statistically significant differences ($Z = -3.839$, $p < .000$) between pre- (Median, *Mdnn* = 11, Range = 9) and post-assessments (*Mdn* = 15.4, Range = 8). As shown in Table 2, the percentage of correct responses increased on all 18 knowledge items, with the highest gain (95% difference) occurring for the item that assessed reasons for replacing incandescents with CFLs. Positive gains, albeit more modest, were seen for other items, including those which measured environmental understandings, such as the transformation of mercury into methyl mercury through bacterial action, the mercury deposition cycle, and bioaccumulation.

Table 2. *Comparison of Knowledge Items on Teachers' Pre- and Post-Assessments*

Items	% Correct **Pretest** N= 19	% Correct **Posttest** N=19	Difference
Technological Knowledge			
Reason for replacing incandescents with CFLs	5	100	+95
Largest source of mercury emissions: coal-fired electricity	42	95	+53
Retorting: Process of reclaiming mercury from lamps	5	53	+47
Energy efficiency of lamps	16	47	+32
How a CFL works	63	89	+26
When CFLs most likely to release mercury into environment	84	100	+16
How to properly dispose of mercury-containing lamps	84	100	+16
CFLs are household hazardous waste	89	100	+11
How most electricity is generated in U.S.	84	89	+5
Environmental Knowledge			
Mercury transforms into methyl mercury through bacterial action	5	58	+53
Mercury deposition	21	68	+47
Bioaccumulation of mercury up the food chain	58	100	+42
Human exposure to mercury through consumption of fish	63	95	+32
Mercury's impact on human health	68	95	+26
Most vulnerable population to mercury exposure	84	95	+11
Technology Assessment (TA)			
Technology assessment as a set of methods	47	58	+11
Results of a TA are used to inform policy and adoption decisions	63	74	+11
Inquiry			
Inquiry is asking questions, gathering and analyzing data, and reaching a conclusion	84	95	+11

Positive knowledge outcomes were also supported by teachers' responses to attitudinal questions. As shown in Figure 1, teachers reported substantial-to-extensive knowledge gains in regards to the advantages and disadvantages of CFLs (*Mdn* = 3.5, Range = 2), routes of mercury exposure (*Mdn* = 3.4, Range = 2), mercury deposition (*Mdn* = 3.3, Range = 2), and describing the impacts of mercury upon the environment in terms of the bioaccumulation of mercury in fish (*Mdn* = 3.3, Range = 2).

Figure 1. *Self-reported improvements in teacher knowledge and skills*



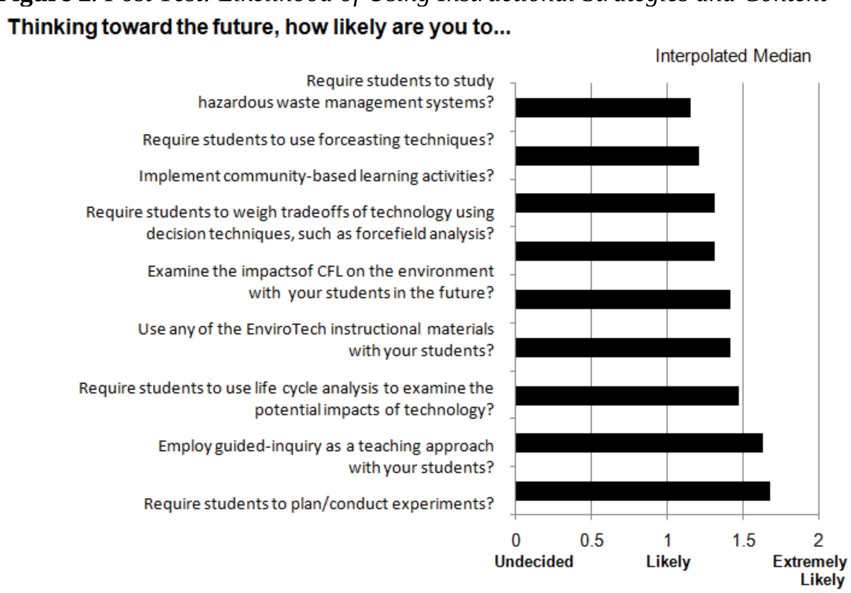
An open-ended question was also posed to teachers: "What is the most important thing you have learned about assessing the impacts of technology on the environment?" The most frequent response related to the value of taking a life cycle or systems approach to teaching about impacts. One teacher wrote, "[we] must consider overall impact, not of the device after manufacture and during its useful lifespan alone, but impacts surrounding creation and final disposition of the device as well." Another teacher pointed out the importance of data-based decision-making when he stated "teaching students to use data collection and analysis in every phase of a product life cycle will enable them to make much more accurate asses[s]ments and informed decisions about technology."

Impact on Teachers: Instructional and Curriculum Practices

In an open-ended pretest question, teachers were asked to "identify and describe the strategies you have used to help students assess and understand the connections between technological decisions and environmental impacts." Class discussions (47% of teachers) were the most commonly cited instructional strategy, followed by literature research (37%), reflection activities (16%), and reports/presentations (16%). To probe directly at the teaching practices advocated by the EnviroTech project, teachers were also asked to identify the frequency that they used guided inquiry, experimentation, forecasting, decision-making techniques, and life cycle assessment. Teachers' reported use of guided inquiry (*Mdn* = 3-5 times/semester) and experimentation (*Mdn* = 3-5) was high with only 11% and 16% of teachers, respectively, reporting that they have NOT used these strategies in the past year. Reported use of forecasting (*Mdn* = 1-2) and decision techniques (*Mdn* = less than 1), such as force field analysis, was lower with 37% and 53% of teachers, respectively, reporting that they have NOT used these strategies.

To better gauge the impact of EnviroTech, items on the posttest asked teachers to think toward the future, and indicate how likely they would be to use these practices with their students. Response items were on a 5-point scale, ranging from extremely unlikely (-2), undecided (0), to extremely likely (+2). As shown in Figure 2, average reported intentions ranged from likely to extremely likely for all instructional strategies, including guided inquiry, experimentation, life cycle analysis, decision techniques, and community-based learning. Given that teachers' past usage of forecasting techniques and decision techniques were low, their intentions to use forecasting techniques (*Mdn* = 1.3, Range = 2) and decision techniques (*Mdn* = 1.4, Range = 2) suggest a positive impact of the project.

Figure 2. *Post Test: Likelihood of Using Instructional Strategies and Content*



Additionally, an open-ended question was asked; "What is the most important thing you have learned about the guided inquiry approach to instruction?" Teachers pointed to the value of posing relevant essential questions and requiring students to gather and analyze evidence. One teacher wrote, "students feel the responsibility inherent in pursuing answers to questions that the adults in their lives have yet to answer as well. We need to engage learners in the pursuit of these answers and let them know that we are counting on them to do their best to help find solutions." Another stated, "The guided-inquiry approach has the ability to deepen student engagement in a significant way. By asking students to gather the data that they use to base their decisions, instructors give their students the chance to discover, question, and analyze, all of which are higher-level thinking skills."

Environmental Concepts and Principles

Responses from the pretest indicated that opportunities to build environmental literacy within technology courses are inconsistent. When asked how strongly teachers agreed or disagreed with the statement "My students have the opportunity to develop environmental literacy," the average response was tending to agree (*Mdn* = .64, Range 4) on a 5-point scale, where +2 = strongly agree, 0 = neutral, and -2 = strongly disagree. However, when asked to "list the environmental concepts and principles that you address in your technology courses," 21% of teachers indicated that no environmental concepts and principles were taught. A thematic review of the teachers' responses to this question yielded five main themes, including ethics/responsibility/action (53% of responding teachers), energy (47%), impacts of human activity on the environment (47%), wastes/pollution/disposal issues (42%), and environmental issues and concepts (37%). Within the ethics/responsibility/action theme, common responses revolved around individual decision-making as it related to the green design, production (e.g., building green), consumption, recycling of products and structures, and one's carbon footprint.

The most elaborate expressions occurred within the energy theme. Teachers indicated that they compared alternative and traditional sources of energy, addressed the impacts of extracting and converting energy to produce electricity, and focused students upon energy efficiency. Within the environmental issues and systems category, most descriptions were undeveloped with only general references to *ecosystems* and *ecology*. Greenhouse gases/global warming (*f* = 4 examples) and ground water (*f* = 3) issues were the most frequently occurring topics. Only single references were made to such important environmental issues as *deforestation*, *acidification*, and *over-population*; no explicit references were made to *interdependence of systems*, *food chains*, or *bioaccumulation*.

Nine items asked teachers to indicate how frequently teachers required students to address sustainability concepts when designing or assessing products. Response items were on a 4-point scale ranging from Always (+3) to Never (+0). As indicated in Table 3, the most frequently emphasized concept was *economic value* (*Mdn* = 2.0, Range = 3.0). The least emphasized concepts were *toxicity* (*Mdn* = 1.0, Range = 3.0) and *embedded energy* (*Mdn* = 1.0, Range = 3.0), with 37% of teachers indicating that they never required their students to address these concepts.

Table 3. Pretest: Frequency that Teachers Require Students to Address Sustainability Concepts

When students design or assess a product or system, how often do you require them to consider the following sustainability concepts?	Frequency[1] N=19 Always *f* (%)	Often *f* (%)	Occasion-ally *f* (%)	Never *f* (%)	Median[2]
Energy Efficiency	0 (0)	9 (47)	5 (26)	5 (26)	1.3 (2.0)
Reusability	2 (11)	8 (42)	6 (32)	3 (16)	1.5 (3.0)
Local Availability	2 (11)	5 (26)	7 (37)	5 (26)	1.2 (3.0)
Renewability	1 (5)	7 (37)	6 (32)	5 (26)	1.2 (3.0)
Biodegradability	2 (11)	3 (16)	8 (42)	6 (32)	0.9 (3.0)
Toxicity	1 (5)	4 (21)	7 (37)	7 (37)	0.9 (3.0)
Value ($)	5 (26)	6 (32)	6 (32)	2 (11)	1.8 (3.0)
Recyclability	1 (5)	7 (37)	8 (42)	3 (16)	1.3 (3.0)
Embedded Energy	1 (5)	4 (21)	7 (37)	7 (37)	0.8 (3.0)

[1] Responses ranged from “Always (+3), to Never (0)”.
[2] Calculated from grouped data.

Several items on the posttest attempted to gauge the impact of EnviroTech on teacher’s commitment to addressing sustainability concepts and principles in the future. As indicated in Table 4, the likelihood that teachers will require students to address energy efficiency, reusability, biodegradability, and toxicity when assessing technology (*Mdn* = 1.6, Range = 1) and designing products and systems (*Mdn* = 1.6, Range = 2) is toward extremely likely and suggests an intent to integrate these concepts into the technology curriculum.

Table 4. Post Test: Likelihood of Addressing Sustainability Concepts and Principles

Thinking toward the future, how likely are you to:	Likelihood Responses[1] Extremely Likely *f* (%)	Likely *f* (%)	Undecided *f* (%)	Unlikely *f* (%)	Extremely Unlikely *f* (%)	Median[2] (Range)
Require students to address sustainability principles (e.g., energy efficiency, reusability, biodegradability, and toxicity) when assessing technology?	11 (58)	8 (42)	0	0	0	1.6 (1.0)
Require students to address sustainability principles (e.g., energy efficiency, reusability, biodegradability, and toxicity) when designing products and systems?	11 (58)	7 (37)	0	0	1 (5.3)	1.6 (2.0)
Require students to study hazardous waste management systems?	9 (47)	5 (26)	4 (21)	1 (5)	0	1.3 (3.0)

[1] Responses ranged from "Strongly Agree (+2), Tend to Agree, Don't Know (0), Tend to Disagree, to Strongly Disagree (-2)"; [2]Calculated from grouped data.

Teachers were also asked to state their agreement with statements that probed teachers' judgments about the appropriateness, or value of, specific actions advocated by the project. As shown in Table 5, 68% of teachers strongly agreed that sustainability concepts and principles should be emphasized in the technology education curriculum. Furthermore, 74% of teachers strongly agreed that examining the impact of CFLs and fluorescent lamps on the environment is a meaningful way to meet Standards 5 and 13 of *Standards for Technological Literacy* (ITEA, 2000). To a lesser degree, teachers were in agreement that the CFL activity improved the environment literacy (*Mdn* = 1.35, Range = 4) and technological literacy (*Mdn* = 1.1, Range = 4) of their students.

Table 5. *Post Test: Teacher agreement*

Please indicate how strongly you agree or disagree with the following statements:	Agreement Responses[1] Strongly Agree *f* (%)	Agree *f* (%)	Neutral *f* (%)	Disagree *f* (%)	Strongly Disagree *f* (%)	Median[2] (Range)
Examining the impacts of adopting and disposing of CFLs and fluorescent lamps is a meaningful way for students to meet Standard #5 and 13 of the Standards for Technological Literacy (ITEA, 2000).	14 (73.7)	4 (21.1)	0	0	1 (5.3)	1.7 (4.0)
The technology education curriculum should emphasize sustainability concepts and practices.	13 (68.4)	5 (26.3)	0	0	1 (5.3)	1.7 (4.0)
This activity improved my students' environmental literacy.	8 (42.1)	9 (47.4)	0	0	2 (10.5)	1.4 (4.0)
This activity improved my students' technological literacy	3 (15.8)	14 (73.7)	0	0	2 (10.5)	1.1 (4.0)

[1] Responses ranged from "Strongly Agree (+2), Tend to Agree, Don't Know (0), Tend to Disagree, to Strongly Disagree (-2)"; [2]Calculated from grouped data.

Attitudes and Behaviors about the Impacts of Technology

Teachers were asked to state their level of agreement to nine general statements about relationships among the environment, technology, and society. For example, "The way people dispose of products can negatively impact the health of others." Items were aggregated and statistical comparisons of pre- and post-tests were conducted using the Wilcoxon Signed-Rank test. No significant differences ($Z = -.243$, $p = .808$) were found between pre- and post-tests. Given the self-selected nature of participation in EnviroTech, participants may have been predisposed toward these issues.

In regards to the purchase and disposal of CFLs, however, evidence indicates that the EnviroTech project impacted personal decision-making. On the pretest, only 47% of teachers reported that they dispose of CFLs by taking them to a hazardous waste collection site. On the posttest, 100% of teachers responded that were extremely likely (79%) or likely (21%) to take a spent CFL or fluorescent tube to a hazardous waste collection site. While 95% of teachers indicated that they were likely (32%) or extremely likely (63%) to replace incandescent lamps with CFLs on the posttest.

Teacher Attitudes: Most and Least Effective Elements

The final items on the posttest asked teachers to identify the most and least effective elements of the EnviroTech project and the webinar format. According to frequency of teacher responses, the most effective elements for improving professional skills were: an appreciation for the information presented in webinars ($f = 7$), working and sharing with other teachers ($f = 5$), the technology assessment methods, and information about CFLs and mercury ($f = 4$). For instance, one teacher noted it was the "knowledge gained through webinars regarding Mercury, but also what students found on-line as they answered their own questions." When asked about the least effective element, the only reoccurring comment related to the difficulty of some topics ($f = 2$), such as forecasting, force field analysis, and the mercury deposition cycle. One teacher stated, "Not sure that the forecasting, at least as demonstrated, would be something I could get students to do, I struggled to keep my attention focused, and I am sure the students would have more trouble than I."

In regards to the distributed webinar format, teachers overwhelmingly appreciated the ability to participate in a discussion with people from across the U.S. ($f = 8$), noted the convenience of "anytime-anyplace" access ($f = 5$), and the recordings of webinars ($f = 3$). Comments regarding ineffective elements of the webinar included technical difficulties regarding the audio elements of the conferencing system ($f = 9$). When asked "how likely are you to enroll in another professional development course which uses a webinar format," all teachers responded in the affirmative with 79% of teachers indicating that they were extremely likely to do so.

Conclusion

Several *Standards for Technological Literacy* (ITEA, 2000) share common elements with environmental education guidelines (NAAEE, 2010) including the standards/guidelines that speak to examining the environmental impacts of technologies and technological systems and to developing inquiry and analysis skills. However, technology teachers may be ill-prepared, lacking the pre-requisite knowledge and skills they need to integrate environmental concepts and processes into their curriculum and teach technology assessment skills. The EnviroTech project—with its use of distributed webinars, semester-long engagement, and local implementation of guided inquiry projects—demonstrated a viable model for addressing these professional development needs. EnviroTech focused teachers and their students upon a single contemporary consumer decision (adoption of CFL vs. incandescent lamps) and then provided the information, resources, and examples they would need to help their students assess the impacts this decision might have upon the environment and human health.

Prior to starting the project, participating technology teachers reported narrow examples of environmental concepts and teaching strategies used to help students learn how to assess the impacts of technology on the environment. As evidenced by teacher portfolios and pre-/post-assessments, teachers expanded their understanding of environmental processes—especially the mercury deposition cycle and bioaccumulation—and sources of human exposure to mercury, and expanded their repertoire of instructional strategies to include experimentation, calculations of energy efficiency, and comparing lamps and sources of mercury using graphs. Teachers reported strong commitments to implement a broader range of instructional strategies (e.g., life cycle analysis and forecasting) and strong intentions to integrate sustainability principles (e.g., energy efficiency, recyclability, toxicity, and biodegradability) into their student's assessment and engineering tasks in the future.

Although these teachers strongly agreed that examining the impact of CFLs and fluorescent lamps on the environment is a meaningful context by which to meet Standards 5 and 13 of STL (ITEA, 2000), it is clear that achieving these standards will require much more focused efforts from curriculum developers, researchers, teacher educators, and others who deliver professional development experiences to technology teachers. Assessing technology requires sophisticated understandings of the environment and technology, as well as the inquiry and mathematical skills that enable learners to analyze and predict potential impacts. We need to test promising pedagogies that weave together multidisciplinary knowledge sets and engage students in authentic assessment tasks. Life cycle analysis, forecasting, and data-driven decision-making—such as force field analysis—are powerful tools for assessing the impact of technology on the environment. We still have much to learn about how and when to use these analysis tools in a technology classroom. An examination of lighting choices, coal-fired electricity generation, and the mercury deposition cycle is but one example of how we could simultaneously enhance the environmental and technological literacy of teachers and their students. But the important outcome is that we develop both the skills and will to make environmentally-sound, better-informed decisions about the technology we adopt, design, use, and discard.

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