AC 2011-1212: IMPROVING TECHNOLOGICAL LITERACY THROUGH
THE USE OF NEWS ARTICLES

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Introduction

A new course, Science, Technology and Public Policy, was first offered at Community College of Philadelphia in the Fall of 2009. The course is designed to promote technological literacy by introducing students to basic scientific principles in Biology, Chemistry and Physics, showing how these principles are applied in areas such as biotechnology and nanotechnology, and exploring societal issues related to these technologies. An intended outcome of the course is that students will be able to apply this framework to a technology not explicitly covered in the class. Assessment of this outcome is based upon student performance on a final project, where they are asked to do just that.

Technological literacy has been defined as “an understanding of the nature and history of technology, a basic-hands-on capability related to technology, and an ability to think critically about technological development.” Providing an explanation and developing an understanding of the basic science and scientific techniques employed in the application of these technologies touches upon the first part of this definition. Using that background to make and support a personal decision regarding the use of these technologies would address the third part and what is probably the most critical part of the definition. It is essential that “ordinary citizens [are able] to make thoughtful decisions on issues that affect, or are affected by, technology.” “Science and technology are so pervasive in modern society that students increasingly need a sound education in the core concepts, applications and implications of science” in order to function as citizens in a democratic society charged with making long-term decisions on these emerging technologies.

The course, Science, Technology and Public Policy (ASET 101) is a 3 credit, non-lab science course. It is a required course in the Applied Science and Engineering Technology curriculum, but also fulfills the science general education requirement at the institution, and so appeals to a broader audience than those specifically in the curriculum. In addition, the course is open to higher level developmental students as well as high school students through a dual enrollment program, thus providing an opportunity for students to explore science, technology and related societal issues early in their academic career. Students who are still deciding on academic and/or employment goals may also find the course helpful in that it provides an overview of several different career directions and pathways in STEM fields.

The overall goals of the course are:

- Increased technological literacy
- Increased awareness of, and interest in, pursuing science/technology curricula/careers
- Increased retention rates of students

In order to assess the effectiveness of the course in helping students achieve a level of technologically literacy, we have examined their work carried out in the final project, where students work in groups of three, and are assigned to review a technology that has not already
been covered in class. Each group is expected to provide a description of the technology and what it is used for, discuss the underlying scientific principles that make the technology possible, ascertain the positions of various stakeholders who may favor or oppose use of the technology, identify public policy questions that are important regarding the use of this technology, and finally, to state their own individual position on use of the technology. (The final project was more extensively described in a previous paper.\textsuperscript{5})

Overall grades for the final project during that first year were satisfactory, with a more or less normal distribution around the grade of “C.” (n = 99)

![Final Project Grade Distribution](image_url)

While this is certainly not an unreasonable grade distribution, it does indicate that a majority of the students are missing, or only minimally grasping, important ideas central to the attainment of technological literacy.

A closer review of student work during the first year of the course showed mixed results, with students generally able to explain a technology and the advantages and disadvantages of using the technology, but often showing weakness in differentiating between science and technology, explaining the scientific foundation of the technology, and discussing public policy implications.

These results indicate a need to help students better understand the distinction between science and technology, and their relationship with public policy.

What went wrong?

Our overall approach in ASET 101 has been to provide students with factual knowledge related to the scientific underpinnings and applications of a particular technology, and present that information in the context of understanding trade-offs and limitations inherent in the use of any technology. By providing an overall framework for looking at the intended and unintended consequences of using various technologies, it was our hope that students would be able to apply this framework to other technological advances not covered in class. Fostering this ability in students falls under the broad definition of technological literacy. Our results during the first year the course was offered, however, were not completely satisfactory.
We believe that the overall premise of providing students with a framework for a technologically literate approach is sound. One of the key findings of “How People Learn” is that “To develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.”

It is our assumption that we have provided a sound conceptual framework for our students. Therefore, our next line of inquiry is to focus on the delivery method—are we teaching the framework effectively?

Our general approach during the first year was to model the framework. For example, in the biotechnology module, we introduce the idea of genetically modified crops. Students typically are unaware that there are many food products they consume on a regular basis containing ingredients that come from genetically modified crops. There are also typically many misconceptions about what it means for a crop to be genetically modified.

We walk students through a process of defining what exactly the technology is, the scientific foundation of the technology (DNA, protein synthesis, modification of DNA, etc.). Then we have students explore positive and negative effects of using the technology from the perspective of different stakeholders (small farmers, consumers, agri-business, etc.). Finally, students are asked to express their own opinion on whether this technology should be utilized, and defend their position with factual information.

A similar process is carried out in relation to process technology and nanotechnology. In this way, we have modeled the framework we want students to learn, and walked them through it, three times. During the final project, students are asked to apply this framework on their own.

It was our initial supposition that simply modeling this framework would be sufficient for students to understand and apply it. That is, students would be able to transfer their learning in biotechnology, process technology and nanotechnology, to carry out a similar analysis of some other technology, such as wind power, geothermal power, and so on. As noted above, however, the results of our experiences during the first year of the course have demonstrated that this approach has not been optimal, to say the least.

In his book, “Why Don’t Students Like School?,” Daniel T. Willingham states that transfer can be limited in two ways. Either students do not understand the deep structure of the issue they are exploring, or they understand it, but do not see how the surface structure (that is, the particular details) of the problem they are trying to solve maps to the deep structure. In terms of ASET 101, the deep structure would be the overall framework we are introducing to students, while the surface structure would be the specific technologies the students are investigating.

What strategies does Willingham recommend? One is to provide multiple examples, and to point out the deep structure that is common to these examples. “How People Learn” also addresses this point: “A key finding of the learning and transfer literature is that organizing information into a conceptual framework allows for greater “transfer”; that is, it allows the student to apply what was learned in new situations and to learn related information more
quickly.” Another strategy is to give students lots of practice working through problems on their own to help them gain a greater understanding of the deep structure. Willingham says, “... practice helps transfer because practice makes deep structure more obvious.”

In order to improve outcomes, and to better integrate issues currently in the news, a new ongoing assignment, “Technology in the News” (TIN) was developed and introduced during the Fall 2010 semester. Throughout the semester students read a variety of current news reports of issues that are strongly related to technology, such as oil drilling, hydraulic fracturing (currently a major issue in our state), biotechnology, and so on. Students are asked to identify and differentiate technology, science and public policy issues, as well as understand the position of various stakeholders. Students are also asked to come to a preliminary personal position on the subject/technology at hand, and to identify additional questions they have about the topic. The repetitive assignment format, applied to a range of technologies that appear in the news, provides a consistent structure for students to reinforce the framework we want them to apply with multiple examples, and provides them the practice in doing so. This also provides an opportunity for formative assessment of student effort during the semester to provide ongoing guidance to students as they develop a more sophisticated level of technological literacy.

The assignment was utilized four times during the Fall, 2010 semester. Assessment of the effectiveness of the “Technology in the News” assignments once again is based on the summative review of the student’s final project, where they work with a group to independently analyze a technology (as well as the science behind it and the societal issues that arise from it) that has not been covered in class.

Results from the new assignment

By one measure, the new assignment has been very successful. During the standard survey of teaching that students complete during the end of each semester, instructors have the option of adding additional questions. Two questions were added related to the TIN assignment: Students were given statements and asked the extent to which they agree or disagree with the statement, with a 5 being “strongly agree” and a 1 being “strongly disagree.”

The first statement related to the TIN assignment that students were asked to respond to was: “Because of the Technology in the News assignments, I have a better understanding of how technological advances affect society.” With 36 students responding to the statement, the weighted average was 4.34.

The second statement that students were asked to respond to was: “The Technology in the News assignments provided a good way to think about technology in relation to science, stakeholders and public policy issues. The weighted average was 4.19.

While this is a good indicator that students find the assignment useful in achieving the goals we set out for them in the course, it is not a direct measure of actual student success or improved performance as a result of the assignment.
For that, we need to look to the results of student work on their final project, and compare the quality of their work to that achieved by students in the semesters prior to the TIN assignment. Specifically it is important to review not only the overall scores on the final project, but also sub-scores earned on the sections of the project related to explaining the science underlying the technology and public policy questions.

The distribution of grades for the final presentation showed overall improvement, with a larger percentage of students receiving a grade of “B,” than had been the case in the previous year, as can be seen from the graph below. (n = 48)

![Final Project Grade Distribution](image)

Examination of sub-scores in the science and policy sections of the project were mixed. Students showed a slight improvement in explaining the public policy issues, showing an improvement of approximately 5% in their scores. However, when it came to explaining the underlying scientific principles, there was actually a decline of approximately 4% in the scores. The overall improvement in overall grades for the project appears to come primarily from improved organization of students’ presentations.

Conclusions and Future Directions

Results so far are promising, though inconclusive due to the small sample size and mixed results. We will continue to use the Technology in the News during the Spring 2011 semester, with two modifications. First, we plan to utilize the assignment more frequently, providing additional practice and formative assessment to the students. Second, we plan to incorporate additional classroom discussion to help students understand the difference between science and technology, and to understand how new technologies impact society, thus raising public policy questions.

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2 ibid
5 ibid.
8 ibid.