AC 2010-1138: VENUES TO INTRODUCE AND TEACH IMPACT OF ENGINEERING IN HISTORY, SOCIETY, AND HUMAN DEVELOPMENT

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A technological literacy approach to introduce and teach the impact of engineering throughout the human history

Abstract

This paper provides a possible approach to introduce and teach impact of engineering to non-engineering students with a focus on the technology and engineering aspects. One effective way to enhance technological literacy is to offer classes that will introduce, explain, discuss, and enhance students' knowledge about engineering and the impact of engineering on the society. There are many effective classes that are offered in history and philosophy schools such as history of science, history of technology and related areas. However, this paper focuses on the impact from the technologist perspective. The paper introduces the general premise for such a class and provides different models to review the impacts from historical and technological developments. For instance one could focus on water, construction and road development, medicine, weapons, tool making, and other venues of introducing the subject. The paper introduces effective approaches to offer the class and reviews the impacts of engineering and technological developments through focusing on one of the topics. In order to help future developers, this paper defines the topic and discusses how focusing on each topic enables the class to show the impacts throughout the human developments and eras.

Introduction

Technological literacy serves many purposes in enhancing a non-engineering student's education. Many students are interested in learning how various technologies work that they may encounter in their future careers. Other students intend to work with engineers and pursue a greater appreciation and practical understanding of the responsibilities of their future co-workers. A significant purpose of technological literacy is to enhance the understanding of technological impacts, allowing for better decision making and understanding of the many externalities of technological advancements. To teach this concept to non-engineering students, we propose a process utilized in the Fall of 2009 in E ST ***at ********* University. This approach focuses on student interest and explores different topics that introduce the impacts of engineering throughout human history.

Current Approach to Technological Literacy

Current classes that teach the concept of technological literacy in collegiate education appear to focus either on a philosophical discussion of technology or the historical development of technology. This is evident through experience in the university setting regarding available courses as well as through relevant research.

Each of these approaches has its benefits. Focusing on the historical design and evolution of certain kinds of technology allows students to develop an understanding and appreciation of the origins of technology and fundamentally asks how technology works and why it developed in the way it did. Technological philosophy courses encourage students to question technology, its

moral and ethical purposes, and how technology fits within society. Both approaches have proven valuable in the field of technological literacy.

Course Overview

This course is innovative in both the content and the curriculum design. The content combines the conventional approaches of philosophy and history to address the whole picture of technology. The intent is to develop an overarching understanding of technology that identifies not only the who, what, where, and when of a technological innovation through historical lessons but also addresses the why and the how of a technology's impact on society through philosophical discussion.

As well as utilizing two fields of thought on technological literacy, this course heavily emphasizes a curriculum design of personal relevance. The concept of personal relevance in classroom education is not drawn upon often, though students with personal motivations and goals in their learning may embrace the individuality and find more meaning to their education[1]. Technology is a vast topic that may overwhelm and discourage students unless addressed in a way that is meaningful. The personal relevance approach encourages these students to identify their specific goals and tailor their learning to areas that will benefit them in the long run. The specifics of this approach in this class will be discussed later.

The course outline may be divided into a discussion of content and a discussion of curriculum design. The content of the history of technology and the philosophy of technology concepts were both addressed through weekly reading assignments and discussion. Personal relevance was encouraged throughout, though it is primary addressed through the paper and presentation portion of the course. Each of these areas will be discussed individually.

Assignments and Discussion

The history of technology and the philosophy of technology concepts were both addressed in this course through assignments and class discussion days. The course met twice a week and students would typically receive an assignment each day that would be discussed the next class period. At the beginning of the semester, the students and instructor dedicated a class period to discussing potential topics to cover for the semester. To identify topics that would be most interesting and practical to non-engineering students, the class began by discussing a paper from a previous student that identified several possible subject areas to explore. These subject areas were primarily military technologies suggested due to the student's personal interests, and from this student's suggestions the class determined that understanding the impacts of technology would be most beneficial if students had personal interest in the subject matter. The specific technologies and technological issues to cover in a class on technological literacy can change depending on the students' interests as well as what the current popular technologies are in society. For the Fall 2009 class, students recommended the class explore engineering innovations of the ancient civilizations of Greece, Persia, Rome, and Egypt, read texts on education in technological literacy, and explore the lives and innovations of inventors and scientists such as Henry Ford, Thomas Edison, and Nikola Tesla. The assignments explored these areas through

different media sources, including book chapters, journal articles, and parts of documentaries. For example, several assignments related to the engineering innovations of the ancient civilizations included documentary portions from the Building an Empire series from the History Channel.

For each assignment, a student was chosen to lead discussion the following class period on the subject matter. All students were expected to be prepared to discuss the material. This included reading the assignment and taking notes. The selected student would prepare a summary, discussion points, comments, and any particular questions the student had about the material. Though this material did not have a page length requirement, it was typically 1-3 pages. This encouraged accountability on the part of the student but also on his or her classmates, as the student would have the freedom to call upon a classmate for discussion or commentary. This particular approach of assignments and discussion days was best suited to expand the students' knowledge of the historical events surrounding technology, as it provided the structure of reading and writing familiar to many college classrooms.

This approach also followed the personal relevance concept in curriculum design. Personal relevance in technological courses encourages inquiry into technology, not just a recitation of facts or concepts[1]. The intent of the assignments was to provoke thoughtful discussion that did not necessarily follow a specific outline of questions or facts, but followed the interests and questions of the students. By the end of the class period, students developed ideas that were not simply found in a book but were discovered through conversation and inquiry.

Paper and Presentation Portion

The paper and presentation portion of this class specifically addressed the concept of personal relevance by allowing students to pursue topics that met their individual goals. At the beginning of the semester, each student chose a broad societal area to explore technologically, and often the student's academic interests and major influenced the area he or she chose to research. One student, a business major, decided to research currency and the impacts of this technological practice. Another student, with coursework interests in water resources, chose to explore historical and current water technologies and how these technologies influenced societal development.

The research paper was a semester long project intended to allow students to delve deeper into a particular subject area of technology that interested them and would drive their interest for the entire semester. The general requirements were to select a broad subject area that related to technology, cover the historical aspects of the technology, and address the impacts of this technology. All paper topics had to be approved by the instructor to be considered acceptable. The paper did not have a length requirement, although five pages was considered the minimum needed for a quality project. The paper required at least 10 sources, although more sources were highly encouraged.

The class met twice a week for an hour and a half, and once a week or once every two weeks a class period was dedicated to discussion of the research projects. During these class periods each student would provide an update on their progress, and the rest of the class as well as the

professor would give feedback and suggestions. The students were given deadlines for the abstract, the outline, and the final paper and two class periods were set aside at the end of the semester for presentations on the paper subject matter. Students were given half an hour for each presentation, and PowerPoint slides were encouraged as visuals to cover the material.

Course Effectiveness

This approach to the study of technological literacy by non-engineering students is primarily based on the personal relevance concept to ensure student identification with the subject matter. One of the difficulties in teaching engineering subject matter to non-engineering students may be the technical and specific nature of the material. While one student is intrigued by the intricacies of computer hardware, another may be more interested in manufacturing processes or roadway design. This class operated with a standardized structure of class assignments and discussion, but the subject matter varied based on student interest. This allowed each student to pursue material that interested them within the confines of the basic requirements of technological impacts. With the paper and presentation, students drew on other classes and other academic interests to research a topic that would be most helpful to their future studies. The in-class assignments allow the professor to tailor the learning to the students' interests while still ensuring that specific areas, such as engineering in ancient civilizations and the impacts of important people in engineering history are addressed. The student led discussions ensure accountability and class interaction on the subject matter.

The effectiveness of this course can best be modeled by a consideration of a student in this course. This student was majoring in the environmental sciences and pursued technological literacy coursework to expand her understanding of technology as it impacted water resources in particular. Her intentions with the class were to ensure that her knowledge was well rounded by considering not only the sciences in her studies but also the practical applications of technology towards her field of study. Her paper topic was the historical impact of water engineering and how these technologies continue to raise ethical and moral questions in society today, effectively combining both the philosophy and the history of technology that define this course.

This student's passion for this subject matter within her technological literacy education influenced her classmates and her future in a positive manner. During the class she would suggest assignments involving sanitation, drinking water and irrigation, and her interest and knowledge of the subject matter influenced several class discussions that drew in related technological areas of city planning, flood retention, and agriculture. Her interests influenced two other students to pursue topics related to water resources for their final papers. As of this writing, this student intends to pursue a career in the law, focusing on laws related to the water resources and the technologies that she learned in this class. Her story emphasizes how personal relevance positively impacts the motivation of students in the classroom, and can have a lasting impression on students in the class.

Potential Topics

The students in this class explored broad societal areas that defined and were defined by technological innovation for their paper assignments. Their individual non-engineering majors and academic interests influenced their pursuit of engineering and technology in certain subject areas. This allowed the class to bring engineering impacts and understanding to these students on a personal level. Each of these topics may be used individually to teach engineering impacts to students.

One student explored the historical and current technologies in the field of medicine. There are countless examples of how lives have improved, been affected or altered because of the advancement of technology in certain fields and it was this student's belief that technological advancements in medicine had the greatest impact on human life. Technology is in our everyday lives, and without the advancements in medicine and technology society may have evolved differently. From research on stem cells, the advancement in technologies in the fields of nanotechnologies and ultrasound technologies, and improvement of vaccines and treatments or the ordinary seasonal flu. The amount of money and research that is devoted to a cure for cancer is reason alone to realize that the advancement of technologies in the field of medicine is very important to pursue. With changes daily, medicine will always be evolving and improving and is an area that could be pursued in a class on technological literacy[2].

Another student, interested in pursuing technology related to his business major, chose to explore technological advancements in currency. Over the course of history, currency used by humans has evolved and advanced. Money has a technology of its own. In the way automobiles have improved, the technology of money has developed as well.   Early civilizations of the world built on bartering eventually leading to coins and paper currency today. Advanced forms of currency like debit cards seem to be leading to a paperless society. Throughout this process, problems such as inflation and the global financial crisis have arisen[3].

Another student chose to focus on agricultural advancements throughout the different ages of societal development. The pre-agricultural time period focused on hunting and gathering, but technological innovations such as irrigation, higher quality tools, and systematic crop production allowed food provision to be more efficient. Through the Bronze Age, Roman agriculture, agriculture of the Middle Ages and industrialized agriculture improvements in machinery and irrigation continued to improve crop production and allowed societies to grow. Agricultural technologies continue to develop with more improvements to farm equipment efficiency and genetically modified crops. The impacts of engineering and technology in agriculture may be seen with settled populations and improved and increased crop production[4].

One student prepared a more extensive work than her classmates due to her academic interests and research in a previous class. This student previously researched water engineering in another technological literacy course. While that course concentrated on how the technology worked, this particular course focused on the historical impacts of the technology on society. This student utilized her other coursework in the environmental sciences and her previous research to further develop her understanding of water resources technology. Throughout history, engineers sought to address problems of hunger, disease, trade, transportation, and perhaps most intuitively, thirst through the control of water resources. The methods to solve these problems varied, from utilizing natural processes to manage water movement to building large structures to control and

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force the motion of water in certain ways. Today, many of the current water management technologies are original or evolutions of ancient designs. The impacts of these water engineering technologies are many and can be witnessed most directly in the growth of global human population, as the sum of these technologies has allowed the human population to grow exponentially. Any one of these subject areas of medicine, currency, agriculture, or water resources has a far-reaching impact across society and a multitude of technological advances to explore should it be adapted to a semester long course[5].

Future Classes

The material of these topics on technological literacy may be used for future classes, to either develop into a semester long course on one topic, combine the different subject areas, or to identify new venues to explore. In the classroom, students may read the papers from these students and either find that one of these topics interests them or find new questions and areas to explore. Each paper provides articles, websites, and books on every impactful issue that can be used for future reading. A professor may use specific questions from students to find new readings and assignments that are tailored to the interests of this specific group of students.

Conclusions

To teach the impacts of technology and engineering in a technological literacy course, we propose focusing on combining both the philosophical and the historical areas of technology, providing a personal relevance curriculum design and exploring different topics that introduce the impacts of engineering throughout human history. The class at **** ****** University in the Fall of 2009 taught the concept of the impacts of technology through a research paper, presentation, and class discussions and assignments. Throughout each portion of the course, the students followed the historical evolution of technology to identify the technological impacts over time. The students in this class chose to pursue medicine, agriculture, currency, and water resources, and either these or other topics may be utilized to teach this concept. Student direction and input made this course more approachable to non-engineering students and allowed them to identify more easily with technological concepts. We have found that this design for impacts of technology to enhance technological literacy was effective, and that a similar design could be effective at other institutions.

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