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The Making of a Technology Literacy Course

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The Making of a Technology Literacy Course

Abstract

Our school is an urban, state-supported university and the engineering programs at this institution have been instrumental in providing educational opportunities for under-represented groups of minorities. In a society that becomes more and more dependent on technology, higher education should have at its core a fundamental goal to provide every student with the ability to understand the social, political, economic, and ethical implications of new technological developments.

This paper will present the reasons for creating this kind of course and how it is designed to help students discover how modern technology affects society and how they can use it to improve their cognitive skills, analysis, synthesis, and evaluation. The course was built to provide opportunities for students to explore the positive and negative aspects of modern technology, understand the social, political, economic, and ethical aspects of issues that are impacted by advancement of technology, and realize how to utilize it for the benefit of humanity. The course is structured to provide students with an environment conducive to a free exchange of ideas and open dialogue.

To instill the principles of teamwork, students majoring in various disciplines are organized in groups to work together on a variety of subjects. An assessment process is in place to evaluate the effectiveness of the course in meeting the course objectives. This paper describes in detail the course content, and presents the assessment results as well as continuing work to expand students' interest in studying the effects of technology on society.

Introduction

In an increasingly technologically-inclined society, the vast majority of the population becomes increasingly ignorant of the way the technology works and the way it directly affects society. Starting in the 1980s, the United States realized that science and technology had a continuously increasing role in the everyday life of our citizens and initiated a major effort to define cultural and scientific literacy [1-3]. Bauer, et al. published a comprehensive review of the key issues in public understanding of science research, outlining the divergence between science literacy and society in general.

Current developments connected with Global Warming, Pollution, Green Energy, and Genetic Engineering show that the "Trust deficit" and the "Crisis of confidence" between Society and Science are more prevalent now than ever before in our society and that our future depends on how we will address these vital issues[5].

As society continues to evolve, technological and engineering literacy needs to address the complex interrelationships between technology, society, the environment, the engineering design process, core principles of technological systems, specific technological products and eventually domains of application. The tremendous growth in technological fields such as information, environmental sciences, telecommunications, energy, and biotechnologies in recent decades has imposed improvement as well as challenges in our lives. Scientific discoveries along with advances in the higher education have contributed to the largest part of these improvements. With continuous growth in the utilization of these technologies, the need for educating the population about different aspects of these technologies becomes more evident. It is beneficial to our society when the limitations, regulations, and in general, the pros and cons of these technologies are well understood by the public.

Very often, major decisions regarding important issues such as primary or secondary education or finance, etc. are made by individuals who have very limited knowledge of advanced technologies and their impact on the society. Engineering and technological literacy education have converged to address approximately the same set of topics [6-8]. However each pursues those topics from a different perspective, with engineering literacy focusing on creating or designing technology and. technological literacy approaching technology from the perspective of the consumer as a phenomenon that already exists.

In 1996 ABET (formerly the Accreditation Board for Engineering and Technology), adopted a new set of standards for undergraduate engineering education. They were called Engineering Criteria 2000 and shifted the focus of undergraduate engineering accreditation from lists of required courses to eleven learning outcomes [9].

Preliminary Work

Some of the new outcomes went beyond the standard classic engineering education. Among them five outcomes (listed below as "f" through "g") were a clear reflection of the need to

anchor engineering education into ever-evolving reality of interaction between technology and society:

f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively
h. The broad education necessary to understand the impact of engineering solutions in a global and societal context
i. A recognition of the need for and an ability to engage in life-long learning
j. A knowledge of contemporary issues

In 2000 the International Technology Education Association (ITEA) published Standards for Technological Literacy: Content for the Study of Technology [10]. The ITEA standards represented a significant development establishing the parameters defining technological literacy. They represented an important step in asserting that all students should begin to develop an increasingly sophisticated understanding of technology starting at the earliest years of school.

The effort to define engineering and technological literacy continues unabated even to this day [11-13]. The evolution of technology happens so fast that is particularly important that people understand the new technologies, how they affect our society, and how they shape our future.

Thus, the College of Engineering at University of Texas at San Antonio (UTSA) decided to develop a "Technology and Society" course for non-engineering students. It is considered one of the best ways to prepare the students to fully participate in the decision making and the political process of our society.

The proposed course had to be unique and innovative. We proposed to develop and offer it as a university core under the "Social and Behavioral Sciences" domain. It is a "Technology Awareness" course that is intended for non-engineering students but engineering students are allowed to enroll too. Until this course was initiated, UTSA did not offer any course that dealt with modern technologies and their social impact. The course had to be designed to inform non-engineering students of modern technologies and their impact on society. The course must cover basic principles of different technologies such as computers, telecommunications, medicine, environmentally friendly energy production, and transportation in layman's language. It also explores and discusses socio-technological interplay. As a result of all these efforts and considerations the new EGR 1343, "Impact of Modern Technologies on Society" has been born.

Instructional Design

Following the new ABET recommendations listed as "f" through "j" criteria, four required learning objectives have been established for the new course. Student outcomes representing what students will know, be able to do, or value when they graduate have been designed to be specific and measurable. They are statements describing in precise terms the observable behaviors or actions that students will demonstrate and that the intended learning outcomes have occurred. Assessment methods were established to evaluate and directly measure each learning outcome.

The course learning outcomes are also well aligned with exemplary educational objectives of Social and Behavioral Sciences. After completion of this course, students will:

1. Discover how modern technology can help them to improve their cognitive skills of analysis, synthesis, and evaluation. They explore the positive and negative aspects of modern technology and realize how to utilize it for the benefit of humanity. (Critical Thinking Skills Requirement)
2. Analyze and manipulate the impacts of modern technology on society under different scenarios. (Empirical and Quantitative Skills Requirement)
3. Understand the social, political, economic, and ethical aspects of issues that are impacted by advancement of technology. They assess the effectiveness of each technology in shaping the social behavior of individuals. (Social Responsibility)
4. Write reports, make classroom presentations using multimedia, and participate in debates and discussions pertaining to the development of modern technologies. (Communication Skills)

The course encourages the students to analyze and reflect on technology's effect on society as well as the effect of society on technology. There is no other relationship more intertwined with our future than this!

Course Description

This course, designated as EGR 1343, is a 3-credit hour lecture that fulfills the core curriculum Social and Behavioral Science area requirement. Its aim is to inform engineering as well as non-engineering students of the social impacts of modern

technologies. The course explores issues faced by society as technology becomes an integral part of human life. The course prepares students to think critically, practically, creatively and responsively about technological and sociological challenges, and encourages them to examine solutions of their own. Students must understand the basic terminologies associated with different technologies. Being a college freshman student is sufficient to understand the content of this course.

Instruction consists of:

a. Topics introduced through lectures, discussions, and reading assignments;

b. Students working individually and collaboratively to complete assigned tasks and projects;

c. Field activities, Internet, and library research on assigned subjects;

d. Oral and multimedia presentations and written assignments;

e. Quizzes, midterm test, and final exam.

After an extensive search the selected book for the course was "Technology and Society: Issues for the 21st Century and Beyond / 3rd Edition" by Linda S. Hjorth, Barbara A. Eicher, and Ahmad S. Khan [14]. The book has been divided into nine parts covering nine separate topics:

Part I, History of Technology

Part II, Ethics and Technology

Part III, Energy

Part IV, Ecology

Part V, Population

Part VI, War, Politics, and Technology

Part VII, Health and Technology

Part VIII, Technology and the Third World

Part IX, Technology of the Future

Although the topics appear to be separate they are all united by a single idea: that

technology is the engine driving the changes in our society. The "Course Outline" presented in Appendix 1 shows the distribution of the subjects and the related activities throughout the semester.

The third edition was published in 2007, and some of the issues are somewhat dated but this shortcoming turned out to be a valuable benefit. Students had to study the outdated material, research the subject, and update the information with the latest developments and issues, drawing conclusions based on comparison between the book statements and the actual reality.

Results and Interpretation

Assessment of student learning is considered a challenging issue in courses on engineering and technology literacy [15]. Development of a concept map requires selectivity and judgment, classified at the "synthesis level" of Bloom's taxonomy. This requires a high degree of cognitive engagement, and therefore when the students debate the technology- intensive subjects in parts III, IV, V, and VII they are required to develop concept maps of their subjects to support their statements.

The methods used to assess the student learning outcomes include an entry and exit quiz, homework assignments, reports, class discussions, quizzes, and exams. At the beginning of the semester, the instructor administers a pre-requisite quiz to evaluate the students' general knowledge of modern technologies.

During the semester, teams of 3-4 students are given different topics to investigate, write reports and prepare for the class discussions. These assignments not only improve students' knowledge of different technologies, but also improve their communication as well as teamwork skills. Several quizzes, one midterm, and one final exam measure the learning outcomes for individual students.

The results, after offering the course for two consecutive fall semesters in academic years 2014/2015 and 2015/2016, are promising. Although the course was offered at the most inconvenient time (7:30 to 8:45 MW), due to scheduling problems, attendance met our expectations and the diversity reflected the reality of our student demographics. Tables 2 and 3

show the class demographics and intellectual orientation for both semesters that the course was offered.

Year	Total	White	Hispanic	Black	Asian	Male	Female
2014	33	14	13	3	3	24	9
2015	24	7	13	2	2	18	6

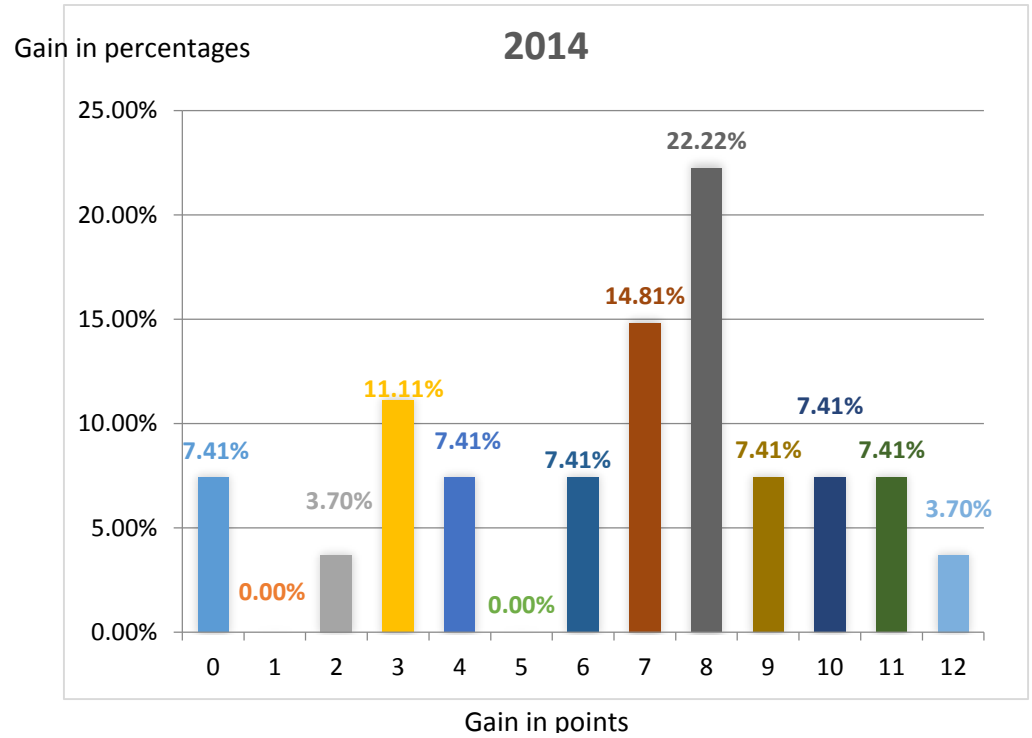
Table 1. *Class Structure by race and gender*

Political	2014	2015	Beliefs	2014	2015	Studies	2014	2015
Conservative	7	4	Religious	15	17	Technical	23	22
Independent	18	15	Non-observant	15	5	Non-technical	9	0
Progressive	8	5	Agnostic	3	2	Undecided	1	2
	33	24		33	24		33	24

Table 2. *Class Structure by intellectual orientation*

The class structure provides important information for the professor regarding debates of sensitive subjects such as “Population Control”, “Ethics”, “War”, and “Health” to name just a few. To counteract possible escalations of particular subjects, the respect for opposing opinions was strictly enforced from the beginning of the class. For that reason during the first three weeks of class there were no debates scheduled and only class discussions followed the lectures. As a result of this approach, in both classes we had very animated debates but in the end everybody left the class with a better understanding and positive feelings about the debated subjects. The diversity of the students was a positive factor in making it possible to approach every subject from various points of view. The fact that all six drop-outs from the course were males would make an interesting research subject in itself.

Outcomes assessment has been performed in several ways. The general assessment was performed through an identical entrance and exit test that evaluated student on the four stated outcome with a score of 20 points (Appendix 2). Figure 1 shows the gain in points for both classes.



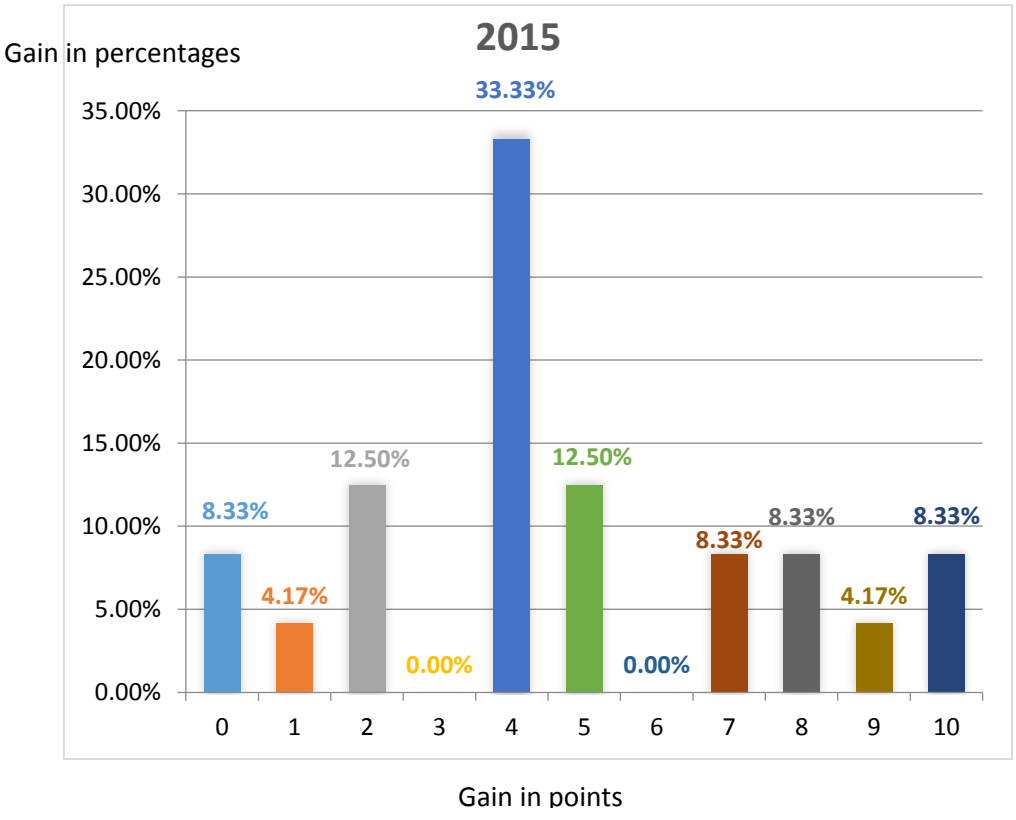


Figure 1. Points gained between entrance and exit test

In addition, each of the four course objectives are evaluated individually based on specific assessment methods that when considered together determined the final grade.

- Objective 1 is assessed based on 75% of results from Internet Exercises and 25% of the individual contributions to discussions related to Parts VII through IX.
- Objective 2 is assessed based on 50% of the Scenario Debates and 50% of the Team Reports scores.
- Objective 3 is assessed based on 40% of the Scenario Debates, 20% of Quizzes, 20% of the Midterm Exam, and 20% of the Final Exam.
- Objective 4 is assessed based on 40% of the Team Reports, 20% of the Midterm Exam, and 20% of the Final Exam.

Bonus points are awarded for a well-organized and maintained notebook. The notebooks must include the following material and had to be tabbed as shown below:

Tab 1 - Class Notes (students **<u>are required</u>** to take good notes!)

Tab 2 - Class Discussion Notes (in chronological order)

Tab 3 – Internet Exercises (in chronological order)

Tab 4 - Vocabulary

Tab 5 – Team Reports (in chronological order)

Tab 6 - Quizzes (in chronological order)

Tab 7 – Miscellaneous (handouts, articles, etc…)

Figure 2 shows the final grade distribution for the two years when the course was offered.

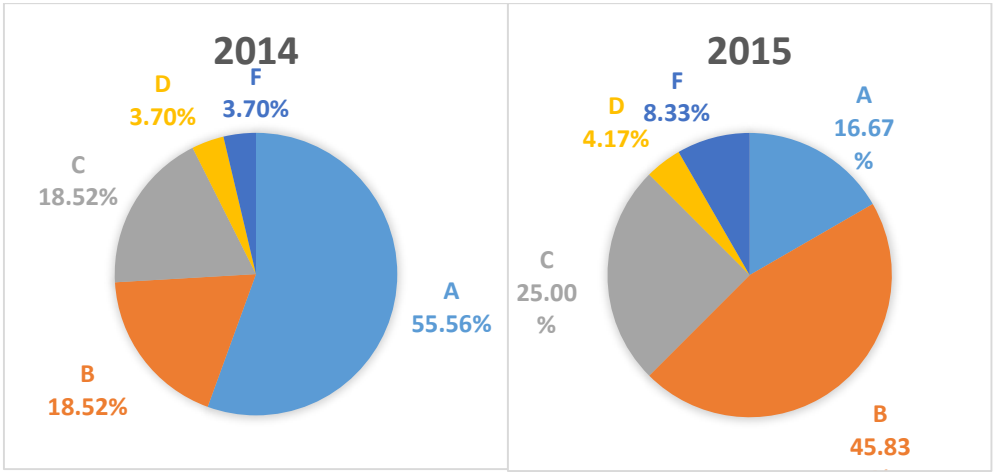


Figure 2. Final grade distribution

Conclusions

After teaching this course for two semesters several recommendations emerge to help other faculty attempting to teach this course and succeed.

1. It should be mandatory for students taking this course to come to class with the material to be covered in that session pre-read. Since many of them may have never been exposed to the material, may not understand the vocabulary, may have misconceptions about that particular subject, or may not feel comfortable with the subject, they cannot participate in any discussion without reading the material. To have an all-inclusive class all students have to have some common ground on which to build an opinion.
2. The faculty teaching this class must have a broad knowledge and understanding of engineering, technology, and world problems, since the class debates may take unexpected turns, raise unanswered questions, uncover unknown situations, or bring to light things that are not usually covered in everyday conversations. The faculty must establish from the beginning an academic approach to any subject, respect among all participant in the discussion, and a sense of curiosity that will encourage everybody to explore areas of knowledge and thought never experienced before.
3. This class is a good candidate to be organized as a Socratic Seminar. For the next offering of this class we plan to have a classroom suitable to arrange tables in a circular format to encourage free exchange of ideas as the Socratic Seminar concept recommends.
4. Future course offerings will include new developments in assessing "Technology and Engineering Literacy (TEL)"[16, 17], which aims to provide tools to measure whether students are able to apply technology and engineering skills to real-life situations. This will enable us to evaluate the effectiveness of our program, in improving technology and engineering literacy throughout our student population.

The course received exceptional reviews from the students and our hope is that it will be accepted as the first course provided by the School of Engineering to be included in the core curriculum by the Texas Higher Education Coordinating Board.

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Appendix 1
Course Outline

UNIVERSITY OF TEXAS AT SAN ANTONIO - School of Engineering
EGR 1343 / Impact of Modern Technologies on Society
Fall 2015 COURSE OUTLINE

Wk #	Date	Part	Sections	Topic	Assignment
1	8/19	-	-	Presentation, Course and Administrative Requirements, CATME	Team Formation
2	8/24	-	-	Introduction	
	8/26	I	1 - 4	Early History of Technology	
3	8/31	I	4 - 7	Modern History of Technology	
	9/2	II	8 - 10	Ethics and Technology	
4	9/7	Labor Day			
	9/9	II	11 - 13	Ethics and Technology	
5	9/14	II		Scenario Debate	Due: Internet Exercises: II.1 ; II.2.f and k
	9/16	III	14 - 17	Energy (Traditional)	
6	9/21	III	18 - 24	Energy (Renewable)	
	9/23	III		Scenario Debate	Due: Internet Exercises: III.3 and III.10
7	9/28	IV	25 - 28	Ecology	
	9/30	IV	29 - 32	Ecology	
8	10/5	IV		Scenario Debate	Due: Internet Exercises: IV.1.c, d, l, and m
	10/7			**Midterm Exam (Part I to IV)**	
9	10/12	V	33 - 36	Population	
	10/14	V	37 - 40	Population	
10	10/19	V		Scenario Debate	Due: Internet Exercises: V.1.b, f, p, and w; V.2.o
	10/21	VI	41 - 45	War, Politics, and Technology	
11	10/26	VI		Scenario Debate	Due: Internet Exercises: VI.1.c
	10/28	VII	46 - 49	Health and Technology	
12	11/2	VII		Scenario Debate	Due: Internet Exercises: VII.1.a, c, d, and f
	11/4	VIII	50 - 53	Technology and the Third World	
13	11/9	VIII	54 - 56	Technology and the Third World	
	11/11	VIII	57 - 59	Technology and the Third World; World Toilet Day	
14	11/16	VIII		Scenario Debate	Due: Internet Exercises: VIII.3, 5, and 6
	11/18	IX	60, 61	Technology of the Future	
15	11/23	IX	62, 63	Technology of the Future	
	11/25	IX	64 - 66	Technology of the Future	
16	11/30	IX		Scenario Debate	Due: Internet Exercises: IX.2.a, b, g, and m
	12/2			Review and Discussion	
-	12/11	7:00 - 9:30 am		**Final Exam**	

Appendix 2
Entrance/Exit Test

Name: **Date:**

EGR 1343 - The Impact of Modern Technology on Society

Initial Assessment

Please read the following questions and answer only the ones for which you are confident that you know the answer. Do not guess since this is a test to evaluate your level of knowledge. If you do not know the answer, draw a line after the question. If you are not sure if the answer is correct place a question mark before writing the answer.

Objective 1: Critical Thinking Skills

Question 1: List three advantages of genetically modified foods:

1.
2.
3.

Question 2: What means of motion has done more to change the way cities are built than any other? _____

Question 3: List five disadvantages of nuclear energy:

1.
2.
3.
4.
5.

Objective 2: Communication Skills

Question 4: In what century did the Industrial Revolution start? _____

Question 5: What major trend in home building was the direct result of the invention of the vacuum cleaner?

Question 6: What invention helped Alfred Nobel found the Nobel Prize? _____

Objective 3: Empirical & Quantitative Skills

Question 7: What is the estimated median number of on-line friends the members of the "Millennial Generation" have? _____

Question 8: How many days does a light year have? _____

Question 9: What major change has been implemented on passenger ships after the Titanic disaster?

Objective 4: Social Responsibility

Question 10: What represents "I am Charlie" statement?

Question 11: Provide two examples that Internet connects people:

Question 12: Provide two examples that Internet isolates people: