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Technological Literacy for All: A Course Designed to Raise the Technological Literacy of College Students

What is technology? If you were to ask someone to define technology, you have about a 75% chance of getting the answer of computers, electronics, and the internet (Rose, Gallup, Dugger, & Starkweather, 2004). This, however, is a far cry from what truly defines technology. The end result of our technological advances surrounds us. It is the car or bike we use for transportation to the toothbrush we use to clean our teeth. It is the process of building homes, roads, and products as well as agriculture, land development, and biotechnology. It is in our use of wood, metals, plastics, and concrete. Simply put, technology is everything we humans modify or make out of our natural environment to suit our needs. It can be formally defined as, "The innovation, change, or modification of the natural environment to satisfy perceived human needs and wants" (International Technology Education Association [ITEA], 2000, p. 7).

Understanding what technology is, and is not, is the first step in becoming technologically literate. One should also understand how technology is created, how it works, how it shapes society, and how society shapes technology (Garmire & Pearson, 2006). The importance of technological literacy cannot be understated. Our technological literacy influences one's occupational choices, health and economic well-being, choices for recreation, and political decisions. It also allows people to better understand and adapt to the ongoing, rapid changes in technological developments. According to the Committee on Technical Literacy (Pearson & Young, 2002):

> Technological literacy can provide a tool for dealing with rapid changes. A technologically literate person will find it easier to understand and assimilate new technologies and so will be less likely to be left behind. Equally important, technologically literate people will have a high enough comfort level and broad comprehension of technology to put the changes in context and accept them even if they do not fully understand them. (p. 44–45)

Due to the ramifications of having a technologically illiterate society in a time when technology is so pervasive, a call for increased technological literacy has been made by the National Science Foundation (Bloch, 1986), the American Association for the Advancement of Science (1993), and the International Technology and Engineering Educators Association (International Technology Education Association, 1996). Although the call for technological literacy is

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decades old, the teaching of technological concepts and processes continues to be limited within the K–12 educational system (Bybee, 2000). This study was designed to gauge the ability of a single-semester course to raise students' technological literacy as well as gains in student perceptions of the importance of technology education in the K–12 curriculum.

STEM 110T Course

Course Overview. The STEM 110T course, Technology and Your World, was developed through the Department of Science, Technology, Engineering, Mathematics, and Professional Studies as part of ODU's Lower Division General Education requirement. STEM 110T is one of thirteen courses offered that students may choose to take in order to fulfill ODU's *Impact of Technology* requirement. These courses are intended to "develop students' abilities to make reasoned judgments about the impact of technological development upon world cultures and the environment as well as upon individuals and societies" (Old Dominion University, 2009, para. 2). Through these courses, students are provided with an understanding of not only how technologies function but also their impact on society (Old Dominion University, 2009). The purpose of this study was to verify that the STEM 110T course is developing technological competencies outlined by the *Standards for Technological Literacy*. The research question guiding this study was: To what extent does the STEM 110T course at Old Dominion University affect the technological literacy of course completers?

Course Description. Eight sections of the STEM 110T course are offered each fall and spring semester with five sections scheduled during the day and two in the evening. An additional two to three sections are offered during the summer term. The sections are taught by a combination of PhD graduate students and adjunct faculty. Each section carries a maximum capacity of thirty students, and all sections typically fill each semester.

As per the 2011–2012 Old Dominion University catalog, the STEM 110T course is designed to provide students with:

> An overview of the resources, and systems of technology. Emphasis is on the impacts that technology has on individuals and their career. Discussion and activities explore the evolution of technology, its major systems and their impact on individuals and their careers (p. 297).

The purpose of the course is to assist each student in developing "critical and analytical thinking skills regarding the development, selection and use of technology" (Old Dominion University, 2012, p. 1). The course is designed to meet the following competencies as listed in the course syllabi (Old Dominion University, 2012).

A. Develop an understanding for the continuous evolution of technology and its impact on society, and the lives and careers of individuals.

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B. Describe the progression of *energy, material, and information resources and their significance in human development.*
C. Describe the use and impact of *communication and information technologies.*
D. Describe the use and impacts of *physical technologies such as manufacturing, construction, transportation*.
E. Describe the use and impact of *biological and chemical technologies*.
F. Assess the limitations and impacts of technology on individuals, their careers, and society.
G. Forecast future developments in technological resources and systems.

The STEM 110T course is divided into seven major areas with each area focusing on a specific topic related to technology. Topics taught in this course are in alignment with ITEA's *Standards for Technological Literacy* and are as follows:

1. What is Technology?
2. The Problem Solving/Design Process
3. Producing Products and Structures
4. Communicating Information and Ideas
5. Transporting People and Cargo
6. Energy and Progression
7. Bio-related Technologies

The STEM 110T course utilizes a variety of instructional techniques (e.g. lectures, class discussions, class activities, assignments, and projects) to disseminate knowledge of technology and its impact on students' lives, careers, and society as a whole. Instructional activities are also designed to assist students in the development of 21st century skills (i.e. communication, collaboration, creativity, critical thinking, and problem solving).

Methodology

The 2001 and 2004 ITEA Gallup Poll surveys were developed as a collaborative effort between ITEA and Gallup (Harrison, 2009). The original intent of the 2001 survey was to assess the general public's perceptions of technology and technological literacy in the United States (Rose, Gallup, Dugger & Starkweather, 2004). The survey was modified in 2004 with the intent remaining consistent with that of the 2001 poll. All survey questions were developed based on ITEA's *Standards for Technological Literacy*, thus establishing the content validity of the instrument (Harrison, 2009). According to Volk & Dugger (2005), reliability data showed the 2001 and 2004 ITEA Gallup polls to have "maintained a 95% confidence level with a margin of error set at plus or minus four percentage points" (p. 57). Reliability was further established as the 2001 and 2004 surveys showed similar results leading the researchers to derive the same three major conclusions, regardless of the three-year time lapse, as shown below:

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- The public understands the importance of technology in our everyday lives and understands and supports the need for maximizing technological literacy.
- There is a definitional difference in which the public thinks first of computers when technology is mentioned, while experts in the field assign the word a meaning that encompasses almost everything we do in our everyday lives.
- The public wants and expects the development of technological literacy to be a priority for K–12 schools. (Rose et al., 2004)

A pre–post survey study was conducted during the spring 2012 semester at ODU to assess gains in the technological literacy of students enrolled in the STEM 110T course. A convenience sample of students from all eight STEM 110T sections, taught by three PhD Graduate Assistants and two Adjunct faculty members, was surveyed at the beginning and end of the semester. The survey instrument included a combination of questions from the 2001 and 2004 ITEA Gallup Poll surveys. One question from the 2004 survey, deemed not pertinent due to outdated technology, was omitted from the original survey, and questions from the 2001 survey not included in the 2004 survey were added. The survey consisted of 24 questions, 23 of which were forced response items which used a combination of 4-point Likert scales, dichotomous yes–no questions, and multiple-choice questions. One item was an open-ended question. In addition, seven demographic questions were included to collect information regarding the students' gender, age, ethnicity, employment history in a technological field, year in school, enrollment status, and major.

At the beginning of the spring 2012 semester, a total of 287 students were enrolled in the STEM 110T course. To ensure a high return rate, surveying took place in each of the STEM 110T classes during the first and last weeks of the semester. The researchers visited each of the classes and were responsible for explaining, distributing, and collecting the surveys. The researcher remained in the class during the data collection process, and surveys were collected upon completion. The STEM 110T instructors were not given access to the survey during the study nor did they have any participation in the data collection process.

This study had several limitations that the reader should consider when analyzing the results. The research took place at one higher education institution located in the Southeast United States; therefore, the results may not reflect other institutions or geographic locations. The survey instrument used in this study asked perception questions instead of knowledge questions. A self-perceived development of technological literacy may not accurately indicate one's true literacy. The students involved in this study were concurrently enrolled in other courses at the university, which may have enhanced or hindered the technological literacy of the participating students.

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Results

In total, 230 pre-surveys were completed and returned at the start of the semester and 204 post-surveys at the end, giving return rates of 93% and 84%, respectively. Attrition from the course contributed to the decrease in the number of post-surveys collected. Pre- and post-survey data were manually inputted into Excel spreadsheets; questions left blank or with answers not clearly delineated were not included. A paired samples t-test was run on the mean scores from the Likert scale questions to determine if there were significant differences between the STEM 110T students' pre- and post-survey responses. The major themes from the 2004 Gallup survey results were used to code student responses to the open-ended item; additional themes were added that emerged from the post-survey results. Frequency data was computed for the open-ended, dichotomous scale, and multiple-choice response questions. Significant results from the survey data are discussed below.

Demographics

For the purposes of this study, descriptive statistics, shown in Table 1(next page), were calculated for gender, ethnicity, age, and year in school. As the data shows, the percentage of females (61%) enrolled in the STEM 110T course exceeded that of males (38%). This gender gap is consistent with the current enrollment of males and females in higher education. According to the National Center for Education Statistics (2010), the percentage of females enrolled in degree-granting institutions in the United States in fall 2009 was 57%, as compared to 43% of males. Eighty-nine percent of the study participants fell within the 18–22 age range, the typical range of most college students. Although whites made up approximately 60% of the study population, approximately 25% of the population was African American. The multiracial category had the third highest representation comprising 7.0% of the population with Hispanics (≈1.7%), Asians (≈3.0%), Asian/Pacific Islanders (≈1.1%), and Native Americans (≈0.7%) representing the remainder of the study population. Although STEM 110T is a lower-level general education course, only 57% of the study population were freshmen and sophomores. Many underclassmen, for a variety of reasons, choose to wait to take the STEM 110T course until their junior or senior year, thus accounting for the large percentage of upperclassmen enrolled in the course.

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Table 1
Demographics

Demographic	Pre-Survey (%)		Post-Survey (%)	
Gender	Male	37.8	Male	38.2
	Female	61.3	Female	60.8
Age (yrs)	18-19	43.9	18-19	31.4
	20-22	44.9	20-22	57.8
	23-26	6.5	23-26	5.4
	27-29	1.3	27-29	2.5
	30-49	3.0	30-49	2.5
Ethnicity	White	58.7	White	60.8
	African American	25.2	African American	24.5
	Hispanic	3.5	Hispanic	2.0
	Asian	2.2	Asian	3.9
	Asian/Pacific Islander	1.7	Asian/Pacific Islander	0.5
	Native American	0.4	Native American	1.0
	Multiracial	7.0	Multiracial	6.9
Year in School	Freshman	11.3	Freshman	11.3
	Sophomore	45.2	Sophomore	47.1
	Junior	23.9	Junior	23.5
	Senior	17.4	Senior	17.6

Concept of Technology

Questions in the survey directed at assessing the students' concept of technology showed that completing the STEM 110T course was positively correlated with their concept of technology. In an open-ended format, students were asked, "When you hear the word *technology*, what first comes to mind?" Ideally, it is understood that technology encompasses much more than just computers and the Internet. Provided in Table 2 is a complete list of responses which indicate increased technology literacy among the STEM 110T students. Results demonstrated that the STEM 110T course impacted students' thinking of what technology means, as 26% of students on the post-survey indicated they first think of "computers" when they hear the word *technology* as compared to 38% on the pre-survey (Table 2). In addition, a decline was observed in the number of students noting electronics and cell phones on the post-survey, 12% and 11%, as compared to the pre-survey, 5% and 6%, respectively. These are significant findings because computers, electronics, and cell phones have an increased presence in students' lives, resulting in them oftentimes being their first line of thinking in relation to technology.

Items on the post-survey also indicated a more holistic view of technology, as compared to the pre-survey. As Table 2 (next page) shows, a significant increase was seen in the number of students on the post-survey (15%) who responded with the statement "Anything that makes tasks/life easier/better," as

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compared with the pre-survey (3%). Other responses worth noting which emerged on the post-survey included, "everything in the modern world." "improvements in life and the modern world." "man-made creations and enhancements to answer needs of mankind," and "changing the world."

Table 2
When Your Hear the Word Technology, What First Comes to Mind?

Survey Responses	% Mentioned Pre-Survey	Post-Survey
Computers	38	27
Electronics	12	5
Cell Phones	11	6
Advancement	7	7
New Inventions	3	2
Machines/Machinery	3	3
Health/Medicine	1	3
Anything that makes tasks/life better/easier.	3	15
Everything in the modern world.	N/A	6
Improvements in life and the modern world.	N/A	5
Manmade creations to answer needs of mankind.	N/A	4
Changing the world.	N/A	2

When asked on a 4-point scale ranging from 1 for *not at all important* to 4 for *very important*. how important it was for people to be able to understand and use technology, no significant difference was found between the pre-survey (M = 3.83, SD = 0.481) and post-survey results (M = 3.86; SD = 0.364); $t(203) = -0.687$, $p \geq 0.05$). These results indicate that, on average, the STEM 110T students, regardless of their technological literacy level, entered the course with the opinion that it was very important for people to understand and use technology.

To further assess understanding of technology, the students were presented with two definitions of technology and were asked which they felt more closely fit their thoughts upon hearing the word *technology*. On the pre-survey, 67% of the students selected the definition "computers and the internet," but the post-survey results showed 72% selected "changing the natural world to satisfy our needs" (Table 3, next page). These results clearly show the impact of the STEM 110T course in altering the students' thought process in terms of how they define technology.

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Table 3
Given the Following definitions, Which of the Following More Closely Fits What You Think of When You Hear the Word "Technology"?

Statements	Pre-Survey (%)	Post-Survey (%)
"Computers and the internet"	67.2	32.8
"Changing the natural world to satisfy our needs"	27.0	72.1

The final question used to assess understanding sought to determine what the students were more likely to think of when hearing the word *design* used in relation to technology. The results showed a minority (40.2%) of the STEM 110T students thought of *design* as "a creative process for solving problems" on the pre-survey, while a majority (58.8%) believed *design* to be "blueprints and drawings from which you construct something." By the end of the semester, 58.8% of the students thought of *design* as being "a creative process" as shown on the post-survey results (Table 4). This 16.6% gain with viewing *design* as a "creative process for solving problems" is significant as it is in alignment with the *Standards for Technological Literacy* (Rose & Dugger, 2002).

Table 4
Which of the Following Are You More Likely to Think of When You Hear the Word "Design" Used in Relation to Technology?

Statements	Pre-Survey (%)	Post-Survey (%)
"A creative process for solving problems."	40.2	64.7
"Blueprints and drawings from which you construct something."	58.8	34.8

Impact of Technology

Understanding the impact technology has on society as a whole is an important part of technological literacy. Several statements were presented to assess the students' views on the impact of technology on society. For each statement, the students were asked, on a 4-point Likert scale ranging from *Strongly Disagree* to *Strongly Agree* to determine the extent to which they agreed or disagreed with each statement. As the results in Table 5 show, on average, the students disagreed with the statement "Technology is a small factor

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in your everyday life" to a greater extent on the post-survey (M = 1.53, SD = 0.601), as compared to the pre-survey (M = 1.67, SD = 0.915); $t(201) = 2.011$, $p \leq 0.05$). When presented with the statement "Engineering and technology are basically one and the same thing." the post-survey results (M = 2.26, SD = 0.809) showed a higher level of disagreement, as compared to the pre-survey (M = 2.47, SD = 1.020); $t(200) = 2.148$, $p \leq 0.05$). Although no significant difference was observed between the mean score of the pre-survey (M = 2.34, SD = 0.801) and post-survey (M = 2.40, SD = 0.871); $t(193) = -0.653$, $p \geq 0.05$), responses to the statement "Science and technology are one and the same." the results suggested that the students, on average, entered into the course with an understanding that a difference exists between them. These results demonstrate knowledge of technological literacy, as the students understand that although science, technology, and engineering are interrelated and depend on each other, they are separate entities. With the current emphasis on STEM in global education, it is important that people understand a distinction exists between not only engineering and technology but also science and technology. This course appears to have a vital role in students' acquisition of this delineation.

As shown in Table 5 (next page), post-survey results (M = 3.04, SD = 0.702) showed a higher level of agreement to the statement "Most environmental problems can be solved using technology," as compared to the pre-survey (M = 2.64, SD = 0.682); $t(196) = -5.757$, $p \leq 0.05$). The students, on average, were also found to agree more with the statement "Design is a process that can be used to turn ideas into products" on the post-survey (M = 3.51, SD = 0.610), as compared to the pre-survey (M = 3.35, SD = 0.607); t (198) = -2.689, $p \leq 0.05$).

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Table 5
To What Extent Do You Agree or Disagree With the Following Statements Regarding Technology?

Statements	Pre-Survey		Post-Survey	
	M	*SD*	*M*	*SD*
"Technology is a small factor in your everyday life"	1.67	0.602	1.52	0.915
"Engineering & technology are one & the same"	2.47	1.020	2.26	0.809
"Science & technology are one & the same"	2.34	0.801	2.40	0.871
"Most environmental problems can be solved using technology"	2.64	0.682	3.04	0.702
"Design is a process that can be used to turn ideas into products"	3.35	0.607	3.51	0.610

Interest in Technology

Study results indicate that as students' technological literacy levels increased, so did their awareness and interest in the development and use of technology. Although the mean score on the pre-survey (M = 3.47, SD = 0.716) indicated that the students, on average, came into the course feeling it was important to know how various technologies work, there was a significant increase in the level of importance on the post-survey (M = 3.64, SD = 0.521); $t(198) = -2.749$, $p \leq 0.05$). As Table 6 (next page) demonstrates, results indicated that students felt it was more important to understand whether it was better for a product to be repaired or thrown away on the post-survey (M = 3.66, SD = 0.621), as compared to the pre-survey (M = 3.47, SD = 0. 763); $t(199)$ = -2.487, $p \leq 0.05$). No significant difference was seen in the level of importance students placed on "being able to develop solutions to a practical technological problem" between the pre-survey (M = 3.37, SD = 0.798) and post-survey (M = 3.50, SD = 0.758); $t(198) = -1.617$, $p \geq 0.05$) (Table 6). However, as the mean scores show, responses to this statement indicated a higher level of importance being placed on having the ability to develop solutions to technological problems at the end of the semester. Responses to the aforementioned questions were on a 4-point Likert scale ranging from *Not at all important* to *Very important*.

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Table 6
How Important Is It to You, Personally, to Know Each of the Following?

Statements	Pre-Survey *M*	Pre-Survey *SD*	Post-Survey *M*	Post-Survey *SD*
Knowing whether it is better to repair products or better to throw them away.	3.47	0.763	3.66	0.621
Being able to develop solutions to a practical technological problem.	3.37	0.798	3.50	0.758

In the technological areas of "modification of plants and animals to supply food" (*M* = 2.48, *SD* = 1.052; *M* = 2.82, *SD* = 0.1.007), "robotics and other technologies in manufacturing" (*M* = 2.58, *SD* = 0.950; *M* = 2.83, *SD* = 0.983), and "new construction methods for homes and buildings" (*M* = 2.69, *SD* = 0.997; *M* = 2.94, *SD* = 0.993), student interest level was found to significantly increase between the pre-survey and post-survey ($t(201) = -3.259$, $p \leq 0.05$; $t(201) = -2.644$, $p \leq 0.05$; $t(200) = -2.412$, $p \leq 0.05$), respectively (Table 7). No significant difference was found between the pre-survey (*M* = 2.83, *SD* = 1.089) and post-survey (*M* = 2.83, *SD* = 1.052; $t(199) = -0.769$, $p \geq 0.05$) for interest in the technological area of "space exploration" (Table 7). When asked how informed they felt about the aforementioned technological areas, students indicated that they felt more informed at the end of the course, as compared to the beginning, in all four technological areas: "modification of plants and animals to supply food" ($t(201) = -9.016$, $p \leq 0.05$), "robotics and other technologies in manufacturing" ($t(201) = -9.423$, $p \leq 0.05$), "new construction methods for homes and buildings" ($t(201) = -9.351$, $p \leq 0.05$), and space exploration ($t(201) = -5.006$, $p \leq 0.05$) (Table 8). As the results showed, although the students did not show an increased interest in space exploration, the course did increase their level of understanding (Table 8, next page).

Table 7
How Much of an Interest Do You Have in the Following Topics?

Statements	Pre-Survey *M*	Pre-Survey *SD*	Post-Survey *M*	Post-Survey *SD*
Modification of plants and animals to supply food.	2.48	1.051	2.82	1.008
Robotics and other technologies in manufacturing.	2.58	0.949	2.83	0.983
New construction methods for homes and buildings.	2.69	0.997	2.94	0.993
Space exploration.	2.83	1.090	2.91	1.052

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Table 8
How Informed Do You Feel About the Following Topics?

Statements	Pre-Survey		Post-Survey	
	M	*SD*	*M*	*SD*
Modification of plants and animals to supply food.	2.06	0.947	2.90	0.864
Robotics and other technologies in manufacturing.	1.93	0.776	2.73	0.923
New construction methods for homes and buildings.	1.97	0.828	2.79	0.862
Space exploration.	2.13	0.874	2.59	0.884

An additional question worth noting sought to determine the students' attitude towards the various forms of technology used in everyday life. Although a significant difference was not found, 73% of the STEM 110T students on the pre-survey and 78.9% on the post-survey indicated they "would like to know something about how it works" (Table 9). In contrast, 26% on the pre-survey and 20.1% on the post-survey responded that they "don't care how it works just as long as it works" (Table 9). Although these results are positive, they are also somewhat troubling because approximately one-fourth of the students indicated, at the conclusion of the course, little to no interest in knowing how technologies work.

Table 9
Which of the Following Statements Best Describes Your Attitude Towards the Various Forms of Technology You Use in Your Everyday Life?

Statements	Pre-Survey (%)	Post-Survey (%)
You don't care how it works just as long as it works.	26.0	20.1
You would like to know something about how it works.	73.0	78.9

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Technology and Education

Due to the increased focus on STEM in K–12 education, the survey included questions that assessed the importance of high school students having an understanding of the various technological areas. Respondents were presented with several items to which they were asked to rate importance on a 4-point Likert scale ranging from 1 for *Not at all important* to 4 for *Very important*. As demonstrated in Table 10 (next page), the post-survey results ($M = 3.48$, $SD = 0.658$) showed the STEM 110T students felt it was more important for high school students to understand "the relationship between technology, mathematics & science," as compared to results from the pre-survey ($M = 3.38$, $SD = 0.816$; $t(200) = -2.758$, $p \leq 0.05$). The STEM 110T students, on average, also assigned a higher level of importance for high school students to have an understanding of the "relationship between technology and the economy" ($M = 3.37$, $SD = 0.816$; $M = 3.59$, $SD = 0.658$), the "relationship between technology and the environment" ($M = 3.47$, $SD = 0.693$; $M = 3.62$, $SD = 0.646$), and "the role of individuals in the development & use of technology" ($M = 3.47$, $SD = 0.708$; $M = 3.29$, $SD = 0.720$) on the post-survey, as compared to the pre-survey ($t(200) = -2.758$, $p \leq 0.05$; $t(200) = -2.253$, $p \leq 0.05$; $t(199) = -2.530$, $p \leq 0.05$) (Table 10). Although the mean scores on the pre-survey indicated the STEM 110T students, on average, felt it was important for high school students to understand the "overall effect of technology on our society" ($M = 3.61$, $SD = 0.640$) and the "relationship between technology, mathematics & science" ($M = 3.33$, $SD = 0.807$), no significant difference was observed between the pre-survey and post-survey results ($M = 3.62$, $SD = 0.661$; $t(199) = -0.245$, $p \geq 0.05$; $M = 3.45$, $SD = 0.780$; $t(200) = -1.535$, $p \geq 0.05$) (Table 10).

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Table 10
How Important Do You Feel It Is That High School Students Are Able to Understand and/or Do the Following?

Statements	Pre-Survey *M*	Pre-Survey *SD*	Post-Survey *M*	Post-Survey *SD*
The relationship between technology and the economy.	3.38	0.816	3.59	0.658
The overall effect of technology on our society.	3.61	0.640	3.62	0.661
The relationship between technology and the environment.	3.47	0.693	3.62	0.646
The relationship between technology, math & science.	3.33	0.807	3.45	0.780
The role of individuals in the development & use of technology.	3.29	0.720	3.47	.708

When asked whether the study of technology should be a required or optional subject in high school, 66.2% of the STEM 110T students on the post-survey felt it should be required, as compared to 33.8% on the pre-survey (Table 11, next page). In addition to technology being a required subject, the mean scores, as shown in Table 12, demonstrated that the STEM 110T students felt it was more important at the end of the course for high schools to prepare students in the following technological areas: the "relationship between technology, math & science (M = 2.90, SD = 0.918; M = 3.24, SD = 0.828), the "role of people in the development & use of technology (M = 2.84, SD = 0.804; M = 3.23, SD = 0.815), "knowing something about how products are designed" (M = 2.68, SD = 0.892; M = 3.16, SD = 0.845), "the ability to select and use products" (M = 3.20, SD = 0.824; M = 3.44, SD = 0.743), and "understanding the advances and innovation in technology" (M = 3.04, SD = 0.796; M = 3.41, SD = 0.749). Significant differences were found between the results on the pre-survey and post-survey for all five technological areas ($t(196) = -3.896$, $p \leq 0.05$; $t(197) = -4.293$, $p \leq 0.05$; $t(197) = -5.336$, $p \leq 0.05$; $t(197) = -3.038$, $p \leq 0.05$; $t(195) = -4.699$, $p \leq 0.05$).

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Table 11
Should the Study of Technology Be a Required Subject in High School or Should It Be Optional?

Statements	Pre-Survey (%)	Post-Survey (%)
Technology should be a required subject.	46.1	66.2
Technology should be an optional subject.	52.9	33.8

Table 12
How Important Is It for Schools to Prepare Students in the Following Areas?

Statements	Pre-Survey		Post-Survey	
	M	***SD***	***M***	***SD***
The relationship between technology, mathematics & science.	2.90	0.918	3.24	0.828
The role of people in the development & use of technology.	2.84	0.804	3.23	0.815
Knowing something about how products are designed.	2.68	0.892	3.16	0.845
The ability to select and use products.	3.20	0.824	3.44	0.743
Understanding the advances and innovations in technology.	3.04	0.796	3.41	0.749

The results presented in this section clearly illustrate the impact of the STEM 110T course in not only improving technological literacy levels at the post-secondary level but also raising awareness of the importance for an increased focus on technology at the high school level.

Discussion

Citizens need to be technologically literate in order to succeed and thrive in our increasingly technological global society (Garmire & Pearson, 2006). Old Dominion University, similar to other institutions, has responded to this need by requiring a technology component to be included within the general education graduation requirements. STEM 110T, one of thirteen courses that students may choose to take to meet ODU's "Impact of Technology" general education requirement, seems to have achieved its intended goal on many fronts but still has room for improvement on others.

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The course appears to be giving students a greater understanding of what aspects make up technology. Based on pre–post testing, completers of the STEM 110T course gained a better understanding that technology is more than just computers. This is demonstrated through the open-ended responses to "When you hear the word *technology*, what first comes to mind?" The STEM 110T students were more likely to view technology as being narrowly defined as computers and electronics at the beginning of the semester as compared to the end. Further evidence of this increased technological literacy was shown through students using statements such as "everything in the world" and "manmade creations" when defining technology on the post-survey. It should be noted, however, that computers were still the top response of students who completed the course. As a result, the course could benefit from adding more content around the general definition and practical examples of technology throughout history. Ideally, by the end of the semester , the students perception of technology would be more closely aligned with the "innovation, change, or modification of the natural environment to satisfy perceived human needs and wants" (ITEA, 2000).

An interesting result from this study came from what the STEM 110T students believed high school students should be able to understand and do with technology. The number of students who believed technology should be a part of the high school curriculum grew from 46.1% to 66.2% following completion of the course. The STEM 110T students believed that high school students should not only be taught how to select the best product but should also be technologically aware of how products are developed. In addition, it was felt that high school students should have an understanding of the interrelationships between technology and such areas as math, science, the environment, and the economy. Producing a citizenry that values technology education will help insure its pivotal role in K–12 STEM education. These results indicate that STEM 110T completers would be more likely to favor a strong presence of technology education in the curriculum. Therefore, we can assume they would encourage future generations to enroll in technology education electives as well as vote for initiatives that favor technology education development in K–12 schools.

One of the more exciting results of the study was the gain in interest in technology following completion of the course. A greater majority of the STEM 110T students showed an interest in food and animal modification technologies, robotics, and construction industries. Recent concerns about the United States' falling behind in technological advancements have led to a call for more home-grown technologists. This course appears to be beneficial in exposing students to possible technological career areas they might not otherwise have known about.

The STEM 110T course seems to be making strides in developing technological literacy. Completers of the course have a better understanding of the definition of technology and have shown increased attributes in certain areas

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involving technological literacy. However, more can be done to increase all aspects of technological literacy. Students still need to develop the want and need to understand how technology works, how it is created, how it shapes society, and how society shapes technology. This is a tall demand for a one-semester course. The researchers, however, are optimistic that the results of this study are an indication that gains in technological literacy can be achieved through a one-semester technology course utilizing real-world problems and situations.

Applications and Future Research

The results from this study may aid other institutions interested in developing courses that are specifically designed to raise technological literacy. The course layout and designated topic areas were designed around the *Standards for Technological Literacy* and seem to have an impact on students understanding and interest in technology. Efforts should be made to include content that emphasizes the global impact of technological literacy and the need to understand how it was developed, how it works, and how it shapes society and individuals.

The researchers hope to use the results from this study to implement minor changes in the STEM 110T course curriculum. Longitudinal effects will be analyzed utilizing the same survey instrument over the next several semesters of the course offering. As STEM 110T is just one of the many technology courses taught as part of the technological requirement for ODU graduates, future studies of other course impacts will be necessary to gain a more holistic view of how well ODU is reaching its technological literacy goals. As technology continues to evolve, so does our need to acquire an understanding of it. Teaching about technology's role in our society is one method of providing technological literacy to the future leaders and decision makers in the United States. Old Dominion University's STEM 110T course appears to be making strides in providing meaningful technological literacy to its student population and will hopefully assist in producing technologically literate graduates capable of navigating the 21st century and beyond.

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