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An Exercise to Promote and Assess Critical Thinking in Sociotechnical Context

John Krupczak Jr, NSF Division of Undergraduate Education

Professor of Engineering, Hope College, Holland, Michigan. Former Chair of the ASEE Technological Literacy Division. Former Chair of the ASEE Liberal Education Division. Senior Fellow CASEE, National Academy of Engineering, 2008-2010.

Dr. Mani Mina, Iowa State University

Mani Mina is with the department of Electrical and Computer Engineering at Iowa State University. He has been working on better understanding of students' learning and issues of technological and engineering philosophy and literacy. In particular how such literacy and competency are reflected in curricular and student activities.

An Exercise to Promote and Assess Critical Thinking in Sociotechnical Context

This work addresses a practical means to more clearly link the completion of an ABET-accredited undergraduate engineering degree with critical thinking about sociotechnical issues. An exercise has been created which can be used to develop and measure an aspect of critical thinking by engineering students in a sociotechnical context. This exercise can be used as one possible measurement of the ability of an engineering student to demonstrate attainment of ABET outcome (h), understanding the impact of engineering solutions in a global and societal context. This outcome has been viewed as difficult to measure and therefore under consideration to be eliminated from the ABET criteria. The approach is based on asking students to predict impacts of a new technological product as described in a news article. A simple rubric is included which allows numerical grading of student responses. The rubric helps students to discern the difference between impacts and other aspects of new technology such as features, product capabilities, and necessary design requirements. The activity can be completed in a single class session. While more time would be beneficial, an objective of the current work was to create a very short and easily implemented activity so as to facilitate adoption by other faculty. Results show measurable increases in first year engineering students' ability to understand the impact of engineering solutions in a global and societal context. It is vital that the education of today's engineers expand beyond mere technical competence to include the critical thinking abilities more broadly associated with technological leaders and technologically literate citizens. Considerable work has been done to develop the concepts of engineering and technological literacy as appropriate for the education of all students. At the same time less attention has been given to examining if individuals trained as engineers actually possess a broad understanding of technology and are able to engage in the type of critical thinking and decision making considered vital for a technologically literate citizenry. While the current results reported here are limited, this activity and assessment appear promising. Given the relevance to current discussions of ABET accreditation criteria revisions, this work is being reported at the present stage for the benefit of the engineering education community.

Introduction

Current ABET accreditation standards were established nearly two decades ago and have been in effect unchanged since their adoption[1,2]. In the intervening years, considerable work has been done to develop the concepts of engineering and technological literacy as appropriate for the education of all students. This has included *Technically Speaking*[3] and *Tech Tally*,[4] sponsored by the National Academy of Engineering (NAE), and the *Technology and Engineering Literacy Assessment*, developed for all K-12 students as part of the National Assessment of Educational Progress carried out by the US Department of Education[5]. These works developed and elaborated on the elements of technological and engineering literacy that should be achieved by all Americans. In the time since 2000, the NAE has also produced *The Engineer of 2020: Visions of Engineering in the New Century*[6,7]. The Engineer of 2020 advocated an effort to clarify and establish engineers as "as broad-based technology leaders, in the mind of the public and prospective students." Similarly, the NAE's *Changing the Conversation: Messages for Improving Public*

Understanding of Engineering,[8] sought to establish the public image of engineers as creative problem solvers and who "bring ideas to life, turn bold new ideas into reality," and "use their knowledge to improve people's lives in meaningful ways." In the context of these intensive and high-profile efforts to define technological literacy for all Americans and establish the role of engineers in society as technology leaders turning ideas into reality for society's benefit, it is more important than ever that engineers have the capacity to think critically about sociotechnical issues and demonstrate attainment of the broad education necessary to understand the impact of engineering solutions in a global and societal context.

The motivation for this work is an approach to student educational development based on the three dimensions of technological literacy outlined in *Tech Tally*. This includes the social, technical, and ethical aspects of technology. *Tech Tally* identifies three dimensions of technological literacy as shown in Figures 1 and 2. These are knowledge, capabilities, and critical thinking and decision-making. Engineering educators who reflect on this perspective will note that most engineering classes focus on the capabilities and knowledge dimensions, while the dimension of critical thinking and decision-making is not well-represented in the engineering curriculum.

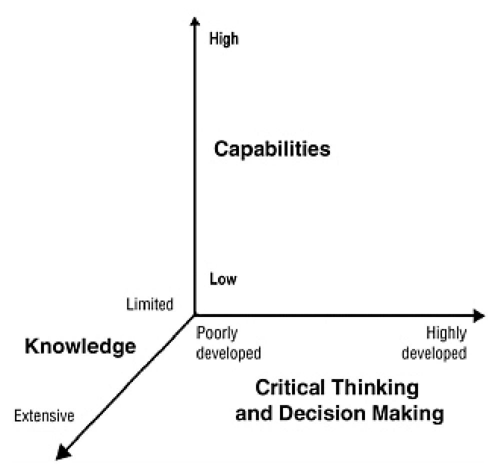

Figure 1: A Graphical Representation of the Three Dimensions of Technological Literacy (Adapted from *Tech Tally*).

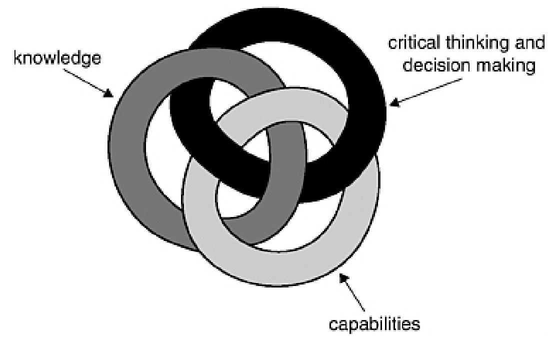

Figure 2: A Visualization of the Three Dimensions of Technological Literacy as Interlocking Rings Showing Their Inseparability (Adapted from *Tech Tally*).

The status of being technologically literate cannot be bestowed upon engineering students without first considering the inseparability of these dimensions. This is evident when asking the question: “When students finish a class, what would we like them to be able to do?” In most classes, the main goal of the faculty has been focused the knowledge and capabilities dimensions. Due to the mathematical nature of most engineering science classes, faculty focus on training students to follow, repeat, and then make correct choices in the use of the mathematical tools to solve well-defined numerical problems. However, it is the critical thinking and decision-making abilities that faculty and others would deem important for engineers who are society’s “technology leaders turning ideas into reality for society’s benefit.”

An under-utilized opportunity in the engineering curriculum is the possibility of using critical thinking regarding the socio-technical aspects of engineering fields and finding a means to bring greater prominence to these issues within the existing curriculum. Often students do not understand the application or the social relevance of a particular engineering science concept. They are not able to describe what engineering laws mean when applied to the many technological endeavors that dominate our lives. For instance, most electrical engineering students are not able to engage in anything more than a superficial discussion about how electrical engineering innovations enable vital elements of our modern economy and help to create our standard of living. The products of electrical engineering such as power transmission, communication systems, medical technology and complex control systems are ubiquitous in the daily lives of most people. These technological applications have initiated many changes in the pattern of everyday life, yet engineering students rarely think critically about this aspect of technology.

To help develop the dimension of critical thinking and decision-making these activities must be brought into the education process in an efficient and effective manner. First, additional opportunities for critical thinking will provide the means by which students can be challenged to move beyond problem solving by rote, and deepen their abilities to engage ill-structured problems that demand higher order thinking skills. Second, these opportunities will allow students to understand why they need to be able to think critically and how this can enable them to be better solvers of “real-world” technological problems.

Finding opportunities to weave critical thinking into the engineering curriculum will expand the breadth of students' capabilities to help them to understand, analyze, and solve the multidimensional problems that are facing the world in the 21st century and beyond. Students will become more aware and engaged in the socio-technical world that they live in. It can be anticipated that engineers might become more effective participants in everyday issues and discussions about social and economic issues. Engineers who are comfortable engaging in more critical thinking might be less isolated from public debate and might even improve societies' capacity to address the technological challenges of today and the future.

The correspondence between technological literacy, that is, the broad understanding of all aspects of technology, and the ABET accreditation criteria have been established[9]. The challenge has been finding ways to include all the dimensions of technological literacy in activities within the engineering curriculum given the many practical constraints under which engineering educators must operate.

Summarizing the major features of the exercise developed to promote and assess critical thinking, the basis of the approach is the prediction of impacts as indicators critical thinking and decision making. The activity uses new technological developments from news articles as the subject matter in which critical thinking will be directed. Students are asked to predict some possible impacts of the new technology in question. Impacts are defined as changes in the existing social, economic, and cultural environment. Students are prepared by studying examples of new technologies of the past that have now become common place. As an assessment approach a simple scoring rubric is suggested to facilitate instructor scoring and to encourage more engaged thinking on the part of the students.

Exercise and Assessment Method

This work reports a student activity and assessment method which aims to promote critical thinking in a sociotechnical context linking ABET Criterion 3 Outcome (h) to the three dimensions of technological literacy envisioned in *Tech Tally*.

To promote and measure the extent to which students in Introduction to Engineering "understand the impact of engineering solutions in a global and societal context," students are be asked to predict some possible impacts of an engineering solution. In this case, understanding will be equated with an ability to predict or anticipate the changes that an engineering solution might cause in a societal context.

Using an ability to predict or anticipate an impact is a valid measure of understanding and appropriate to the intent of the ABET Criterion 3 Outcome (h). In Bloom's Taxonomy of the Cognitive Domain, there are six levels [10-14]. Higher levels imply more complexity than lower levels. Using the widely accepted Anderson and Krathwohl modification of Bloom[13-14], the fifth level of evaluating involves making judgments based on criteria and standards through checking and critiquing. Predicting an impact is a judgment made based on criteria and standards and can considered to be in this category. This fifth level represents a high degree of cognitive engagement.

Here we use the term activity to apply to all of the steps associated with using this exercise with students. Activity includes work done in the classroom, related homework, and in-class group activities. Assessment refers to the process of measuring student attainment of the desired learning outcomes. Assessment is a sub-set of the overall activity. In all cases the activity is done in a single class period. As described below, the assessment is given as a question on the final examination for the course.

Description of Assessment

Students are given a description of a very new but existing technological device. The technology selected is something that just became available to consumers or potential users. The description is taken from a news article or similar source written for a general audience. Students are then asked to predict some possible impacts of this engineering solution in a social and global context.

After reading a description of the new technological device, students are asked to list potential impacts. Students are encouraged to list as many potential impacts as they can envision. For this assignment, each student works alone but variations involving group work are possible.

A new but existing technology is used rather than a hypothetical scenario because it is desired to avoid problems that might arise from students taking issue with the question and contending that the hypothetical scenario is unlikely or unrealistic in some way. By using an actual technological product the question of likelihood is avoided. The technological product, or engineering solution actually exists. A very new technology is used so that significant potential societal impacts have not yet occurred. The technology exists, and is available but has not yet diffused into society to the point where social impacts have become evident.

Actual news articles written for a general audience are used in describing the new engineering solution for several reasons. First, a description for the general audience is most appropriate for beginning engineering students that are not likely to have developed in-depth engineering knowledge yet. Second, it helps to avoid faculty bias by using descriptions of technological issues from the public media.

We have found that short news articles about actual new technologies have worked well in engaging the attention of engineering students, however it is certainly possible to envision variations that might also be successful in fostering critical thinking about sociotechnical impacts. For example imagining life in the past may also be a fruitful exercise. Some past technological innovation could be described and then students could try to imagine living at that time and predict possible impacts. Student predictions could be compared to actual impacts.

Scoring Rubric
Each potential impact in a student's list is given a score in the range of 0 to 5.

Table 2: Rubric for Scoring Predictions of Societal and Global Impacts.

0 points:	Answer is not an impact.
1 point:	Identification of an impact that is direct, obvious, readily apparent.
2-3 points:	Insightful and less obvious direct impact.
5 points:	Identification of a second-order impact, such as an impact from an impact.

A response that is not an impact is given zero points. For example a response that is a statement of a feature or capability of the technology has not identified an impact. A response that identifies a design requirement of the new technology is similarly not an impact.

A response is given one point if the response is an obvious or readily apparent potential impact of the new technology. Responses in this category could include impacts regarding safety, health, or the environment. Other readily apparent impacts would be changes for existing competing products, industries, or individuals and groups directly involved with the new product. For example if, several years ago, a student had been shown a new article describing an iPod and asked to predict an impact of the device, reduced sales of compact disk players would be a readily apparent impact.

Responses that are more insightful and identify less obvious impacts are given 2 or 3 points depending on the sophistication of the response. These would be impacts that occur beyond the immediate or primary intention of the producers of the devices. In the case of the iPod a less obvious impact that might have been predicted is creation of a new way for individuals to listen to non-music audio materials such as news broadcasts.

Five points are given to what are described as second-order impacts. In this situation, a student foresees a secondary impact or an impact that results from another likely impact. An example of this would be foreseeing that the pervasive use of iPods would lead to criticism of the device for worsening the lack of personal interaction or social isolation present in modern society. Or foreseeing the need to enact laws, as some cities are considering, that prohibit listening to an iPod while crossing the street due to hazards caused by an inability to hear oncoming traffic.

Initial Pilot Test

This approach to promoting critical thinking in a sociotechnical context was tried in an initial pilot in one section of an Introduction to Engineering (ENGS100) course at Hope College. The course covered a range of the typical introductory engineering topics including the design process, fields of engineering, and some selected engineering science topics. The topic of sociotechnical impacts was addressed in one class session. While this is not a significant amount of time, the concentrated approach was used to make it possible for other instructors to adopt the results. If desired, this material can be addressed in a single class session. Clearly more time can be devoted if available.

A key aspect of the presentation is explaining to the students the ABET criteria and the existence of criterion (h). Students ask “why are we doing this stuff, it’s not engineering.” It is important to explain to these first year engineering students that accreditation requires that students’ meet outcome (h) and have the “broad education necessary to understand the impact of engineering solutions in a global and societal context.” Otherwise the freshmen tend to think if there are no calculations involved or if the activity is not building something it is not relevant to engineering and can be ignored.

The essential features of the activity involve a brief overview of the impact on society of engineering innovations of the past. The light bulb and the transistor are chosen because the dramatic impact can be conveyed in a brief overview. The class then works in groups to list the impacts of a comparable recent invention in their own lifetime. The iPod was chosen since currently most student can remember a life before and after the existence of this technology. The group works together to predict possible impacts of an emerging new technology. Recently, self-driving cars has been chosen. Related homework problems predicting impacts are assigned and graded using the rubric described. Students are told to expect a question like this on the final exam.

Sociotechnical Impacts Question on ENGS100 Final Exam

The final exam question for the initial pilot group is described below. The specific example of a new technological product or engineering solution, used was the Skystream 3.7 windpower generator [15]. This is device appeared on the list of the TIME Best Inventions. The description provided to the students was taken from a news release. The verbatim decription given to students is shown below:

> “Breezy Alternative”
> Wind is a wonderfully renewable source of energy, but until now ordinary consumers who wanted to live off of--or contribute to--the electrical grid had no way to capture it. That's where the Skystream 3.7 comes in. It's a wind turbine designed especially for home use. Installed on a 35-ft. tower, it connects to standard utility hookups and starts turning in breezes as low as 8 m.p.h. It can provide up to 80% of the average household's electricity and shave $600 or more off annual utility costs.
> Inventor: Southwest Power
> Availability: Now; about $10,000, including installation”

The following question was posed:

What are some of the possible <u>impacts</u> of the Skystream 3.7 in a global and societal context?
Please write your answer in list form.

The results for the Introduction Engineering course initial pilot are shown in Figure 3. The figure shows the score for each individual student. The scores are plotted in decreasing order from the highest to the lowest score.

The highest score was 28. The lowest was 1. The average was 12 with a standard deviation of 7.7 for this class of 31 students.

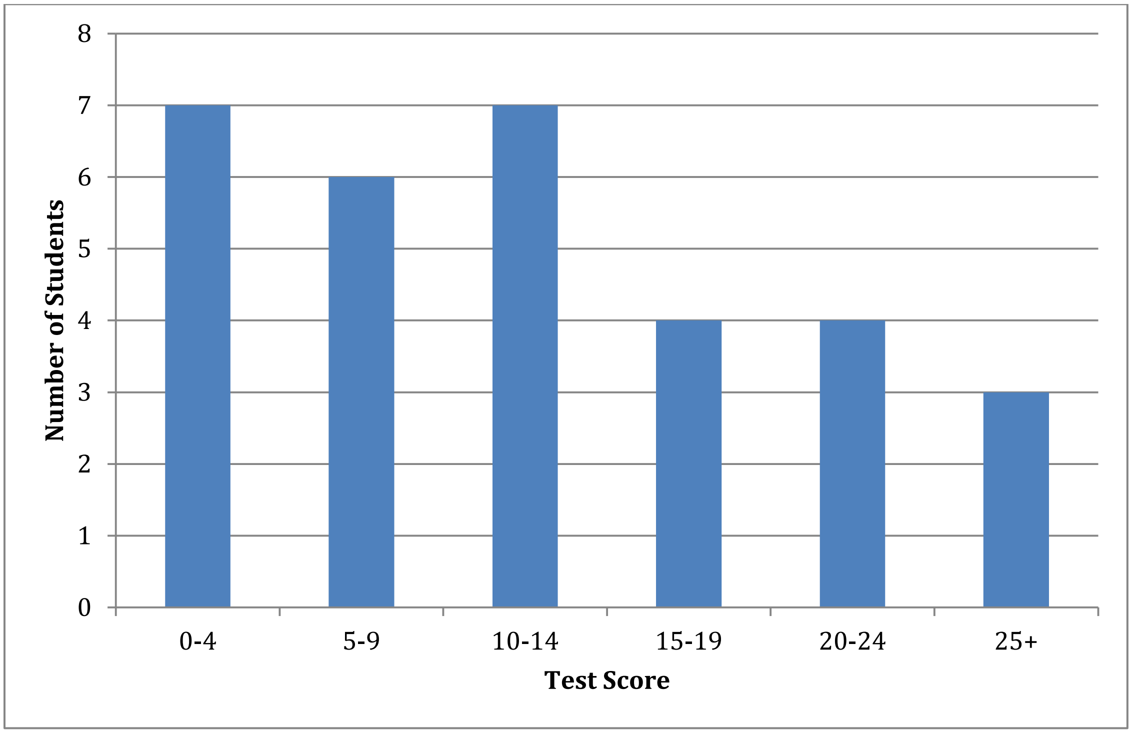

Figure 3: Scores for Predicting the Impacts in a Global and Societal Context – Initial Pilot.

Examples of Scoring

To provide an example of how responses were evaluated using the rubric, the answers of three different students are included verbatim below. After each verbatim response the score given that student response is included. Examples of poor, average, and excellent overall scores are included.

Student 1: Example of a Poor Overall Score
"Air would become cleaner"
1 – Possible impact readily apparent

"Less noise pollution"
0 – Not a possible impact. Noise pollution not strongly liked to electric power generation.

"Less money spent on power in the long run."
1 – Possible impact readily apparent

"Could lead to a more efficient way to generate power."
1 – Possible impact readily apparent

"Wind will never run out unlike fossil fuels."
0 – As stated this is not an impact. This is a characteristic of wind power not an impact.

Student 1: Total score = 3

<u>Student 2: Example of an Average Overall Score</u>
"Companies providing electricity may lose business"
1 – Possible impact readily apparent

"Jobs [in electricity utilities] would be lost"
1 – Possible impact readily apparent

"People would be safer during times when electricity is out, they have their own power source."
3 – Potential impact that is less obvious

"Could be dangerous in natural disasters like tornados and earthquakes"
3 – Potential impact that is less obvious

"Less fossil fuel would be burned."
1 – Possible impact readily apparent

"However, many [fossil fuels] would be burned initially in order to construct Skystream 3.7."
5 – A possible significant but indirect impact that is not obvious

Student 2: Total Score = 14.

<u>Student 3: Example of an Excellent Overall Score</u>
"The general look of residential neighborhoods will be different (good/bad?)"
3 – Potential impact that is less obvious

"Will save homeowners money from electrical bill."
1 – Possible impact readily apparent

"Electrical companies will lose money"
1 – Possible impact readily apparent

"Electrical company might have to fire workers"
1 – Possible impact readily apparent

“New Skystream 3.7 employees will be hired.”
1 – Possible impact readily apparent

“Could cause radio interference”
5 – A possible significant but indirect impact that is not obvious.

“Possible loss of cellphone signals when near a Skystream 3.7”
5 – A possible significant but indirect impact that is not obvious.

“Less power lines may be constructed/needed.”
3 – Potential impact that is less obvious

“May be more likely to have residential lightning strikes, more deaths.”
5 – A possible significant but indirect impact that is not obvious.

“Save a lot of money, other areas of the economy will have increased profit because of the extra money ($600) being spent elsewhere.”
3 – Potential impact that is less obvious

Student 3: Total Score = 28.

Comparison to Students’ ACT Composite Score

An analysis was performed to see if a relation exists between student ACT Composite score and the score for understanding the impact of engineering solutions in a societal and global context. Results from ENGS100 Introduction to Engineering, initial pilot final exam are shown in Figure 4. Data is shown for 27 out of 31 students for whom ACT scores were available.

The results show very little correlation between ACT composite score and the score for predicting the impact of an engineering solution in a global and societal context. The graph in Figure 4 is included point out some interesting specific data points. ACT composite score is based on a combination of reading, writing, mathematics, and scientific reasoning ability. The ACT composite score is considered to be a measure of overall academic ability. There were some students with very high ACT composite scores that had low impact prediction scores. For example any student with an ACT composite score of 30 or higher is in at least the 97th percentile nationally. Some of these students had scores at the class average or lower. Similarly some students with lower ACT scores were among the highest in the class in understanding impacts of engineering solutions. For example and ACT composite score of 25 is in the 80th percentile nationally yet two students with these ACT scores were among the top 4 students in the class.

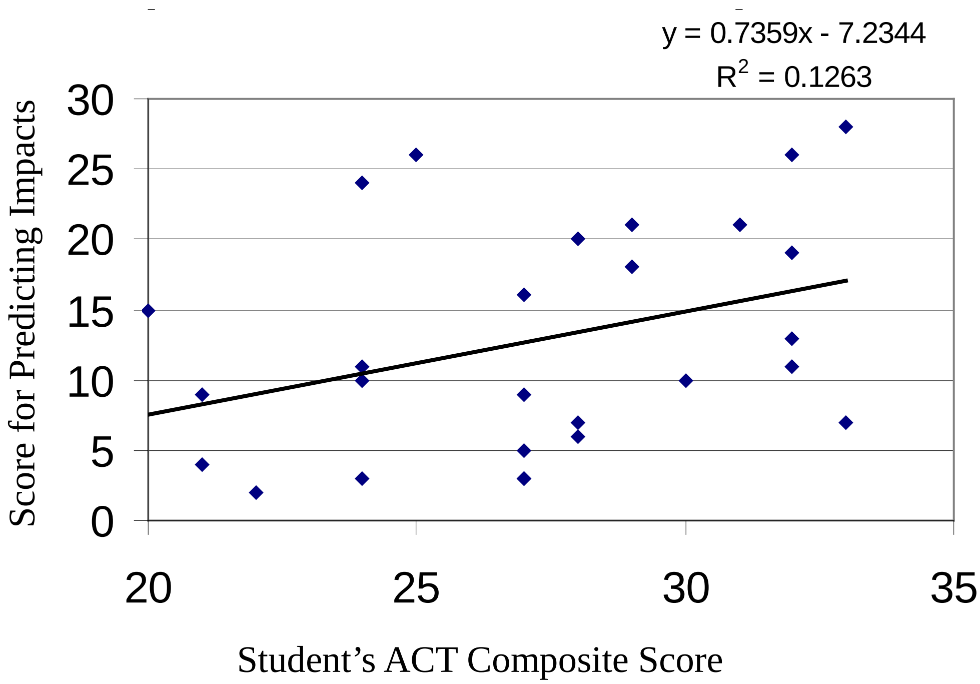

Figure 4: Scores for Predicting the Impacts in a Global and Societal Context Compared with ACT Composite Scores.

For these students in Introduction to Engineering, the apparent absence of a correlation between ACT composite scores and ability to understand impact of engineering solutions is reasonable. The ACT composite score is a measure of academic ability in four areas: reading, writing, mathematics, and scientific reasoning. The subject matter of these ACT tests is narrower than the much broader issue of understanding the impact of an engineering solution in a global and societal context requires a broad education. There is limited overlap between the questions appearing on the ACT and questions of how engineering solutions might impact society.

The lack of a strong correlation between ACT composite score and ability in ABET outcome (h) also indicates that learning experiences, such as the activity described here, must take place for engineers to achieve capability in this area. The ability to understand the impact of engineering solutions is not already present in the beginning engineering students. Unlike basic mathematical skills or reading ability, the ability described by outcome (h) must be acquired through the undergraduate curriculum.

Establishment of a Performance Goal

In keeping with the nature of ABET outcomes assessment, some type of performance goal should be established for engineering students' ability to envision possible impacts of engineering solutions. For students in Introduction to Engineering (ENGS100) at Hope

College, a score of 10 is considered satisfactory ability to understand the impact of engineering solutions in a global and societal context. This score would result from a student identifying 10 obvious or readily apparent impacts of a new technological product. Any combination of impacts is acceptable provided the total score is 10 or higher.

This goal seems reasonable by considering a few possible ways that a student might obtain a score of 10. Even lacking inspiration or insight, each engineering should be able to extract or foresee 10 straightforward impacts. Alternatively, a score of 10 can be reached by envisioning 4-5 less obvious impacts. It would appear that identifying 4 less obvious impacts is at least comparable to 10 more obvious or straightforward impacts. Similarly, a student who can anticipate 2 second order effects of a new technological product would have an ability to understand the impact of engineering solutions in a global and societal context.

At the present stage of development, a sufficient number of test sites have yet to be recruited to demonstrate good statistical psychometric properties. Similarly, next steps would include refinement of the in-class activities to include additional guidance to students to encourage depth of thinking and consequently increased scores.

Types of Topics Used in Questions.

In selecting new technologies to use as the subject of questions, articles are chosen that are relatively brief, typically a page or less. Shorter articles are more compatible with examinations and in-class group activities. Some of the topics used have included the following:

Green Concrete: Concrete that absorbs carbon dioxide from the air when it cures [16].

Woven Electronics: Conductive fibers which enable fabric to become an electronic device[17].

Persuasive Technologies: Technologies that track customers' preferences and customize its services accordingly[18].

The Invisible Skyscraper: A skyscraper that provides a view of the scene behind it by the use of cameras and dispersed LEDs and video displays [19].

WeCU: A system that combines behavioral profiling with automated measurement of physiological reaction responses such as body temperature, heart rate, and respiration in airport security[20].

Tests with Larger Class Sizes

The prediction of sociotechnical impacts test was used in with two other Introduction to Engineering classes at the same institution. Results are summarized in Figure 5. This histogram shows the fraction of the total number of students in each class that obtained scores for a particular range. One result is for the Fall 2012 class which had 99 students. The other results shown is for the Fall 2015 course with 88 total students. Results are not available for 2013 and 2014 due to use of a different curriculum for the course.

The results shown are from the sociotechnical impact question that appeared on the final examination in each offering. This question was just one of the questions on the final. The final examination included questions on a range of engineering topics covered in the course. The question was stated as follows:

"What are some potential impacts of the new techology described in the article provided. Consider potential impacts in a social, economic, cultural, and global context? Please write your answer in list form. Aim for at least 10."

An important feature is that after the question was posed, a target of 10 impacts was specified. This was included to reduce the anxiety of students taking the examination since this was just one question out of the entire examination that included numerous calculation-type questions. Given that students would need to allocate their time to many test questions, it seemed fair to the students to provide some type of expectation so they could feel that they addressed the question adequately and could move on to the other questions on the final.

As can be seen in the figure, the results were highly similar in each year. In Fall 2012 the average score was 11.8 with a standard deviation of 3.9. In Fall 2015 the average was 11.3 with standard deviation 3.4. In both instances 70% of the class scored in the range of 10-14 points.

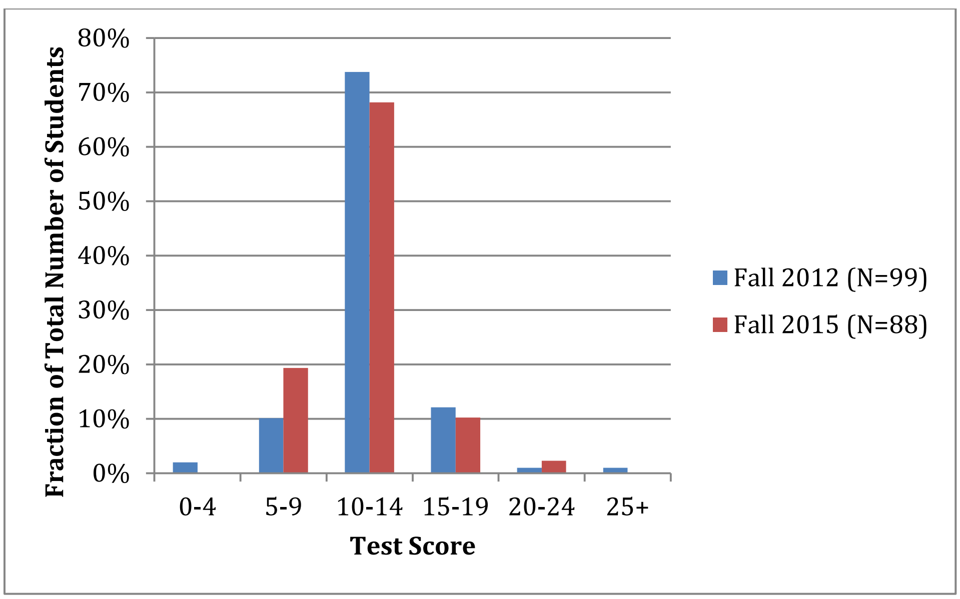

Figure 5: Scores for Predicting the Impacts in a Global and Societal Context with Larger Introduction to Engineering Classes.

These results are interesting from a number of perspectives. First it appears clear that students were seeking to just barely meet expectations and achieve the expected score of 10. This may seem disappointing from the point of view that the students, on the average, only met expectations. However, given that it was an examination situation and as test-takers they needed to allocate their time efficiently, it seems reasonable that they would respond as needed and move on to other questions.

A positive interpretation is the view that most students were able to think critically about a sociotechnical issue and rise to the level of expectations. Since the instructor is evaluating the quality of each student response when applying the scoring rubric the result is not merely a simple count.

For these introduction to engineering students, setting some type of quantifiable goal helped them to engage in critical thinking. This can be seen by comparison of the pilot test results shown in Figure 3 with the Fall 2012 and 2015 data. The average score for the pilot was about the same but a significantly higher fraction of the students scored in the lower range of the distribution. In the pilot about 40% of the group scored below 10. While in 2012 and 2015, the fraction scoring below 10 was only 12% and 19% respectively. A disadvantage of setting a quantified goal for the students in terms of critical thinking is as smaller faction had very high scores. Some of the students who would have been less inclined to think critically we able to engage in critical thinking on a sociotechnical issue to an acceptable level but some of those who might have been able to develop interesting insights curtailed their analysis when the felt that they reached the level needed to “pass” the question.

Comparison Group Results

To gain an estimate of the extent to which the activity has helped the engineering students to think critically, the assessment was used with an approximate comparison group that did not participate in the class activities. The comparison group was given the same assessment question without have undergone any of the activities beforehand. The average score for this group was 6.6 with a standard deviation of 4.0 (N = 37). This is a statistically significant difference.

The Sociotechnical Future

It is clear that the future frontiers of engineering will be largely sociotechnical in nature. Today’s engineering students must be specifically trained to develop critical thinking ability in a sociotechnical context. For example the IEEE president has recently published these comments about smart homes [21].

And then consider the data a person interacting with a smart home can generate. Does that data belong to the person? Does it belong to the manufacturer of the machine that *captures that data? Can the government monitor it in the name of national security? The legal, ethical, and regulatory questions surrounding the issues of data, privacy, and security are staggering and must be considered long before smart homes become widespread.*

In the years ahead, smart homes will be created, developed, and improved by our global professional community. It is critical that technical professionals not limit their role to creating the hardware, software, and interfaces. As a community, we should consider the responsible development of these technologies in the smart-home ecosystem and how to best play a role in shaping their adoption.

Here the IEEE president makes a clear case for why mere technological knowledge and capability (only 2 dimensions of Figure 1) for knowledge are not enough. Engineers need to be familiar with thinking critically about the sociotechnical aspects of engineering solutions. Training responsible engineers to be citizens and technological leaders, concerned with welfare of the society, must recognize the interconnections of the socio-technical aspects and consequences of engineering work.

Relevance to Proposed ABET Accreditation Changes

ABET has proposed revision of the engineering accreditation criteria[22]. In the revision criterion (h) would be eliminated. A number of engineering educators question the wisdom of this move especially since professional skills appear to be a key element in the competitive advantage offered by US-educated engineers[23,24]. ABET cites a “difficulty determining the extent of outcome attainment” as one of the reasons for elimination of outcome (h)[25]. The work reported here demonstrates a promising approach for determining the extent of attainment of understanding the impact of engineering solutions in a global and societal context.

Conclusions

Asking engineering students to predict the impacts of a newly introduced technology can serve as an efficient means of engaging first-year engineers in critical thinking on sociotechnical issues. Before the value of this activity and assessment can be unambiguously defined more data needs to be collected. In the meantime the concepts and methods described here are provided as promising initial results for the benefit of the engineering education community. Establishing some means of grading or scoring is essential in helping students to engage the topics. Showing a link between critical thinking about sociotechnical issues and ABET accreditation is vital in establishing the importance of this ability in the minds of novice engineers. While students may rise only to the level of expectations in their critical thinking, this level is still likely to be beyond the extent to which they would engage in this type of thinking without encouragement and elementary guidance from engineering faculty.

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