Evaluation of the Accessibility of Engineering Vocabulary

Chirag Variawa and Susan McCahan
University of Toronto

Abstract:

Do engineering instructional materials at the university level contain identifiable barriers to success unrelated to course objectives? This is a growing concern as the population of students becomes more diverse. And if there are barriers, how prevalent is this issue and can these barriers be characterized in a way that allows the instructor to easily identify and remove or mitigate them? In response to these questions, a research study is being conducted to at the University of Toronto to look at the accessibility of the language used on assessment instruments, specifically final exams. 40 student volunteers were involved in the study. The preliminary data suggests that one of the obstacles to mitigating barriers based on language will be the student's own assessment of their language proficiency.

Background:

Accessibility to buildings and public spaces for people with physical disabilities became a legal requirement several decades ago with the introduction of the Americans with Disabilities Act[1] and other related legislation. Since then an understanding of accessibility as a basis for design has grown. It is now as much a part of the design process in architecture, particularly public architecture, as economics or safety.[2] The move in architecture led to a definition for Universal Design in general which is an approach that takes into account the widest possible user base. There are many successful examples of this approach applied to products such as kitchen equipment or ATM machines.

More recently the principles of Universal Design have been re-interpreted in the context of education; first at the elementary levels and lately for secondary and higher education.[3,4,5] The principles can be applied to the learning environment at every level: curriculum, courses, classroom space, course materials, and university systems in general. The goal is to create a learning environment that is accessible to the widest variety of students without compromising academic integrity.

In a limited way we can say that academic integrity, in this sense, is defined by the learning objectives and goals of a course or program. If a student is demonstrably able to meet the goals to a specified degree then we would judge that they had met the requirements of the course or program. Accessibility issues arise when there is a misalignment between the learning objectives and the requirements. While these misalignments are sometimes explicit, they are more often implicit. For example, suppose that a field trip is required for the course, but the bus used to transport the students to the field trip site is not wheelchair accessible. This creates an implicit barrier to fulfilling the course requirements for the student in a wheelchair, noting that the ability to board a bus is in no way connected to the goals of the course. While it is not possible to design a course, or course materials, that will take into account all possible users and give them all equal access, it is possible to think broadly about the variety of students in our universities and design courses that take into account that broad population to the greatest extent possible. University populations are changing and we need to think about how we welcome that increasingly diverse population into the classroom.

At the University of Toronto the engineering undergraduate population is very culturally diverse. In the 2007 freshman class we have students from 48 different countries, 6 out of 7 continents, who bring with them their cultural heritage and experiences. The majority of our students come from the greater Toronto area (GTA), and about 10% of the GTA population are newcomers. We have a relatively large number of students (~60%) who speak a language other than English in their home environment, and a significant number who are the first in their family to go to university. In addition, the general technical knowledge base that we assume exists for incoming students may not be as homogeneous as it once was. Anecdotally, it was found in our first year design course that this diversity was uncovering implicit accessibility barriers particularly on tests and exams.

Specifically, the language used on the exams to put engineering design problems into context was causing difficulty for our students. On an assignment, or other type of work, students can freely seek out help, but on an exam the help is limited. Furthermore, the type and degree of help given in terms of helping a student understand a word or term on the exam depends largely on the people who are invigilating in that particular room. This can create inconsistency and a perception of unfairness when the class is spread out through a number of rooms to take the exam. Again anecdotally, it was appeared that the type of difficulty the students were having with the wording fell into three categories:

Technical: terms that we assume students understand from previous technical experience (in or outside of school), e.g. coal.

Cultural: colloquial terms, or common words, that we assume students understand, e.g. kettle.

Language: terms that are common in engineering but not necessarily used frequently in everyday language, e.g. injection.

If these barriers do exist on engineering assessment instruments, this may create an unnecessary obstacle to success for students who could bring a diverse perspective to the profession. Yet we have communication skills identified as a prime competency that we believe is important for our students. To address both of these issues the team teaching the first year design course decided to publish a list of words prior to the exam. The list includes words that will appear on the exam, and some that will not, without definitions. It is the student's responsibility to look over the list and identify which words they do not understand, and find the meanings for those. This approach seems to be working well in practice, but it has a major flaw. It assumes that students are able to identify what they do not know.

Methodology and Results:

To test how well students can self-assess their vocabulary, a study was devised. 40 student volunteers were enlisted to assess their own understanding of a set of words, and also to provide synonyms or definitions for the same set of words. The students were given written instructions (see Appendix A.) and a presentation on how to assess their own understanding. The students were asked to rate their understanding of each word numerically and then to write some synonyms or a definition of the word. The words for this study were chosen such that there were a few in each of the identified categories: technical, cultural, and language. The list of words is shown in Appendix A. Independent of the student's self-evaluation, the definition or synonyms they gave was rated by the researchers against a dictionary definition, this will be referred to as "observed understanding". The goal was to determine whether students could accurately identify their own level of understanding.

The results for one of the words, "succinct" are shown below. The error bars on the data points in Figure 1 indicate the number of responses, i.e. the smaller the error bars, the more students responded with that combination of self-score and observed score. In Figure 2 the frequency of each self score response is shown. There are a number of interesting observations that can be made. First, many students do not have any understanding of the word "succinct". In addition, the distribution is to some degree bimodal. Students seem to have either no understanding of the word, or a reasonably good understanding, with the minimum response frequency falling in the middle of the range.

Second, although the data are scattered, there does seem to be some correlation between self score and observed understanding. In general the students are under-rating their understanding. 24 of the students rated their understanding at or below the observed level. Of the 16 students who rated their understanding above the observed level the average difference between the self score and the observed score was 1.56. This suggests that most students, if told that this word is going to appear on a test, would be able to assess whether they need to improve their level of understanding in preparation for that test, or not.

Conclusion:

There are several general conclusions to be drawn from this study. First, the anecdotal evidence that suggested that vocabulary may be an impediment for our students seems to be borne out by these preliminary findings. The word "succinct" may not be common, but it certainly is used regularly in assignment instructions and long answer question instructions on tests. Furthermore, the understanding of this word is not generally perceived to be a learning objective in an engineering class, yet a lack of understanding may lead to a misinterpretation of instructions which could impact a student's mark.

The data suggest that students are in a position to mitigate this barrier to success if the barrier is pointed out for them. That is, if a vocabulary list or other means are used to alert students to the need for understanding of these words, the students have enough self-awareness of their situation to take steps to improve their knowledge base in this area. This does not suggest that we should demand that our students take these steps. The responsibility for addressing the situation is left up to the student. However, it is appropriate to point out the gap between our expectations as professional communicators, and their current understanding of appropriate vocabulary, to give them an opportunity to work toward that expectation before it impacts their mark.

Overall, this type of approach fits in with the principles of Universal Instructional Design which suggest that people should have equitable access to the learning environment, and that the learning environment should work flexibly with a student's needs. A vocabulary list published before a test is not tailored to any one student, but allows all students, whatever their individual needs, to use this resource in any way that works for them. In future work we are now compiling data on the way students understand vocabulary and barriers to understanding in the authentic context of exam questions.

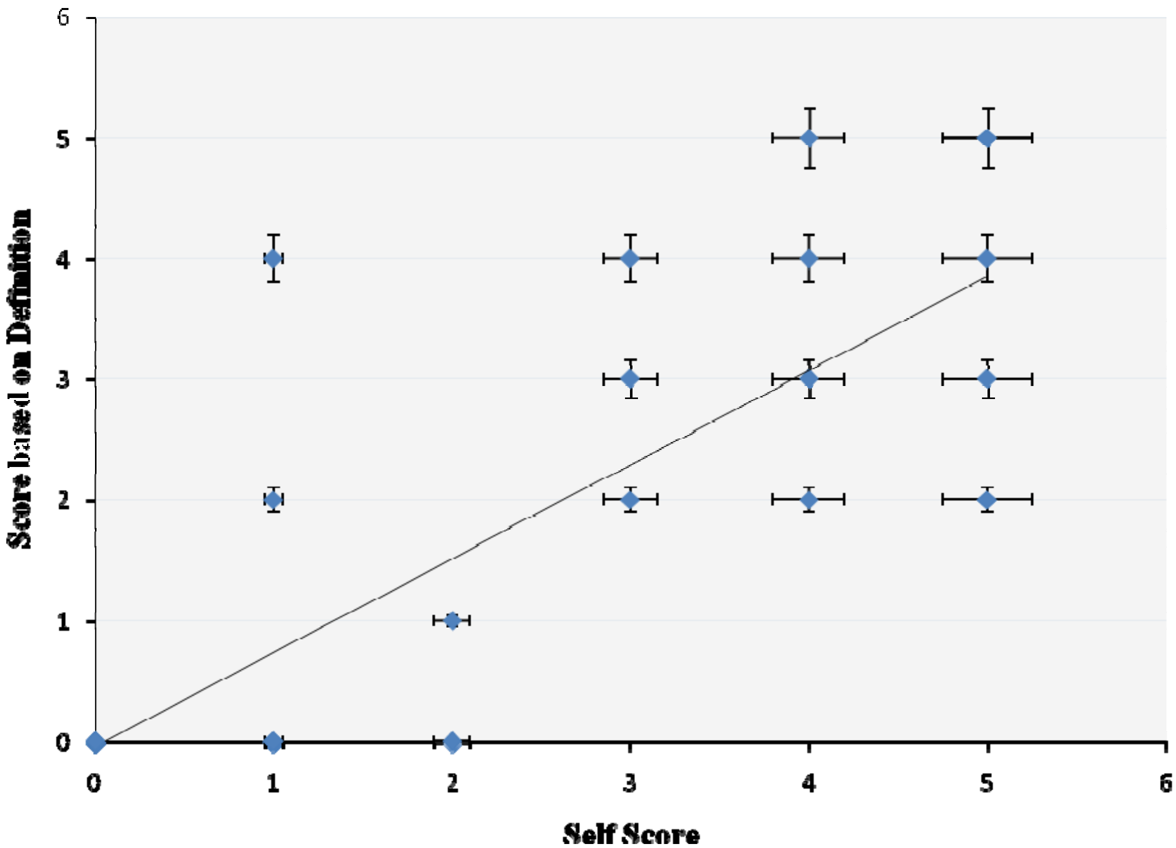

Figure 1. Understanding demonstrated by the synonyms or definition given versus self score for the word "succinct": smaller error bars indicate more than one datum at that point.

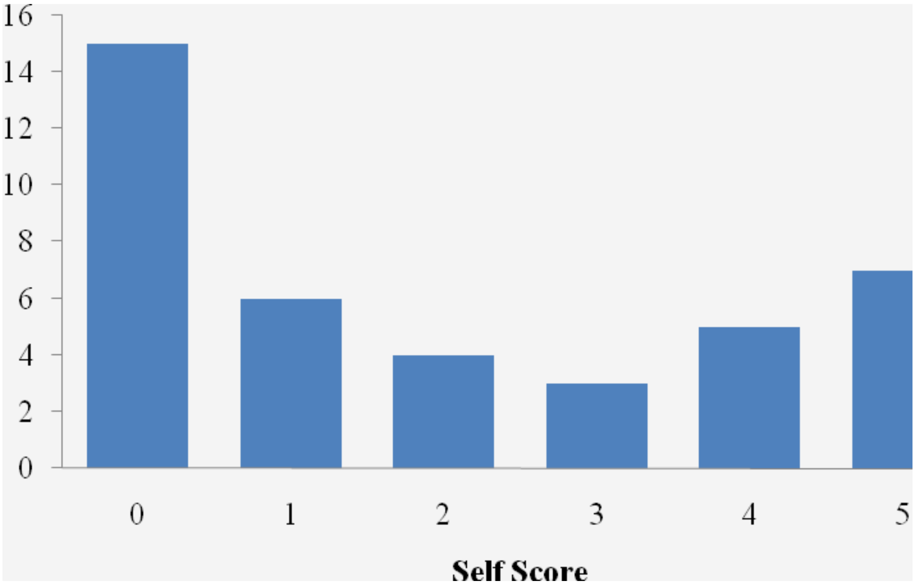

Figure 2. Showing the number of students who assess their understanding of the word “succinct” in each numerical level.

References:

1. Americans with Disabilities Act of 1990, P.L. 101-336, 104 Stat. 327, 42 U.S.C. 12101 et seq.
2. The Center for Universal Design, North Carolina State University. [Online] Accessed January 16, 2006. Available at: http://www.design.ncsu.edu/cud/index.htm
3. Bowe, F. (2000) *Universal Design in Education: Teaching nontraditional students*, Westport CT: Bergin & Garvey.
4. Scott, S.S., McGuire, J.M., and Shaw, S.F. (2003), “Universal design for instruction: A new paradigm for adult instruction in postsecondary education,” Remedial and Special Education, 24(6), 369-379.
5. Pliner, S.M., and Johnson, J.R. (2004), “Historical, Theoretical, and Foundational Principles of Universal Instructional Design in Higher Education,” Equity & Excellence in Education, 37, 105-113.

Biographical Information:

CHIRAG VARIAWA, B.A.Sc expected 2009
Chirag Variawa is a third year undergraduate materials engineering student at the University of Toronto. In addition to being in the top twenty of his class and faculty representative for his department, he spent his summer researching innovative engineering education.

SUSAN MCCAHAN, Ph.D. P.Eng.
Prof. McCahan is an Associate Professor in the Department of Mechanical and Industrial Engineering at the University of Toronto. In addition, she is currently the Chair of First Year for the Faculty of Applied Science and Engineering. She is the recipient of a 3M National Teaching Fellowship and is a Fellow of the American Association for the Advancement of Science for her contributions to engineering education.

Appendix A.: Instructions given to student volunteers.

Answer as many questions as you can to the best of your ability.

For the Synonyms column below, attempt to identify at least 2 words. If you cannot, then write its definition. For the Level of Understanding (numerical) column below, fill in each of these boxes with a number as follows:

0 (Zero) – I **DO NOT** know the meaning of this word. I **WOULD NOT** be able to describe its meaning.

1 (One) – I have a **VERY LIMITED** understanding of this word. I would be able to give a **VAGUE** (imprecise) description of its meaning if asked in a sentence.

2 (Two) – I have an **INCOMPLETE / LIMITED** understanding of this word. I am able to explain the general meaning of the word even if it was not asked in a sentence. If I could speak another language in addition to English, I would probably be able to translate it.

3 (Three) – I have an **AVERAGE** level of understanding of this word. I am able to give a **CLEAR** description of the word even if it was not asked in a sentence. I am able to think of similar words with a similar meaning if required.

4 (Four) – I have an **ENHANCED** level of understanding of this word. I can give a **DETAILED** meaning of its usage, and I know how to position this word in a sentence to make it more fluid. I am able to give a precise definition of the word.

5 (Five) – I have a **SUPERIOR** level of understanding of this word. I know **EXACTLY** when the use of this word will make literature more meaningful or artistic. I am able to discuss its definition, word origin, its cultural significance and can give an **EXTREMELY DETAILED** meaning if required.

Word List

Word	Level of Understanding (numerical)	Synonyms / Definition
Fax		
Propagate		
Feasible		
Tolerance		
Mold		
Succinct		
Field		
Bungalow		
Jello		
Bonnet		