Chapter 7

The Benefits of Teaching Students the Language of Physics

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ABSTRACT

First year physics courses for non-physics majors are among the most difficult course to cope with for science and engineering students alike. Not only are students confronted with physics specific concepts and mathematics applied in unfamiliar environment, students also have to learn the specific lingo of physics and keep it separate from common language and language used in their own field of major. Anecdotally, we know that students have to master the language of their respective field of study in order to master the field. We investigated the link between language of physics used in our first year physics lectures, understanding of related physics concept, and student performance after a language focused intervention. We found that a language conscious approach in first year physics not only improved the performance of students of non-English background but also benefited the performance of students of native English speaking background.

INTRODUCTION

The first year physics course is one that many science, engineering and medical science students will have to master in their career at university.

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While some may have been exposed to the language, others will have had little or no experience of physics or its language. Many non-science majors find first year physics quite daunting, if not intimidating. Of the many factors contributing to this experience are two that stand out quite prominently, students believes that physics is dif-
ficult; and difficulties trying to learn physics at a pace that presumes full command of the language of science and physics.

Research into the problem of enabling students to better acquire scientific vocabulary suggests that ‘technical’ words make up only a small percentage of vocabulary in scientific texts. They therefore pose fewer difficulties than vocabulary which is used in everyday English as well as in a science context. With words that are peculiar to physics, many words have both a scientific and everyday meaning such as ‘work’, ‘energy’ or ‘power’ which can cause confusion for learners. As students bring the everyday association of the words with them, these same words, when introduced in a physics class, can cause confusion. Itz-Ortiz, Rebello, Zollman and Rodriguez-Achach (2003) suggested that a weak version of the Sapir and Whorf hypothesis might be dictated by the language habits of our community predisposing certain choices of interpretation of words. This would cause confusion in students with scientific terms. Researchers have studied semantics in physics (Touger, 1991; Williams, 1999).

In a recent study on the perception of high school students about physics, Angell, Guttersrud, Henriksen, Isnes (2004) found that students find physics difficult because they are confronted with many different representations of physics concepts simultaneously and have to quickly make transformations among them: formulas, graphs, conceptual explanation, experiments. As Redish (1994) pointed out in his implications for cognitive studies for teaching physics, “Physics requires the ability to use algebra and geometry and to go from the specific to the general and back. This makes learning physics particularly difficult for many students” (p. 13). In addition to that standard English enhanced with physics lingo (an English dialect spoken by physicists) presents considerable difficulties similar to the confusion encountered when confronted with a totally foreign language (Stoddard, et. al., 2002; Touger, 2000; Novemsky, 2004).

The challenge facing students with little background in physics is addressed in our course design for non-science students, i.e., students are generally required to take an introductory or foundation mathematics class prior or parallel to their first physics class. Hence, opportunities to practice algebra, formulae, geometry and graphs are provided to assist students with employing those skills in a physics context. Conceptual explanations and experiments rely heavily on the use of common day language within a physics context, often assumes a quite different and distinct meaning.

Many students find it difficult to solve physics based problems although they have a fairly good understanding of how to employ the symbolic representation of physics (formulas, geometry, graphs), the physical (mathematically symbolic) modeling of a physics problem. One student in Redish’s study (1994) put it eloquently “it is as if physics were a collection of equations on fallen leaves.” Mehmet (2009, p. 8) in a study about expectations and beliefs about physics and physics learning that students “tend to regard learning physics as a kind of memorization of separate pieces of information and take what is given by instructors without evaluation.”

The difficulty that students have is in making the link between the collections of leaves and associating each leaf with a particular variety of tree and a particular branch where it came from. Our hypothesis for the study presented here is that a good knowledge of the specific meaning of words used in a physics context will lead students to an improved comprehension of physics concepts and establish a more insightful link between the mathematical modeling of aspects of physics and underlying concepts.

**LANGUAGE IN PHYSICS**

Our observation and testing pool for this study was the Physical Modeling course at the University of Technology, Sydney. Physical Modeling is a one