

The Vocabulary of Physics and its Impact on Student Learning

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Research Question

How students perceive the similarities and differences between everyday meanings and physics meanings of some words and, whether these perceptions affect conceptual learning in physics.



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Linguistic relativity

Linguistic Relativity Hypothesis or Sapir-Whorf hypothesis:

"The language habits of our community predispose certain choices of interpretation."

Sternberg, R.J. & Ben-Zeer., T., (2001). *Complex Cognition, The Psychology of Human Thought.*, New York: Oxford University Press

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Selected Words

Research is limited to Mechanics vocabulary:

Force
Momentum
Impulse



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Method

Research Sample

154 Students in "The Physical World I" lecture. Their textbook: "Conceptual Physics" by Paul Hewitt.

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Method

Pre-instrument (1st survey)

A survey was given **prior to the introduction of the definition of the word of interest**. Students write sentences using the word or a variant of it.

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Method

Post-Instrument (2nd survey)

A few sentences were selected and given back to the students on a second survey **after the definition of the word was introduced in class**. They compare the meaning of the word in the sentence with its meaning in physics.

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Method

The students' responses are classified into three categories:

- (1) Response shows the student can explain how the word "force," as used in each of the sentences, is both similar to and different from the word "force" as used in physics;
- (2) Response shows the student is able to describe *these* similarities and differences for only a few of the given sentences;
- (3) Response shows the student cannot explain *these* similarities and differences for any of the given sentences.

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Method

- A test was given by the class instructor. Students' scores on relevant questions were determined.
- The category of the 2nd survey is compared with this score, per student.

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Method


Interviews:

We conducted 14 semi-structured interviews: Volunteers selected randomly, and a protocol similar to the one used in our written surveys.

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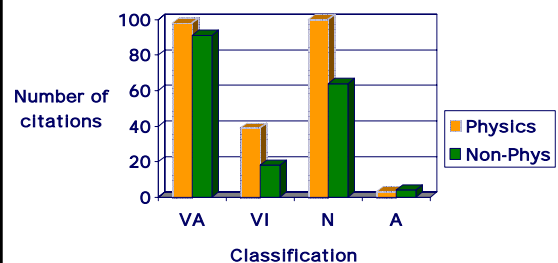
Results: Force

Selected sentences: **Force**

- VA - I forced myself to go to class everyday. 
- (Verb Animate) **My parents forced me to go to college.**
- VI - I forced the box into the closet.
- (Verb Inanimate) **Jim was forcing the nut on the bolt.**
- N - The force on the ball made it move.
- (Noun) **The bomb exploded with great force.**
- I was hit by the force of the 18 wheeler.
- A - **She used a very forceful tone of voice.**
- (Adverb)

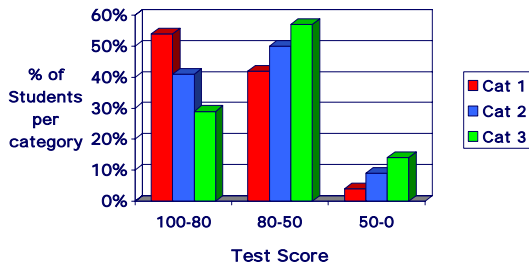
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The use of the word Force



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Results: Force



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Results: Interviews, force

- Force is a push or a pull.
- It causes motion.
- Only 2 out of 14 related force to mass and acceleration.
- Guess the use of the word force by looking at the context in the sentence.
- If they identify physical variables (e.g. mass, acceleration) involved in the physics concept they can differentiate meanings without doubt .

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Results: Momentum and Impulse



Selected sentences: **Momentum and Impulse.**

N - **After their touchdown, the other team had the momentum.**

(Noun) **The football player had a lot of momentum when he tackled his opponent.**

As the car rolled down the hill it gained momentum.

An impulse made her change her mind.

My first impulse was to kick him.

In time of crisis we act on our impulses.

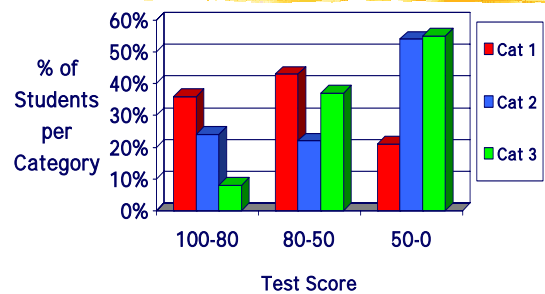
A - **My sister is an impulsive shopper.**

(Adjective)



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Results: Momentum and Impulse



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Results: Interviews, Momentum and Impulse

- Momentum is easily differentiated by the context of the sentence.
- 4 out of 14 identified mass and speed in momentum.
- Impulse cannot be differentiate, none of the students could explain impulse.
- Impulse is usually taken as a quick action, in a snap.

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Instructional Applications

"Learning is a competition of understandings"

Maloney, D. (1993). *Conceptual competition in physics learning*. International Journal of Science Education, **15**(3): p. 283.

Comparing everyday and physics meanings of words will help students to assimilate the meaning of the word in physics.

J. H. McGuire, Tulane University, New Orleans, LA

Larkin, Teresa; Feldgen, M. & Clua, O. (2003) *Learning Styles: A Global Approach*. Announcer, 32 (4): P 83.

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Conclusions

- Students who can differentiate between everyday life meaning and physics meaning perform better on their test.
- From interviews: Students can differentiate meanings if they remember the physical variables (e.g. mass, acceleration, speed) involved in the physics concept.

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More Work

A list of words can be found in:

Williams, H.T. (1999). *Semantics in teaching introductory physics*. American Journal of Physics, . **67**(8): p. 670

Other work:

Schuster, David. *What is in a word? Semantic Misinterpretations of Student's Conceptions*. 126th AAPT national Meeting-Austin TX, Jan. 11-16, 2003. Addendum to Program: Poster, HA21.

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To Kristel Woydziak and Kim Coy: for entering data in the database.

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Results: Force

Category	Number of students	
1	24	Can differentiate
2	32	Have doubts
3	98	Cannot differentiate
Total	154	

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Results: Momentum and Impulse

Category	Number of students	
1	14	Can differentiate
2	41	Have doubts
3	99	Cannot differentiate
Total	154	

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More Information

FORCE

For this survey: **77 Females**, 41 phys and 36 non-phys.
62 males, 39 phys and 23 non-phys.

Students with physics background per category:
(1) 58%, (2) 73%, (3) 53%

We propose that comparing everyday and physics meanings of words will help students to assimilate the physics meaning of the word in their vocabulary. We do not believe the physics meaning of words will take the place of the everyday meaning but rather they would always coexist. Some instructors (McGuire, 2002) have suggested asking students to write essays using these words in different contexts. These different contexts would enable students to confront the very different use of these words in physics and everyday language. Many of the students in conceptual physics classes, such as humanities majors, have strong writing ability, and may find such writing tasks to be quite enjoyable. Efforts to inculcate superior writing skills across the curriculum have been used in several high schools and colleges. The writing exercises described above may have a unique role in such a curriculum.

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