

Problematic Scientific Language

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The purpose of this presentation is to promote awareness of the need for precise language, especially when communicating with students and nonscientists. I am not the first person to bring this topic up, and I hope I will not be the last.

1

This presentation is freely available from www.sticksandshadows.com. Contact the author at heafnerj@sticksandshadows.com.

2

This presentation was created in conjunction with the LCTTA textbook project.

3

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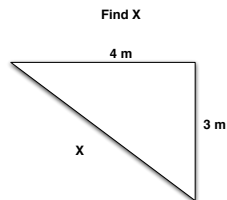
I include an abstract.

Abstract

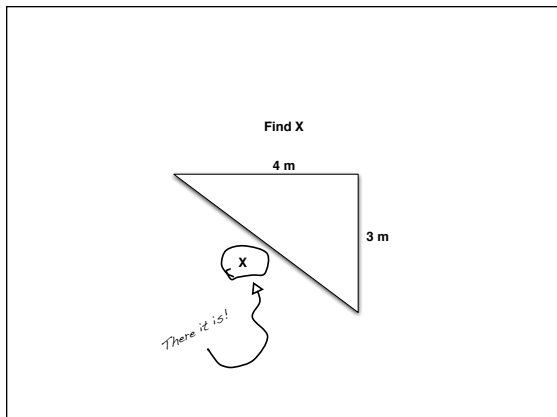
Inconsistent terminology is the source of much confusion among scientists, students, and laypeople. The problems it causes can be eliminated only when scientists pay close attention to word choice. Although soluble, too many professionals refuse to address the problem.

5

Most people will give “5” or “5 m” as the answer. Don’t give any hint as to whether anyone’s answer is right or wrong. A few will get the right answer (according to the instructions).



6



7

The point here is that even teachers don't always use correct terminology. Most students would not get credit for this answer, yet it is the only possible answer given the instructions and no previously agreed upon assumptions as to wording. Ask the audience what the instructions should have said. Most will correctly say something like "Find the value of X."

find the value of
vs.
find

8

Our instructions are not always clearly articulated.

what is represented by X
vs.
X

9

X is merely a symbol that represents some entity. It is not that entity.

multiply
vs.
times

I threw this one in because it is one of the most frequently misused terms and there is absolutely no excuse for it! Under no circumstances is “times” a verb! Ban it. Enforce the ban. Stop the stupidity. Don’t let math teachers continue to propagate this.

10

numerical reasoning
vs.
math

Every time students see numbers, they automatically think of math, brag about their mathematical incompetence, and set up a barrier based on the mythical “mathphobia” that safely gives them yet another excuse to not learn. I contend that there is no math involved in most introductory science courses, the possible exception being introductory calculus-based physics. In science, we need to stop perpetuating the equivalence of reasoning with numbers to mathematics. We need to emphasize the distinction between the two. I make a concerted effort to eliminate the word “math” from my courses and replace it with “numerical reasoning.” Students are always suspicious of this.

11

quotient
vs.
ratio

Ratios compare two like entities. All ratios are quotients but not all quotients are ratios. Velocity is not a ratio. I note the OED disagrees with this definition. Note to mathematics types: stop using the colon notation for ratios! Write ratios as fractions!

12

unit
vs.
dimension

Most textbooks do not go into enough depth with the distinction between these two. It's no wonder students don't know where the radians go. From my experience, no one other than Prof. Anthony French (MIT) knows.

13

critical thinking
vs.
promoting an agenda

These two are often equated, sometimes on purpose. Many, many people think that challenging students to think in a new way or to simply be more open minded is the same as promoting the instructor's personal political, religious, or social agenda. Agendas need not be bad, but they almost always carry a negative connotation. An agenda is distinguished from a conspiracy in that the latter is done in secrecy whereas the former is usually, but not always, done out in the open.

14

hypothesis
vs.
theory

Entire books could be written about this one since it (theory) is the most commonly misused scientific term by both scientists and nonscientists.

15

hypothetical(ly)
vs.
theoretical(ly)

This really follows from the previous slide.

16

model
vs.
theory

The word model may be a better replacement for theory, especially for nonscientists.

17

string hypothesis
vs.
string theory

Without testable and falsifiable predictions and without observational or experimental evidence, you can't call it a theory.

18

music hypothesis
vs.
music theory

Is music the only academic discipline that uses this term consistently correctly? Is music only hypothetical? Does anyone question music?

19

The preponderance of
evidence leads us to
conclude that...
vs.
We believe that...

Scientists don't believe anything. We reach conclusions based on evidence.

20

evidence
vs.
common sense

Common sense is notorious for failing us, especially in introductory science courses. Einstein once said, "Common sense is the collection of prejudices acquired by age eighteen." Common sense tells us nothing. Evidence tells us everything.

21

fact
vs.
opinion

Are they the same? How do they differ? Are all opinions bad? What makes an opinion good?

22

probability
vs.
possibility

This one is difficult for most students to understand. Just because something CAN happen doesn't mean it is LIKELY to happen. Just because it is UNLIKELY to happen doesn't mean it CAN'T or WON'T happen.

23

evidence
vs.
proof

Science is inductive, meaning that no matter how much evidence we gather we can't actually prove anything.

24

confidence
vs.
faith

Science does not operate on faith and it is wrong for scientists to propagate the contrary.

25

uncertainty
vs.
doubt

All science is subject to uncertainty. Some science is subject to doubt. Doubt can be eliminated with further testing or additional observations. Uncertainty can never be completely eliminated.

26

gravitation
vs.
gravity

If all scientific concepts are human inventions, then why is “gravitation” preferred over “gravity?” The answer is that “gravity” gives the impression of a substance that is possessed by matter that makes it attract other matter. Correctly, the name should connote a specific behavior (mutual attraction not attributed to charge) rather than a substance. Let’s eliminate “gravity” from the vocabulary.

27

in low Earth orbit
vs.
in space

I am consistently amused when anyone refers to the ISS or the space shuttle and the passengers are referred to as being “in space” or, even more laughable, “in outer space” when they are no more than about 250-300 miles above Earth’s surface! That’s comparable to the distance between Hickory, NC and Wilmington, NC! As early as fifth grade, I learned the distinction between interplanetary space, interstellar space, and intergalactic space. Let’s use those terms, along with “low Earth orbit,” more frequently and more consistently.

28

contactforcelessness
vs.
weightlessness

There is no such thing as being weightless if weight is defined as the gravitational attraction between an object and Earth.

29

potential difference
vs.
voltage

This one is stubbornly persistent. It is incorrect to substitute a form of a quantity’s unit for the quantity itself.

30

current
vs.
amperage

Same problem as voltage.

31

luminosity (power)
vs.
wattage

Same problem as voltage.

32

fuel efficiency
vs.
mileage

This is an everyday example of substituting a form of a quantity's unit for the quantity itself.

33

charge, current,
potential difference,
power
vs.
electricity

34

“Electricity” is like “gravity” in that it connotes the presence of a substance. It is used as a substitute for charge, current, potential difference, and power (luminosity), none of which is a physical substance. The word should be eliminated from the vocabulary.

X photon or photon
vs.
X ray or ray

35

Rays don't exist. They are mathematical constructs that help explain the behavior of light. What about photons traditionally called microwaves? Referring to a “microwave photon” doesn't seem correct, and neither does “micro photon” so I'm not sure how to handle this other than by referring to photons simply by their energies.

Criticisms

- ◀ Intelligent people know the difference.
- ◀ There is no problem.
- ◀ Usage is defined by...usage.

36

The first point is elitist. The second point is arrogant. The third point is logically invalid. Jargon is fine, but let's make it consistent.

Dawkinsonian
enforcement!

We need unrelenting, uncompromising, and uniform enforcement of correct terminology and precise language.

37

This is fixable!

Let's start courteously and professionally correcting each others' linguistic errors when we see and hear them. More importantly, let's not propagate them in the introductory textbooks. Of all the problems we face in science and teaching, this is one of the easiest to solve.

38

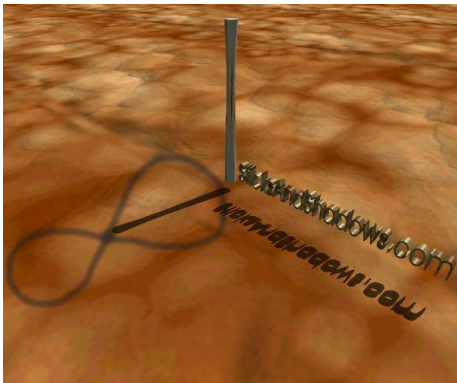
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39

Thank you!

40



41
