Abhijit Mehta
w2.d3
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The Playful Language of Math

I find that even in our technologically dependant society, mathematicians and physicists are often misunderstood. Many people label us as unimaginative, dull and humorless. However, mathematicians and physicists actually make creative use of common words to describe complex things. For us, *nice*, *elegant*, *trivial*, *well-behaved*, *charm*, *flavor*, and *strange* all have meanings that can be very different from their everyday meanings. The migration of these words from common usage to their specialized usage conveys some of the playful attitude that mathematicians and physicists have towards abstract, complex problems.

First, we will examine how mathematicians use a few common words; namely, *nice*, *elegant*, *trivial*, and *well-behaved*. One word that I have always found amusing is *nice*. *Nice* is a word that we mathematicians commonly use to describe functions, or other groups that have some set of properties that make them easy to work with. However, these properties can be totally different in two different situations, and although in math we are usually very careful to use precise language, this word springs up surprisingly often. For example, in a math website that is giving a treatment of differential equations, we see:

> Note that in this case, if $h(t)$ has a limit (as a number) when $t \to \pm\infty$, and $h(t)$ is a "nice function", then we must have $\lim_{t \to \pm\infty} h'(t) = 0$ [2]

In the midst of this fairly technical, rigorous description, it is surprising to see the word "nice" used to describe a function. Another common use of the word *nice* is to describe a solution to a problem (or a mathematical proof) that has some interesting or "beautiful" quality to it. This can be as simple as meaning that the numbers involved are easy to work with; for example:

> The good thing is that my mistake didn't change how you did the problem. It's just that instead of getting a nice clean answer of 3:08 it turned out to be 3:06 and 11 seconds.[1]

Interestingly, *nice* originally meant "foolish" and has meant many other things such as "slothful," "luxurious," "unimportant," "intricate," "simple," and "elegant." [7] In the mathematical sense, "simple" and "elegant" are the intended meanings. (*Elegant* is another word commonly used to describe proofs of solutions that have some special quality.) Although most people familiar with math can point out a proof that is *nice* or *elegant*, it is very difficult to come up with a specific, objective definition for either term. In my math classes, and when I am casually talking about math with my friends, we use the word *nice* frequently, but nice is mostly a description of how a mathematical entity *feels*. This ability to describe math in terms of how it feels, rather than specifically describing a lot of properties, characterizes the love and enthusiasm that we mathematicians have for our subject.

Trivial is another word that we use in an interesting way in mathematics. The OED defines trivial as "belonging to the trivium [i.e., grammar, rhetoric, logic] of Medieval university studies" or common.[7] The OED also gives a specific definition of "trivial" in relation to math:

> "Of no consequence or interest, e.g. because equal to zero; satisfying a given relation on a set with every member of the set; *spec.* applied to a subgroup of a given group that either contains only the identity element or is identical with the given group."[7]

This definition does not really make a clear set of criteria for determining if something is trivial or not. Recalling a conversation between two math graduate students from Princeton, Nobel-Laureate physicist Richard Feynman joked that to mathematicians, anything that can be proven is "trivial":

> " I still remember a guy sitting on the couch, thinking very hard, and another guy standing in front of him, saying, 'nd therefore such-and-such is true."
>
> '"Why is that?" the guy on the couch asks.
>
> "It's trivial! It's trivial!" the standing guy says, and he rapidly reels off a series of logical steps: "First you assume thus-and-so, then we have Kerchoff's this-and-that; then there's Waffenstoffer's Theorem, and we substitute this and construct that. Now you put the vector which goes

> around here and then thus-and-so..." The guy on the couch is struggling to understand all this stuff, which goes on at high speed for about fifteen minutes!
>
> Then the second guy agrees and says, "yeah, yeah, it is trivial" "[3]

The mathematicians in this amusing example use a word that in common usage means, "common" or "of little interest," to describe anything that can be done, even if that thing is very uncommon and interesting! This reveals the sense of humor that we mathematicians have. Although in a sense, mathematicians use the word trivial in a similar way to the way in which it is commonly used, in math, the meaning of the word has become so specialized that it can sound ridiculous when heard by a non-mathematical person, as Feynman jokingly points out in the above example.

A term that is similar to *nice*, but even more amusing, is w*ell behaved*. Like *nice*, it is a phrase that we use frequently in math, even though it is not well-defined. In fact, the OED gives a very flexible math-related definition of *well-behaved*:

> Applied to different entities with varying implications as to their susceptibility to manipulation, as continuity or differentiability (of a function), convergence (of a series).[7]

In the following case, from the solution to a problem posed by UC-San Diego's math club, "well-behaved" simply means continuous and integrable, two well-defined math terms: "Because of the well behaving functionality of g(x) => the g(x) is reflective at phase change of pi and hence must cross zero at least once."[4] However, in a different context, where a mathematician is responding to a question about topological spaces on an internet discussion board, we see a totally different meaning:

> There are various possible interpretations of "well-behaved", but certainly almost everyone agrees that Euclidian spaces—in particular, the real line and the real plane (AKA the complex line)--are well-behaved. Spaces that are "locally like" the real line or the real plane (in a sense that can be nicely described once the student is familiar with T) are then probably the next most "well-behaved" spaces.[5]

Here, the author talks about spaces, instead of functions, being "well-behaved," and then goes on to say that there are degrees of "well-behaved"-ness. Even in an area where precise definitions are very important, the term *well-behaved* is freely used, even though

it doesn't have a definitive meaning. *Well behaved* is a phrase that one would commonly use to describe someone's children or pets, and it is very revealing that mathematicians refer to mathematical objects affectionately. Mathematicians' playful attitude towards math is revealed in this familiar, affectionate, language.

To get a better idea of the motivation behind the changes in meanings of words that we observed above, we will examine a situation where a common word was adapted "on the spot" to describe a mathematical idea. In this example, students on the United States team at the 1999 International Mathematics Olympiad talk about their performance relative to other teams:

> "Do the Romanians "dominate us?" one asks. In math terms, dominate would mean the Romanians' worst player has beaten the best U.S. player. "Do they majorize us?" another asks. This term is more complicated: It would be true if the Romanians' top player got a higher score than the top U.S. player, and if the sum of their top two players' scores beats the sum of our top two, and the sum of their top three beats the sum of our top three, and so on. "What will it mean if there are teams that we beat or tie but don't majorize?" asks Melanie, who then answers her own question: "It'll mean we're clumpier than they are."" [6]

The word "clumpier" is not a mathematical term. It was spontaneously used to describe a statistical distribution without going into specific details. This spontaneity reflects a familiar and playful attitude towards math; it is an example of how mathematicians treat abstract concepts as "real" things. An interesting footnote to this is that even mathematicians do not always understand the meaning of these adapted words. The conversation quoted above continues:

> "What do you mean by clumpy?" asks Lawrence Detlor, from New York City.
>
> "Our scores are closer together."
>
> "That's the opposite of what I thought you meant," he says. "I thought clumpy meant `containing separate clumps.'"[6]

Although we readily use common words in math to describe abstract concepts, mathematically precise definitions of these words often do not exist, and thus the use of common words in math can confuse mathematicians and "lay" people alike. Contrary to

popular stereotypes, mathematicians are not serious and boring; we are fun and playful people who are enthusiastic about what we do.

We can gain more insight into the attitude that lies behind the vocabulary of mathematicians and physicists by examining the words *quark*, *charm*, *flavor*, and *strange*, which are terms used in modern physics. Unlike the math terms that we have looked at, all of these terms have very well-defined, specific meanings in physics. These terms are interesting because they have only come into use in physics within the last half-century, and so we can trace the development of their use in physics.

The development of the word "quark" helps to shed some light on the attitudes of some of the most brilliant physicists. Murray Gell-Mann, who discovered quarks, which are subatomic particles, named them after a line in James Joyce's *Finnegan's Wake.* He wrote that:

> 'I employed the sound "quork" for several weeks in 1963 before noticing "quark" in "Finnegans Wake", which I had perused from time to time since it appeared in 1939... The allusion to three quarks seemed perfect... I needed an excuse for retaining the pronunciation quork despite the occurrence of "Mark", "bark", "mark", and so forth in Finnegans Wake. I found that excuse by supposing that one ingredient of the line "Three quarks for Muster Mark" was a cry of "Three quarts for Mister..." heard in H. C. Earwicker's pub.'—M. Gell-Mann, private let. to Ed., 27 June 1978.[7]

The discovery of quarks was a very important moment in modern physics, and it is very amusing that such important particles were named with a humorous intent. Unlike the other words I have discussed, "quark" is not a common word that was adapted into physics. The fact that a word was "invented" to describe something that revolutionized modern physics points to the fact that physicists, like mathematicians, treat their field in a playful manner. As we can see from Gell-Mann's letter, quark was used because of its humorous connection with *Finnegan's Wake*; not only are physicists playful and enthusiastic about what they do, but they also have a sophisticated sense of humor.

Another word used in particle physics, *strange*, also came into existence in an amusing way. Experiments showed that the properties of certain subatomic particles differed greatly from what the theory predicted. The OED defines various uses for the word "strange," and gives the following explanation for the physics use:

> *Particle Physics*. Epithet of those sub-atomic particles that have a non-zero value of the strangeness quantum number. So called orig. because they had lifetimes much longer than was expected from their being produced by the strong interaction.[7]

This is another example of how physicists did not think up a fancy term to describe a new property, but instead used a simple word that described what they felt about the term. Most non-scientific people think of physicists as being boring, and would expect new properties to be named some complicated, Latin or Greek term. I think that it is quite amusing how the opposite is true; physicists are fun and "down-to-earth," and named a property of particles with their gut reaction: strange.

When physicists needed a word to describe a certain property of quarks, they kept up this light attitude, and chose the word "flavor." The OED actually says that the word was chosen "arbitrarily:"

> *Particle Physics*. [An arbitrary choice of name.] A quantized property of quarks which differentiates them into (at least) six varieties (called up and down, charmed and strange, top and bottom) and which can be changed by the weak interaction; an analogous property of leptons which differentiates the electron, the muon, the tau, and their respective neutrinos. Also, a quark or lepton of a particular flavour.[7]

An example of an interesting choice of "flavor" is the word "charm." When physicists saw that a certain type of quark had some interesting properties, they did not try to piece together a technical term from Ancient Greek and Latin; they simply described what they saw as being "charmed."

Our examples show that the popular stereotype of scientists being antisocial, uncreative, and boring is both ridiculous and unfounded. The laid-back and often amusing way that mathematicians and physicists throw around common words to describe complex phenomena indicates that mathematicians and physicists have a playful attitude towards math and physics and are enthusiastic about exploring the world around them. In fact, it is often the people who buy into these stereotypes who are actually uncreative and boring.

As our society becomes more dependant on technology, people need to become more familiar with the language of math and science in order to have a basic

understanding of many modern issues. It is important for people to have some idea of the playful attitude of mathematicians and physicists so that they can better understand the people who are behind many of the innovations that society takes for granted. The language of science and math can be very confusing to an outsider, but through a basic understanding of what the "math lingo" means, a person can gain quite a bit of insight into the world of science and math. If people try to understand and share in the enthusiasm that we mathematicians and physicists have for science, then they will be able to better appreciate and make informed decisions about modern technologies, and this would benefit everyone.

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Abhijit Mehta
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When I initially thought of the idea for my essay, I drew upon my own personal experiences with math and other math people. I have always been particularly amused by the way that mathematicians use the word "nice," so that seemed like a logical place to start my essay. However, as the first draft developed, the sense of playfulness which mathematicians have that I was trying to explain became obscured by my effort to provide a large amount of data regarding various words used by mathematicians and physicists. To remedy this, my agenda shifted from merely trying to describe how mathematicians and physicists use certain words differently from the general public (in my first draft) to describing how mathematicians and physicists have a playful attitude that is reflected in their vocabulary.

One general change that I made in my paper to reflect this shift in agenda was to bring myself into the essay. Rather than trying to act as an impartial bystander like I did in my first draft, I wanted to become an active part of the essay, so I replaced "they" with "we" when referring to mathematicians to share some of my enthusiasm for math with the reader.

I also tried to make it more clear in the various sections of my essay that the examples I was using had a point: to show the playful attitude of mathematicians and physicists. I did this by adding sections to the ends of certain paragraphs that explicitly discussed how the preceding examples showed that mathematicians or physicists are playful people. To further illustrate this point, I added a section to my first draft that discussed a conversation between members of the 1999 United States International Math Olympiad team, and showed how mathematicians can readily adapt common words to describe their ideas.

One of the biggest changes I made was altering my introduction. In my earlier drafts, I started out by talking about society in general, and then I went on to say almost nothing about society in my paper. However, throughout the course of the essay, I did point to the fact that my examples somehow contradicted a popular stereotype. So, I decided that it would be better to introduce my essay by discussing how the popular

stereotypes of mathematicians and physicists are wrong. I saved much of the material that I cut from my introduction and put it into my conclusion. My conclusion comments on how necessary it is for society to begin to understand math and science in our modern world, (hopefully) leaving the reader with a new idea.

Another major change occurred in my discussion of quarks and other physics terms. Initially, this section was very weak, and I gave the reader a little bit of etymology, at best. In my final draft, I tried to expand my discussion of these words, and use the words to support my argument that mathematicians and physicists are fun, playful, and imaginative.

The main change in focus of my essay was from giving a lot of examples to analyzing the attitudes of mathematicians and physicists. Although I was able to use all of the examples from my first draft in my final draft, the agenda of my final draft is much more interesting than that of my first draft, and the entire paper is much more personal and analytical than my first draft was. In my final draft, I have tried to bring to the paper that personal enthusiasm that inspired me to choose math and physics as a topic for my essay in the first place.