Function Dances

Networking Lounge, 3 pm Wed 2017 NCTM Annual Meeting

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Explanations: Bad!

Too often, we explain mathematical concepts to our students, direct them to read explanations in their textbook, or assign them online explanations (e.g., Khan Academy). We try to hone our own explanations, or we search in an effort to find better explanations in print or video.

But time and again, even the very clearest step-by-step explanations fail to register for a significant number of our students. Worse, students who seem to have understood the explanations later find themselves unable to make use of what we thought they'd understood.

But the fault lies not with the quality of the explanations, nor with the inattention of our students. The fact is that asking students to listen to or view an explanation is an inefficient way for them to learn. Recent findings in brain science and in cognitive science—the science that studies how we think, that analyzes the nature of our knowledge and understanding—support the age-old wisdom that we learn better by doing than by being told. Our bodies are not separate from our brains, and we learn best by exploiting that connection.

For functions, this means that students should experience, in as physical a way as possible, how variables vary, the shape and size of a domain and a range, the actual motion that underlies relative rate of change. These experiences enable students to form *conceptual metaphors* on which to base their abstract mathematical ideas:

> The mechanism by which the abstract is comprehended in terms of the concrete is called *conceptual metaphor*. Mathematical thought … makes use of conceptual metaphor, as when we conceptualize numbers as points on a line. [Lakoff & Nuñez, *Where Mathematics Comes From,* p. 5]

Physics Nobel prize-winner Richard Feynman famously said *What I cannot create, I do not understand.* In this context, it's small wonder that students who read about functions, who pay attention to the very best lectures, still don't really understand what a function is, can't explain why the "vertical line test" works, and have difficulty connecting the shape of a graph to the actual motion of the variables being graphed.

Dances: Good!

In this brief prelude to the conference, we'll act out functions in the form of dance. For each dance we'll have one independent variable and one (or more) dependent variables. Because dance steps are inherently two-dimensional, we'll use two-dimensional language (the language of geometric transformations) to describe them.

We begin with a simple dance: two dancers—a leader (independent) and a follower (dependent)—moving according to the rules of a geometric transformation (reflection, rotation, translation, or dilation). These dances are animated on the first websketch at geometricfunctions.org/links/dance-patterns. The animation is useful, but point is not for students to look at an animation, but rather for them to perform the dance themselves.

But the more people dancing, the better, so we next repeat (*iterate,* in math language) a fundamental dance rule (transformation) to involve a series of dancers, and/or combine (*compose,* in math language) one dance rule with another. The possibilities are endless. The second websketch illustrates a few of these group dances, and you can use the third to create your own.

Web page:
geometricfunctions.org/links/dance-patterns

Related Sessions:
Malke Rosenfeld, Math in Your Feet,
4:30 Wednesday, Networking Lounge

Scott Steketee, *Introduce Function Concepts and Linear Functions Geometrically(!)*, Session 120,
Thursday 11 am, Convention Center 008AB

Our blog: sineofthetimes.org
Please email me with your questions and ideas!