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Bridging to Infinity

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Summary: My own experiences as a mathematics student and teacher have influenced how I think about the infinite. Author Madeleine L'Engle has also shaped my thinking with her writing. I offer some thoughts that connect some of L'Engle's writing with my experience.

Calculus changed my life! Now I realize that many of you are probably thinking the same thing about your lives (!), but I'll go ahead and offer two ways that it changed mine. I showed up at college fresh from the farm and landed in calculus the first term - scared to death. The subject immediately intrigued me - it presented mathematics with a dynamic element that was new to me. Instead of viewing mathematics as a still life, it was now fluidly moving in time. Mathematician Keith Devlin states that "mathematics makes the invisible visible"; the essence of calculus is that it makes visible the infinitesimally small. In so doing, it helps us to "see" why an airplane can fly, for example. While I wasn't particularly interested in the applications, working with calculus felt to me like what sculpting must feel like to a sculptor, or music to a musician.

Infinity, in various forms and fashions, was one of the central concepts that showed up repeatedly; my mind was stretched substantially, to the point that I was somewhat overwhelmed by calculus even as I enjoyed it. In later courses I was introduced to different sizes of infinity, from the smallest infinity on up. When I was in graduate school and early on in my teaching career, I loved to talk about this dynamic element of calculus and elements of infinity and how it was poetry in motion for me. On several occasions, I found myself going on about this with

friends and colleagues at social gatherings (I've noticed that I'm not invited to some of these gatherings very often anymore!).

The second way that calculus affected me was career choice. Because of the trimester arrangement at the small liberal arts college that I attended, I was able to complete the entire calculus sequence (Calculus I, II and III) during my freshman year. At the beginning of my sophomore year, I was fortunate enough to be asked (actually I was told!) to conduct help sessions for the calculus course. That was the beginning of three years of calculus help sessions. So by the time I had graduated, I had essentially gone through the calculus sequence four times! Although I didn't know it at the time, I was hooked on teaching. Significantly for me, my experience with calculus helped me realize I had to work with the concepts (mostly related to notions of infinity), including many examples of symbolic manipulations, before I could really learn the concepts; likewise, many of the students needed to work with the concepts before actually learning them. At exceptionally clear moments of understanding, usually attained by teaching others, it felt as though I was able to traverse the bridge to infinity.

Along the way I discovered that my mathematical training was greatly enhancing my developing theology in that both calculus and theology attempt to bridge from the finite to the infinite. We are finite humans, but there are bigger things out there and we're connected to them. The words of Madeleine L'Engle, in *Glimpses of Grace*, describe the connection: "... Partaker simultaneously of the finite and the infinite, I do not find the infinite by repudiating my finiteness, but by being fully in it, in this me who is more than I know. This me, like all of creation, lives in a glorious dance of communion with all the universe" (37). Even as we are aware that we are finite, we realize that we are also part of a whole that is infinite.

As I continue to talk with children, friends and colleagues about concepts that are somehow related to infinity, and attempt to teach it to students, I've discovered that I'm involved in

somewhat of a paradox. I attempt to use carefully established rules of logic to talk about

something that is ultimately much larger than logic. For example, my young son Nicholas has

become interested in how far away places are and how you would travel to these places: Atlanta

is far away, Florida is far, far away, Japan and Africa are far, far, far, far away. Then the

questions leap to: how far away is heaven; how do we get there; where's the airplane that takes

us to see God?

The formalized language we use, of logic and other sorts, can take us only so far in our pursuit of

what we call truth and knowledge. My bias is towards mathematics and science, so the following

words of L'Engle are very humbling to me:

> It is the scientists themselves who today are telling us that they cannot tell us
> everything - even as we walk on the surface of the moon, even as we probe into
> the strange and further field of genetics. The deepest scientific truths cannot be
> expressed directly. . . . . Fred Hoyle is a famous astrophysicist; but when he has
> an idea that goes beyond present knowledge, . . . he turns to writing fantasy, where
> he can communicate ideas that are too big, too violent, too brilliant to be rendered
> directly. (146)

L'Engle reminds me of the wonderful mystery that surrounds what I'm doing. There's a point

where logic leaves off and I'm left staring at this beautiful and exciting concept of infinity with

my very finite mind.

What I see and feel in mathematics and what I want my students to see and feel is how

mathematics is an inseparable part of the human endeavor. While I want them to know some

practical connections, I mostly want them to experience mathematics as part of the quest to know

and to be, like literature or history or physics. I want my students to experience the patterns and

beauty of mathematics, the "invisible made visible", just as they might experience the raw power

of Michael Flatley as he Irish step-dances, or the way our lives are depicted in the writings of

Flannery O'Conner. To some extent, I suspect anyone who teaches feels that her discipline is a

creative activity, part of the quest to know, part of the human endeavor.

The phrase "human endeavor" has been tossed around quite a bit in academic circles. I think it speaks to some of the loftier goals we have for our teaching and interaction with students. We want them to feel our academic disciplines down in their bones, and in their spirit, the way the speaker in the next passage felt. I savor the image painted by L'Engle:

> I walked slowly down the street and all of a sudden piano music came pouring out of an upper window of one of the houses. It wasn't somebody practicing a music lesson; it wasn't somebody playing carelessly at the piano just for fun, the way Mother sometimes does; it was somebody playing the piano the way a real astronomer would go to a new telescope that might show him an undiscovered star, or the way a scientist on the verge of a tremendous discovery would enter his laboratory; it was somebody playing the piano the way Picasso must have painted his harlequins or Francis Thompson have written "The Hound of Heaven". I stopped and listened and listened. I did not know what the music was, but it made me think of the names of stars. . . (52)

The music was more than music, in the same way that mathematics is more than numbers and patterns, literature is more than stories, the infinite is more than finite.

One of the richest challenges I try to make myself feel as I begin each new semester is a sense of awe in the enormity of what I'll try to do: to somehow expose my students to concepts and ideas in the courses that I teach in such a way that they sense this wonderful mystery that goes along with learning and being human. Of course, moments when that happens seem to be somewhat rare; nevertheless, it seems worth striving for. I have commented to new students about how they will be transformed by their college experiences and also that people they encounter will be transformed by them. I hope for that transformation for myself and for all teachers.

I believe for myself that I come closest to experiencing the mystery of ideas and learning - mystery that transcends language and logic - by allowing for the possibility of being transformed by my students, by long-time colleagues and by new colleagues. This transformation requires that I remain open to alternative approaches to teaching. Sometimes I will be lead to a better way to teach by following my students; at other times, I can benefit from the shared wisdom of fellow

"old-timers" and the exuberance of new ideas presented by a younger faculty member. All in all, I must allow myself to be influenced by the community of scholars and aspiring scholars that surrounds me.

As I think about my teaching, about what I want for my students, I call to mind a transforming experience for me from a few years ago. My wife Robbie and I attended the memorial service of Dorothy Skeel, who was one of Robbie's graduate school mentors over 15 years ago. We remembered Dr. Skeel as one of the best persons we've encountered in our academic experiences; she was friend and teacher, reliable and challenging, honest and inspiring. During the memorial service, there were tributes from students around the world who attested to Dr. Skeel helping them to become educators in the richest sense. Likewise, colleagues spoke of the importance of Dr. Skeel in their lives - how she worked diligently for what she believed in. During the service and afterwards, I found myself wanting to be the kind of person that Dr. Skeel was. Part of what I was thinking was that she was a great educator who was universally loved, respected and admired. Only later did I realize why - Dr. Skeel was greatly admired and loved, but that was true largely because she loved and admired others enough to respect them and to take a stand for them and for issues like the right of all children to receive a solid education. She was an example to me of someone who claimed her humanity and lived with a sense of the infinite. She was a whole person, as described by L'Engle:

> The most "whole" people I know are those in whom the gap between the "ontological" self and the daily self is the smallest. The Latin *integer* means untouched; intact. In mathematics, an integer is a whole number. The people I know who are intact don't have to worry about their integrity; they are incapable of doing anything which would break it.
> . . . Integrity, like humility, is a quality which vanishes the moment we are conscious of it ourselves. We see it only in others. (130-131)

So where does that leave me? I'm reminded that opening myself to transformation and to the mystery of what and how I teach may require that I take a personal stand on issues. A sense of

responsibility is combined with the excitement and challenge of beginning each new semester. I hope for all of us who teach that we begin anew each semester, full of excitement, open to challenges and transformation, and willing to accept our professional and personal responsibilities.

Calculus changed not only my perspective on mathematics, it also changed my entire worldview. As calculus provides a bridge from the finite to the infinite, it creates opportunities to build from a static perspective to one that is dynamic. What seems clear to me is that teaching is my chance, our chance, to build from the finite to something much greater. We have to not only realize our finite nature, our humanity, we have to also claim it as part of the infinite.

References:

[1] Devlin, Keith, *FOCUS – The Newsletter of the Mathematical Association of America*, August 1997.

[2] L'Engle, Madeleine (with Carole Chase), *Glimpses of Grace: Daily Thoughts and Reflections*, HarperCollins, San Francisco, 1996.