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Freedom through Inquiry

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The Mathematical Yawp

by Francis Su

Freedom through Inquiry

AUGUST 11, 2016AUGUST 12, 2016 / MATHYAWP

I delivered this speech at the *Inquiry-Based Learning Forum & 19th Annual Legacy of R.L. Moore Conference* on August 4, 2016. It is partly an homage to an influential teacher, partly an excuse to articulate what makes some styles of teaching so effective, and partly an excuse to talk about difficult issues facing our nation and our classrooms today.

Freedom is not the right to do what we want, but what we ought. —
Abraham Lincoln

Freedom through Inquiry

First thanks for the invitation to speak here today. It's a real treat for me, especially because I got my mathematical legs through IBL: inquiry-based learning.

I'm pleased to see the traction that inquiry and active learning are getting in the math community because of the support of Harry Lucas and the Educational Advancement Foundation. MAA loves IBL and active learning, and many of our members have grown in these areas because of EAF's support. As some of you know, this year's Project NExT program had active learning at its core. And you'll be pleased to know that on the Conference Board of the Mathematical Sciences, I and presidents of several other math societies are working on an official statement in which we are

endorsing active learning.

Today, I'd like us to explore these questions: what is freedom? And how does a culture of inquiry help us and our students to become freer people? Three examples may give us some insight.

1. PRE-SCHOOL

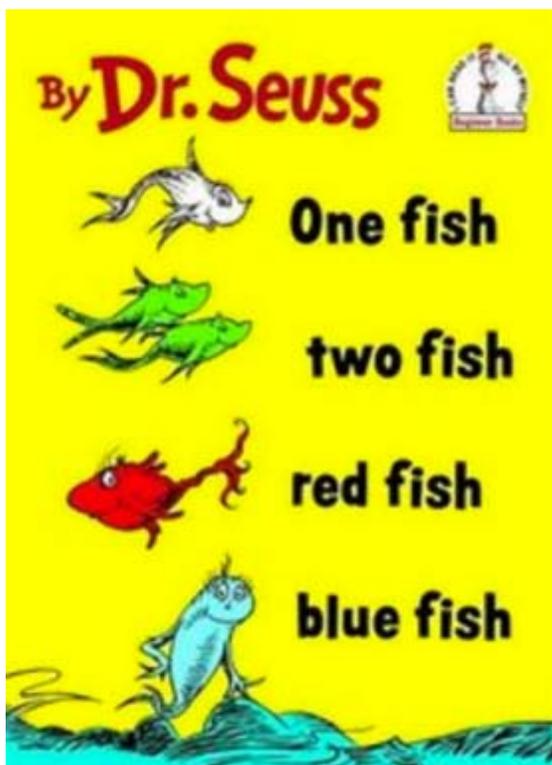
The first is a study in contrasts from my childhood.

My parents wanted me to learn math early, so even before I went to school, my father would try to teach me numbers and arithmetic. But he was a busy college professor, and so he would make up these long worksheets of addition problems to keep me occupied while he did his own work. Yes, I did the worksheets as a dutiful little Asian-American kid, but didn't find them very much fun. If you listened to what my Dad was saying, you would have heard phrases like:

"No, do this one over."

"You can't go out to play until you get every one right."

Now compare that approach to that of my mother, who would sit with me and read books about numbers. Like this one by Dr. Seuss:



Say! Look at his fingers! One two three...

How many fingers do I see?

One, two, three, four, five six seven

Eight nine ten, he has eleven!

*Eleven! This is something new!
I wish I had eleven too!*



*Bump! Bump! Bump!
Did you ever ride a Wump?
We have a wump with just one hump!*

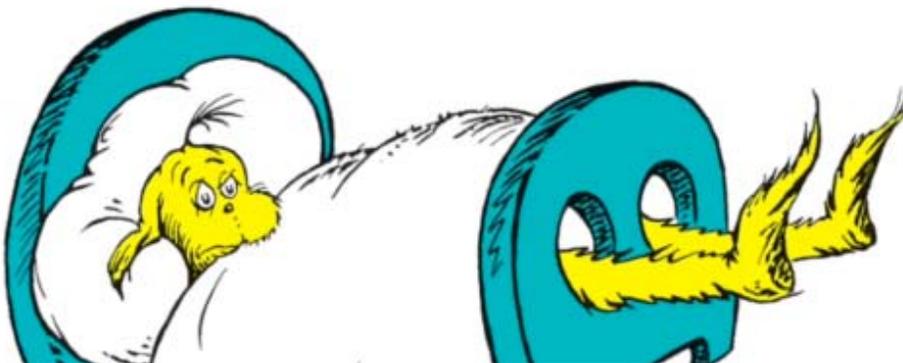
*But we know a man called Mr Gump.
Mr. Gump has a seven hump Wump!
So...*

*If you like to go bump bump,
Just jump on a hump
Of the Wump of Gump.*

*Who am I, my name is Ned
I do not like my little bed*

*This is no good
This is not right!
My feet stick out of bed all night!
And when I pull them in, oh dear
My head sticks out of bed up here!*

–from *One Fish, Two Fish, Red Fish, Blue Fish* by Dr. Seuss





My mother and father had different approaches to teaching.

My father's approach was more like a one-way transmission of information. He showed me what to do, but left me to myself to do worksheets. I followed the rules he taught me for arithmetic, but often without understanding. I learned the standard algorithm for how to add numbers bigger than 10 by "carrying" and I could do it just fine, but I didn't at that age have any idea what I was doing. I was following recipes. And my father's praise and reward were always connected with my performance. Although his style was not as strict as a "tiger mom", one could imagine a much stricter parental approach that could keep a child from enjoying math forever.

On the other hand, my mother's approach was relational. She sat with me, and together, we read books about counting. This Dr. Seuss book was also relational— it was full of wonder and delight, and invited more questions. Like: why does that creature have eleven fingers? And it's not even 5 and 6 fingers on each hand as you might expect, but rather: 4 and 7 on each hand! And what kid reading this book wouldn't think that the bed with two holes for feet is kind of outrageous? This fanciful strangeness invited further imagination.

This study in contrasts is a parable of constraint versus freedom. With my mother and Dr. Seuss, I had the freedom to explore, and the freedom to ask questions, the freedom to think ridiculous thoughts. Ridiculous and fanciful thoughts were praised! (Who says you can't have a seven hump wump?)

But this freedom had its fulfillment only in the context of a relationship like that with my mother, where asking questions was welcome. And this freedom was encouraged by my relationship with the book, because this book invited questions that weren't even explicitly there. Such as: why did this creature have 4 and 7 fingers on each hand?

2. GOING TO COLLEGE

I'll fast forward to another experience in my life as a second study in contrasts.

I was a high school senior attending a lecture for prospective students at the University of Texas at Austin. The topic was 'Infinity' and the speaker was a professor named Mike Starbird. His lecture

style was different than anything I had experienced in high school. It was highly interactive, and he was constantly asking questions of the audience. I'd never before been in a room with 300 people where everyone was engaged and actually paying attention.

Today we might categorize this interactive style as one of many different ways to practice 'active learning' in the classroom.

And I left that lecture thinking: wow, if every class in college was like that, I'm coming *here*. And I'm going to major in *math*. So I enrolled at Texas and when I got there I looked to see what Starbird was teaching. To my dismay, I learned that Starbird was on sabbatical that year.

Oh well, I thought. Not a problem. If every college professor were like Starbird, I was going to be just fine!

So having placed out of calculus, and thinking I was 'good' at math, I jumped into an honors differential equations course. On the first day, the professor began talking about matrices, a topic I had never SEEN before! And linear algebra was not a prerequisite for this course. Now... I'm not that easily fazed. Even though my small-town high school had struggled to offer calculus, I was able to learn calculus from books. (Back when books were a thing.) So seeing a matrix seemed mysterious and exciting and new, and I could probably pick it up easily.

But then he wrote a little "e" on the board, took this matrix of numbers and put them where you would place an exponent of the "e". I looked around and assumed everyone else knew what this strange creature was, so I wasn't about to raise my hand and ask him. Meanwhile he just kept talking.

What was that "e"? Was it a symbol? Was it Euler's number? Either way it made no sense with the array above it. Was he exponentiating a matrix? And then to top it off, somehow differential equations were solved using creatures like this! He continued talking and talking. I was intimidated. Symbols were flying by, and I just resigned myself to sitting in my chair and taking notes. The notes weren't even right because I had no idea what I was writing down.

That was just the first day of class.

All semester it went like that. I kept quiet, fearful of asking any questions because no one else was asking questions and the professor wasn't inviting them. All semester I struggled to keep up, my understanding always two weeks behind, which was not soon enough to help me on my homeworks and exams, where I was always guessing at solutions I didn't understand. All semester I sat

in my chair, and I just took notes.

I felt trapped. Trapped in my chair, trapped in this class, running on a hamster wheel I couldn't get off until the end of the semester, fearful any mistake meant I would trip and fall off the wheel. This is not freedom.

Oh, I had a sense of humor about it, though I was pretty sure by the end of the term I wasn't going to be a math major.

But I decided to give it one more try. Maybe I should take linear algebra next, I thought, since it was the class I should have taken before this one. The professor for that course turned out to be quite good. He was much more interactive and approachable and I began to feel more confident again. So I stuck with the major.

And then... the next year, Starbird was back and I jumped into his course.

The class was topology and Starbird was teaching it using a "modified" Moore method— a prototype of an inquiry-based learning class. Instead of being lectured at, we given a list of theorems and provided the challenge of discovering their proofs for ourselves, through guided interaction with Starbird and with each other. We presented our proofs for the scrutiny of our peers.

But that's only the surface of what was going on. The underlying strength of the course was how Starbird used this format to encourage a different culture of the classroom.

I believe the class was successful because we were given freedom— the freedom to explore questions— and our explorations took place in relationship with each other, with the material, and with Starbird. Good questions were praised. Ridiculous ideas were welcome.

And honestly it was the most transformative class I have ever taken. Every day was like a Dr. Seuss book, filled with surprise and wonder, where the fanciful was celebrated and a springboard to new questions.

*One set, two set
Red set, blue set!*

*This set's closed, this one's open
This one's neither, this one's clopen!*

*We don't have to be too formal
Compact Hausdorff sets are normal!*

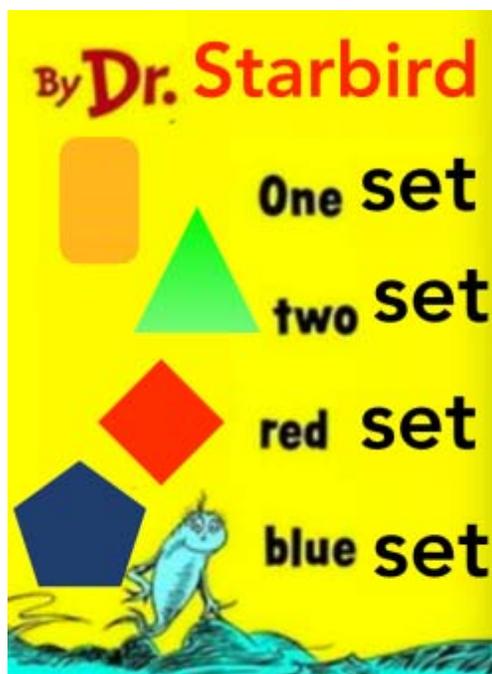
*Say look at these sets! One two three...
Which of them have the same boundary?*

*This looks like an enchilada!
Have you seen the Lakes of Wada?*

*Who am I? My name is Su
I do not like my little proof.*

*This is no good. This is... oh dear.
My proof sticks out and fails right here!*

*And when I try to patch its quirks
My induction no longer works!*



Freedom is the ability, in relationship with my peers, to proclaim: “my feet and my head are sticking out of my bed”. Or the freedom to say “my proof is wrong” without shame or judgment. Indeed a wrong proof was always a point of delight, because it meant we were seeing something subtle, and it was a challenge to further problem-solving!

What if we could help people across the educational spectrum see a culture of inquiry as a means of producing an environment of freedom: where students can respond to every setback without shame and as a springboard to further investigation?

3. THE CAPTIVITY OF EXPECTATIONS

Let me describe a third case study in contrasts, related to differences in what we, as teachers, expect of our students. If you’ve been reading the MAA’s newsmagazine FOCUS, you’ll know that I’ve been writing about this topic over a series of several columns.

Whom do we expect to succeed in our classes? And of whom do we have low expectations?

Expectations can strongly influence how a student actually does in the class. There is substantial research on “expectancy effects” that show our teacher expectations can actually affect how students learn. The most famous is the 1963 Rosenthal-Jacobson study that gave students a fake aptitude test and told their *teachers* which students were expected to “bloom” (when in reality the so-called “good students” were randomly selected). Over the next year, those students actually did better than their classmates.

This is the silent “captivity of expectations”. And it’s antithetical to freedom in the classroom.

One way, though not the only way, this can manifest itself is in issues of race. People often think that Asians are inherently better at math. I don’t believe that’s the case, any more than I believe that Asians are worse at being leaders, even though we’ve never had an MAA or AMS president before me who was Asian (or any minority for that matter).

I’m speaking of this grateful that the Educational Advancement Foundation is committed to improving diversity in mathematics—and we at MAA are grateful for the work they’ve done within Project NExT to support underrepresented groups. Let’s give them a hand for that. And we know active learning and IBL methods can be effective to improve diversity, since research indicates such methods can have significant benefit on underrepresented groups.

Now, talking about race is hard. I say this as an Asian-American who is sometimes regarded as a minority and sometimes not, and who has experienced the feelings that go with both territories.

But talking about race can be tackled with the same methods we advocate in the inquiry-based learning community — where we ask questions constantly and do not shame each other when we occasionally fail at talking about it well. We stick our feet out, pull them in, but then invariably our head sticks out too and we learn to think differently. We see these challenges as opportunities and springboards to grow in understanding of one another.

I’ve been reading the book *Teaching to Transgress* by Gloria Watkins (known by her pen name “bell hooks”) who is an African-American writer and professor. She writes about her experience as a student growing up in segregated America. I will confess it is in some places hard for me to read. But I share it because she writes eloquently about the difference in education she received in segregated black schools versus integrated schools, and the role of freedom in education.

“Within these segregated schools, black children who were deemed exceptional, gifted, were given special care. Teachers who worked with us

and for us to ensure that we would fulfill our intellectual destiny and by doing so uplift the race. My teachers were on a mission.

To fulfill that mission, my teachers made sure they “knew” us. They knew our parents, our economic status, where we worshipped, what our homes were like, and how we were treated in the family...

Attending school then was a sheer joy. I loved being a student. I loved learning...

Home was the place where I was forced to conform to someone else’s image of who and what I should be. School was the place where I could forget that self, and through ideas, reinvent myself.”

Here she contrasted home—where she felt constrained and captive to someone else’s expectations—with school, where she felt freedom to explore ideas. But then she encountered a more stunning contrast.

“School changed utterly with racial integration. Gone was the messianic zeal to transform our minds and beings that had characterized teachers and their pedagogical practices in our all-black schools. Knowledge was suddenly about information only. It had no relation to how one lived, behaved. It was no longer connected to antiracist struggle.

Bussed to white schools, we soon learned that obedience, and not a zealous will to learn, was what was expected of us. Too much eagerness to learn could easily be seen as a threat to white authority...

For black children, education was no longer about the practice of freedom. Realizing this, I lost my love of school.”

“The classroom was no longer a place of pleasure or ecstasy. School was still a political place, since we were always having to counter white racist assumptions that we were genetically inferior, never as capable as white peers, even unable to learn.”

“That shift from beloved, all-black schools to white schools where black students were always seen as interlopers, as not really belonging, taught me the difference between education as the practice of freedom and education that merely strives to reinforce domination.”

What we see in this contrast are exactly the same ideas we saw in my earlier examples. In the supportive environment of Watkins’ all-black schools, the educational practice was rooted in community. There was a culture of ideas and inquiry. She could play with ideas and say things that transgressed boundaries.

In the unsupportive environment, she was captive to expectations: always feeling like she had to prove herself. She was afraid that if she spoke up, she would be perceived as stepping out of bounds.

Education felt like domination. Watkins also speaks eloquently in the book of white teachers who did not allow racist biases to determine how she was taught, and with those teachers she felt liberated.

We have a duty, all of us, to understand race issues, especially with all that's going on in our nation today. We have a duty to approach it with a culture of inquiry. That's why I'm reading this book by Watkins. I want to ask questions, sit in her shoes, understand her struggles and connect them to my own experience.

In the mathematical community, let's provide each other the grace and space to talk about these difficult things. And if we provide each other with the grace and space to talk about race without shame, we won't have to fear saying ridiculous things. We'll be able to forgive each other for ways in which we might inadvertently offend. Because whether we realize it or not, these issues affect whether students feel domination or liberation in the classroom.

And of course it's not just race that affects the culture of the classroom. I came from a small town in South Texas, where most students in my high school didn't leave town for college. So for me, going away to Austin was branching out. After leaving Austin, I went to Harvard, and I was suddenly in an environment where everyone else in my class was from an Ivy League school, and they already had taken a full slate of graduate classes while they were undergraduates. I felt underprepared and out of place. And just like Watkins, I had professors who didn't believe I was capable of making it through, especially when I failed my qualifying exams the first time.

But do you know what kept me going when I was told explicitly that I wouldn't succeed in graduate school? Do you know why I believed I could?

It's because I had that inquiry-based Moore-method class with Starbird that I knew that I could do research. I already had the experience of discovering things for myself. I knew that I knew how to ask good questions, because we had the freedom to ask any question in Starbird's class and figure out which ones were fruitful. And I knew how to use those questions as a springboard to independent investigation.

And because of that, I knew, no matter what anyone said or believed about me, that I could push through. Today's literature suggests that inquiry-based teaching methods confer significant benefits on underprepared students, and of course I believe it. Because I've lived it.

Because of a culture of inquiry established by my former teacher, I

had a real freedom. Freedom from the shackles of other people's expectations. Freedom from wondering whether I could ask a stupid question— because there are no stupid questions, only springboard questions.

THERE IS NO REAL FREEDOM WITHOUT COST OR WITHOUT RELATIONSHIP

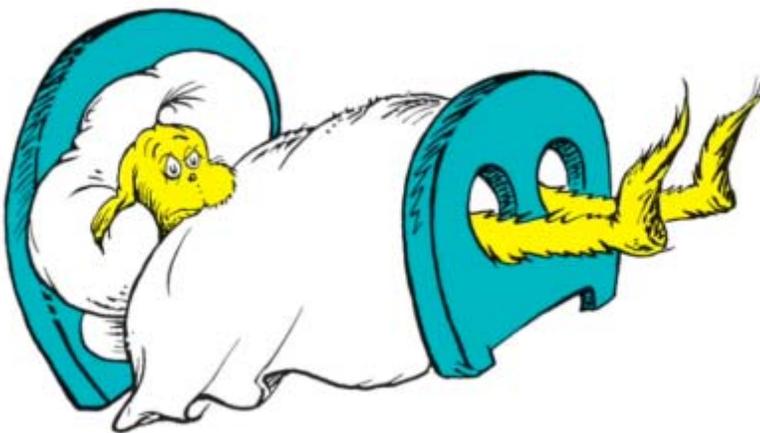
When I hear people talk about freedom, I find it interesting that some define freedom as the absence of constraints, as if it means: just do anything you want. I don't believe that's real freedom.

There are liberating constraints.

True freedom never comes without cost. The cost of a teacher who poured into you and gave you the grace and the space to ask questions. The cost of a parent who paid for those music lessons and your cost of commitment to take those lessons, so that now you can express yourself on that piano in ways you never could have otherwise.

And true freedom never comes without relationship. The relationship of a teacher and student, creating an environment for real exploration and growth. The relationship of two people, both excited about mathematics, flourishing in greater ways than they otherwise would have, for having known each other.

As teachers, may your feet always stick out, and may you help your students let their feet stick out too.



Uncategorized

2 thoughts on “Freedom through Inquiry”

1. *tmolr*

AUGUST 14, 2016 AT 1:14 PM

This is so beautiful. Your description of the differential equations course brought tears to my eyes. I also thought I was “good” at math... Until I got to college. Then I felt lost, trapped, and dumb for the next 3.5 years. And I started by thinking, oh, I might as well retake first semester calculus even though I took it in high school and got a 4 on the AP exam. Got a C+ and realized I was in way over my head.

I still came out of UC Berkeley with my math degree, but I felt like I faked my way through it and barely hung on. Such a sad change from my younger years, where I had thought it was my talent. The level of rigor and abstraction required of me in college was so far beyond anything I'd had to do before. And I had zero problem-solving strategies. If I couldn't decode it directly from the textbook, it was hopeless. My shame kept me silent, furiously scribbling notes from lectures that I didn't understand.

Now, I always have a few students who get annoyed that I won't just show them “how” to solve a problem. Whenever possible, I make them derive the algorithms on their own. Some complain that I'm “not really teaching.” They're right, I guess. I'm not teaching, I'm just facilitating their own learning. Setting up the conditions and giving them the space they need to teach themselves. Or that's what I'm trying to do, at least. How successful I am at that remains to be seen, I suppose.

Thank you for this post.

2. Pingback: [Jeff: My IBL Story | A Novice IBL Blog](#)

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