Okay, bud, how do you turn the boring bits of math into puzzles

tl;dr
Provoking curiosity in our students about anything requires us to manage several tensions simultaneously. It requires keeping several lines tight — not slack — but not so tight they snap.

Read on for recommendations from some careful researchers.

Previously
Here is where the series stands: I've suggested that educators dramatically overvalue the real world as a motivator for students (one example) and that pinning down a definition of what is "real" to a child is no light assignment. I've suggested, instead, that the purpose of math class is to build a student's capacity to puzzle and unpuzzle herself. And we shouldn't limit the source of those puzzles. They can come from anywhere, including the world of pure mathematics. As an existence proof, I listed some abstract experiences that humans have enjoyed (everything from Sudoku to the Four Fours).

Currently
This is a bunch of question-begging, though, and my commenters have rightly called me out:

Okay, bud, how do you turn the irredeemably boring bits of math into puzzles?

We struggle here. Across three conferences this fall, I've received different answers from respected educators about how we should handle the boring bits of math. (No one offers a definition of "boring," by the way, but I take it to mean questions about mathematical abstractions — numbers, variables, etc. — instead of the material world.)

One educator suggested we "flip" those boring bits and send them home in a digital video. Another suggested we ask for sympathy, telling kids, "Hey, it can't all be fun, okay? Just go with me here." Another suggested we aim for empathy, that by accentuating our own enthusiasm for boring material our students might follow our lead. These answers all require you to believe there are mathematical concepts that are irredeemably boring, that there are aspects of the world about which we can't possibly be curious. I don't.

So I spent my holiday reading about curiosity, starting with some bread crumbs laid out by Annie Murphy Paul. These are some lessons I learned about teaching "the boring bits."

Disclaimer
Interest and curiosity aren’t binary variables. They aren’t “on” or “off.” In his research on curiosity, Paul Silvia noted that “people differ in whether they find something interesting” and that “the same person will differ in interest over time” (2008, p. 58).

In 1994, George Loewenstein wrote a comprehensive review of the literature around curiosity [pdf] and even he despaired of locating some kind of universal theory of curiosity. (“Extremely ambitious” were his exact words; p. 93.)

We should temper our expectations accordingly. So my goal here is only to locate high-probability strategies for making students more interested more often. That’s the best we can hope for.

**Lessons Learned**

Provoking curiosity in our students about *anything* requires us to manage several tensions simultaneously. It requires keeping several lines tight— not slack— but not so tight they snap.

These are tensions between:

- **The novel and the familiar.** Stimuli that are too familiar are boring. Stimuli that are too novel are scary. (Silvia, 2008; Berlyne, 1954)
- **The comprehensible and the confusing.** Material that is too comprehensible is boring. Material that is too difficult is intimidating (Silvia, 2006; Silvia, 2008; Sadoski, 2001; Vygotsky, 1978).

It’s probably impossible to maintain this tension for each of your students but here are some recommendations that can help.

**Start with a short, clear prompt that anyone can attempt.**

Kashdan, Rose & Fincham (2004) claimed that curious people experience “clear, immediate goals … and feel a strong sense of personal control” (p. 292). Watch where we find that even in pure, abstract tasks:

- **The Magic Octagon.** “Pick where you think the arrow will be next.”
- **Jinx Puzzle.** “Just pick a number, any number.”
- **Area v. Perimeter.** “Just draw a rectangle, any rectangle.”

These could all fit in a tweet. In half a tweet. They’re light on disciplinary language, which keeps them comprehensible. In the final two tasks, students maintain a sense of personal control as they select individual starting points for each task.

**Start an argument.**

In 1981, Smith, Johnson & Johnson ran an experiment that resulted in one group of students skipping recess to learn new concepts and another group proceeding outside as usual, uninterested in learning those same concepts. The difference was controversy. The researchers engineered arguments between students in the first group, but not in the second.

Can you engineer arguments between students about the boring bits of mathematics?

- Is zero even or odd?
- Does multiplying numbers always make them bigger?
- Can you create a system of equations that has no solution?
- True or false: doubling the perimeter of a shape doubles its area.

At NCTM’s annual conference in Denver, Steve Leinwand said “the most important nine words of the Common Core State Standards are ‘construct viable arguments and critique the reasoning of others’.”

So not only can arguments stir your students’ curiosity but they’re an essential part of their math education. That’s winning twice.

**Engineer a counterintuitive moment.**

Hunt (1963, 1965) and Kagan (1972) popularized the “incongruity” account of curiosity. George Loewenstein summarizes: “People tend
to be curious about events that are unexpected or that they cannot explain” (1994, p. 83). These events are difficult to engineer, of course, because they depend on the knowledge a student brings into your classroom. You have to know what your students expect in order to show them something they don't expect.

Here are several existence proofs:

- **The Magic Octagon.** The arrow isn't where the student thought it would be. “Wait, what?”
- **Jinx Puzzle.** We all wind up with the number 13. “Wait, what?”
- **Area v. Perimeter.** Swan asks, “Now where are the impossible points.” Impossible points? “Wait, what?”
- **Ben Blum-Smith's Pattern Breaking.**

These moments are *everywhere*, though it's an ongoing effort to train my eyes to find them. You can find them when the world becomes unexpectedly orderly or unexpectedly disorderly. When we all choose numbers that add to five and graph them, we get an unexpectedly orderly line. When we try to apply a proportional model to footage of a water tank emptying (“It took five minutes to empty halfway so it'll take ten minutes to empty all the way.”) the world becomes unexpectedly disorderly. For younger students, the fact that $2 + 3$ is the same as $3 + 2$ may be a moment of curiosity and counterintuition. You know you landed the moment because the expression flashes across your student's face: “Wait. What?”

You also create a counterintuitive moment when you ...

**Break their old tools.**

Students bring functional tools into your classroom. They may know how to count sums on their fingers. They may know how to calculate the slope of a line by counting unit-squares and dividing the vertical squares by the horizontal squares. They may know how to write down and recall small numbers.

You create counterintuition when you take those old, functional tools and assign them to a task which initially seems appropriate but which then reveals itself to be much too difficult.

- “Great. Now go ahead and add 6 + 17.”
- “Great. Now go ahead and find the slope between (-5, 3) and (5, 10,003).”
- “Great. I'm going to show you the number $5,203,584,109,402,580$ for ten seconds. Remember it as accurately as you can.”

These tasks *seem* easy given our current toolset but are actually quite hard, which can lead to curiosity about stronger counting strategies, a generalized slope formula, and scientific notation, respectively.

**Create an open middle.**

When you look at successful, engaging video games (even the fake-world games with no real-world application) they generally start with the same initial state and the same goal state, but how you get from one to the other is left to you. This gives the student the sense that her path is self-determined, rather than pre-determined, that she's autonomous. (See: Deci; Csikszentmihalyi.)

- **Sudoku.** You start with a partially-completed game board and your goal is to complete it. You can wander down some dead ends as you accomplish the task. How you get there is up to you.
- **Jinx Puzzle.** You get to choose your number. It will be different from other people's numbers. What you start with is up to you.
- **Area v. Perimeter.** You get to choose your rectangle. It will be different from other people's rectangles. What you start with is up to you.

I'm not recommending "open problems" here because the language there is too flexible to be meaningful and too accommodating of a lot of debilitating student frustration. I'm not recommending you throw a video on the wall and let students take it wherever they want. I'm recommending that you're exceptionally clear about where your students are and where they're going but that you leave some of the important trip-planning to them.

**Give students exactly the right kind of feedback in the right amount at the right time.**

Easy, right? Feedback has been well-studied from the perspective of student learning but feedback's effect on student *interest* is complicated. Some of you have recommended “immediate” feedback in the comments, but this may have the effect of prodding students down an electrified corridor where every deviation from a pre-determined path will register an alarm, creating a very closed middle. Students need to know if they're on the right track while simultaneously preserving their ability to go momentarily off on the wrong track. This isn't simple, but the best games and the best tasks maintain that balance.

- **Four Fours.** You arrange the fours into whatever configuration you want and then you check your answer. The feedback isn't immediate. But you can check it yourself.
- **Area v. Perimeter.** You develop a theory about the impossible points then *later* test that theory out on different rectangles and coordinates.
- **Sudoku.** You don't receive feedback immediately after you write a number in a box. But eventually you're able to decide if the gameboard you've created matches the rules of the game.
Conclusion

You could very well say that these rules apply to "real world" tasks just as well as they apply to the world of pure mathematics. Exactly right! In the first post of this series, I said that "the real world-ness of [an engaging real-world] task is often its least essential element." Real-world tasks are sometimes the best way to accomplish the pedagogy I've summarized here but it's a mistake to assume that the "real world," itself, is a pedagogy.

As I've tried to illustrate in this post with different existence proofs, it's also a mistake to assume that pure math is hostile to student curiosity. The recommendations from these researchers can all be accomplished as easily with numbers and symbols and shapes as with two trains leaving Chicago traveling in opposite directions.

Often times, it's even easier.

References


Featured Comments

blink:

I wonder, though, if declaring some content â€“ boring bits â€“ gives up the game. (If they are *truly* and irredeemably boring, why teach them?) First, we need to understand these â€“ boring bits â€“ better and think about big-picture coherence.

Consider a jigsaw-puzzle. A missing piece is â€“ interesting â€“ quite apart from its shape or color (although they may be independent sources of interest). What matters is that it fits! Similarly, no one salivates over dates and locations in history. Yet we care about these facts because they allow us to tell stories, discover relationships, and find patterns. It is silly to complain that a particular fact is â€“ boring â€“ on its own. Here again, what matters it how it fits.

Evan Weinberg:

I like that these six methods have nothing to do with making math easy. This is often the identified goal that students and teachers (and countless online videos) work towards, particularly in the context of students that have failed math in the past. Having success is enough of a motivator for students to push through some material that is not particularly engaging, it does not have staying power.

Jason Dyer challenges the group to apply these principles to fifth-degree polynomial inequalities:
I don’t suppose we could take something extra-boring and try to do a makeover? Sort of like Dan’s makeover series except start from the hardest point possible?

I am having to currently teach working out polynomial inequalities like $2x^5 + 18x^4 + 40x^3 < 0$. There’s an intense amount of drudge and fiddly bits and the extra pain of having a lot of steps to do. Any ideas?

I give it a shot.

fake-world math

About Dan Meyer

I'm Dan and this is my blog. I'm a former high school math teacher and current head of teaching at Desmos. He / him. More here.

42 Comments

Jim Pardun

January 20, 2014 - 4:52 pm -

Thank you Dan. Once again my brain is flooded with ideas and my pencil can’t keep up. I read your work and I’m thankful that I still have many years left of this wonderful career I have chosen.

Matthew Oldridge

January 20, 2014 - 4:53 pm -

Finding “high-probability” strategies, is the best we can hope for, at any given time. Nice! That’s a turn of phrase that won’t soon be forgotten.

We can try a few probability statements out:
- it is unlikely that this textbook will generate any interest at all
- it is probable that a short, precise, non-technical activation for a given topic will spur at least some student interest
- it is highly unlikely to engage all students, all of the time, if I can paraphrase your moving graph.

Random thought-Einstein lived in the fakest mathematical world possible. So fake, he despaired at the end of his life it wasn’t even real. (There’s a paradox for you!)

Kenneth Tilton

January 20, 2014 - 5:38 pm -

Agreed: what do they mean by boring? In fact, is dullness really the problem? When I search twitter for “algebra” I find young folks wailing in anguish over the inscrutability of math, not its dullness.

But the faulty dull and unrealistic presuppositions go unchallenged and suddenly math teachers are taking tap lessons* so we can entertain students into studying this wonderful art, or manufacturing strained real-world applications.

* Search on YouTube for ten minutes and you can find the most ridiculous pandering “look! math is fun!” videos that fool everyone except the eye-rolling kids.

Meanwhile students (er, people) actually have no problem hunkering down and working as long as they can see the fruits of their labor. This is what few education reformers understand. I remember overhearing kids in the lowest track class of our tough inner city school absolutely bragging on how hard our team’s history teacher made them work. They were proud of the effort she got from them.
As for “How do we turn math into puzzles”, I do like the ideas above as nice teacher-led excursions off the work path towards pure math fluency, because they are challenging in a different way. My favorite is, if -3 is a number, then -3^2 would be 9. It is not, so -3 must be a sign operation (with lower precedence than exponentiation) on the number 3, and a more dramatic conclusion is that there must not be negative numbers. Discuss. :)

Combine that with better teaching (the 850k+ YouTube videos on Algebra reveal the teacher to be a big part of the problem) and effective practice of pure maths and student-driven learning and we may have a formula for learning in the 21st century when, no, we are not allowed to ask students to “just go with me here”.

Jill W.

January 20, 2014 - 6:11 pm -
Very thought provoking, Dan!

Donald Campbell

January 20, 2014 - 6:17 pm -
The novel and the familiar. Stimuli that are too familiar are boring. Stimuli that are too novel are scary. (Silvia, 2008; Berlyne, 1954)
The comprehensible and the confusing. Material that is too comprehensible is boring. Material that is too difficult is intimidating (Silvia, 2006; Silvia, 2008; Sadoski, 2001; Vygotsky, 1978).
I really like the way you used these two quotes to help visualize the rock and the hard place most teachers get into. I like the idea of checking the “tension” of a students math ability. Lots to think about. Thanks.

blink

January 20, 2014 - 6:38 pm -
Many great ideas here — thanks.

I wonder, though, if declaring some content “boring bits” gives up the game. (If they are *truly* and irredeemably boring, why teach them?) First, we need to understand these “bits” better and think about big-picture coherence.

Consider a jigsaw-puzzle. A missing piece is “interesting” quite apart from its shape or color (although they may be independent sources of interest). What matters is that it fits! Similarly, no one salivates over dates and locations in history. Yet we care about these facts because they allow us to tell stories, discover relationships, and find patterns. It is silly to complain that a particular fact is “boring” on its own. Here again, what matters it how it fits.

Too often, we take the big picture for granted or even miss it ourselves. We may as well ask students to memorize digits of pi — Tuesday’s objective: recall digits 348 through 357. Too often, this is what students think we are doing now.

Courtney

January 21, 2014 - 10:50 am -
I have become the annoying person at school who is always forwarding links to blog articles for people read. Here we go again. Thank you for writing a piece that so clearly lays out the tensions we face. I am going to keep this one in my plan book.

Jason Dyer

January 21, 2014 - 11:17 am -
While only the opening and ending are general enough to be relevant to your work, you might check out Marcel Danesi's book The Puzzle Instinct; he calls solving a puzzle a “mental catharsis”.

Michael Pershan

January 21, 2014 - 5:04 pm -

the purpose of math class is to build a student’s capacity to puzzle and unpuzzle herself

Even if this is the purpose of math class, we aren't operating in a universe where math class has only one purpose. For one, different teachers/parents/students/citizens have different goals. For another, push comes to shove I think we'd all probably agree that we want our students to have the opportunity to go to college.

To me, the question comes in two parts.
1. What do I care about?
2. What's the math class I can run that will satisfy as many of the purposes that various stakeholders have?

I mean, I imagine that I'm preaching to the choir here because we all want to keep our jobs.

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**Evan Weinberg**  
*January 21, 2014 - 7:08 pm -*

The granularity and specificity here of identifying how to generate that engaging inner conflict is fantastic, Dan. Nice work.

I like that these six methods have nothing to do with making math easy. This is often the identified goal that students and teachers (and countless online videos) work towards, particularly in the context of students that have failed math in the past. Having success is enough of a motivator for students to push through some material that is not particularly engaging, it does not have staying power.

These methods also levy the power of being in a classroom of other people. Teachers that can use these methods and capitalize on the power of the group in the room won't be replaced by a computer program anytime soon.

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**Jeff Layman**  
*January 21, 2014 - 8:47 pm -*

Hi Dan,

Since curiosity isn't content-specific, do you see the Lessons Learned you wrote about working in other areas?

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**Kenneth Tilton**  
*January 22, 2014 - 2:58 am -*

Those of us working on educational computer programs are banking on teachers like Dan leading the “deep” and/or motivating activities which will give on-line training its soul, and we expect that teachers like Dan will welcome the class time freed up for such activities by software that generates, helps with, and corrects homework and exams.

I am reminded of the observation that automation has never reduced the number of jobs in the long run, it just creates jobs that are better paid and less boring.

Hmm, there's that word again. :)

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**Steve Leinwand**  
*January 22, 2014 - 10:47 pm -*

Thanks Dan. This is a very compelling summary of the challenges we face in constructing effective lessons. My take away from the post is to start with engaging situations (mathematical, real-world or both) to stimulate immediate interest, build on this with rich and thoughtful questions to maintain this stimulation, and do it all in ways designed to give students a reason to care, which is so often missing in many of the classes I observe. That is, as you note, a blending of the mathematics, the contexts and the instruction to take advantage of the natural curiosity of the human species. I think that everyone will be pleased to see the descriptions and illustrations of eight research-affirmed Mathematics Teaching Practices that support the Common Core Mathematical Practices in the forthcoming NCTM â€œPrinciples to Actions: Ensuring Mathematical Success for Allâ€”to be released in New Orleans in April. Itâ€™s a long overdue encapsulation of what we know about effective teaching of mathematics (with powerful vignettes and examples) and the essential program elements needed to support such teaching.

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**Barbie Panther**  
*January 23, 2014 - 2:22 am -*

I can see great similarities with the boring bits of organic chemistry. Particularly creating an open middle allowing students to sometimes get a little lost along the way to a solution. Thanks Dan for the food for thought.

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**Kevin Hall**  
*January 23, 2014 - 6:39 am -*

In my opinion, the single best bang-for-the-buck strategy for making the “boring bits” interesting is classroom discourse centered around “what does that mean?” The satisfaction or catharsis of pure math is it's connectedness and clarity, which is why indirect proofs are often unsatisfying.

That's why I think Christopher Danielson's hexagons activity is so compelling. It takes something simple and builds up a rather complicated taxonomy of the shapes, but the real hook is that at each stage of developing the taxonomy, I completely understand why that new category was necessary. The final taxonomy seems completely connected (the
categories have a relationship to each other) and clear (I can explain that relationship fully). My experience has been that even some of my strongest students are deprived of that experience, because they're several steps behind where I think they are in understanding formal notation. Discourse is the way to bring that out and make it social and non-threatening.

Here's an example from a discussion this year in my class. The students knew that changing \( y = \sqrt{x} \) to \( y = -\sqrt{x} \) reflected the graph vertically. I asked what will happen if you change the equation to \( y = \sqrt{-x} \). It's a simple question, kind of following Dan's approach of a low barrier to entry. Lots of students predicted that it would reflect horizontally. OK, we can check that prediction on Desmos, and it works. But that's just where our work begins, because WHY does it do that?

I asked them to take a point on the original graph of \( y = \sqrt{x} \), and they chose \((9, 3)\). I asked, “What's the matching point on the new graph of \( y = \sqrt{-x} \)?” They identified \((-9, 3)\). Then I asked, “Why, if you want to get the output of 3, do you need to substitute -9 into this equation, instead of 9?” To a teacher, this is completely obvious. But in a class of good post-Algebra 2 students, it was only the third or fourth student who was even in the right ballpark. For example, one student said “If you substitute -9, you're taking the square root of -9, which has an i [imaginary number], so it will make it go to the left”. That's not correct at all, but that was what was in his head.

When teaching with formal notation, that kind of thing happens a lot more than teachers realize. But in a discourse-centered room, it's a good thing, because it's an opportunity for socially agreeing on a correct response.

After the first correct student explained, I asked another student to paraphrase, but she got mixed up. So it was back to the board for the correct student, and then back to the student struggling to paraphrase. This social dimension of “What is my classmate trying to tell me?” and “Is the student who's paraphrasing really saying the same thing as the original explainer said?” inject life and a little suspense into the situation. Will she explain it correctly? If she leaves a part out, could I help her out and suggest what she forgot?

I try to follow the Accountable Talk strategies for discourse, although I'm still learning them. You can learn more about them here:

https://www.coursera.org/course/accountabletalk

Thanks, Dan, for the reading suggestions. It'll take a while, but I'll try to read them eventually.

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Kenneth Tilton
January 23, 2014 - 8:57 am -
@kevin, the Eulerian identity \( e^{i\pi} = -1 \) translates to multiplication by -1 constituting a 180 degree rotation in the complex plane, ie “left”. So…sign that kid up! :) Much more here (look for the section on “Eulerian identities”): http://tauday.com/tau-manifesto

I stumbled on this while concurrently investigating whether negative numbers exist since \(-3^2 = -9\), in turn while thinking about how to persuade students that a negative times a negative is a positive. It occurred to me that signs applied to numbers add a new semantic, an arbitrary direction of that number along an arbitrary linear ordering, and applying a new minus effectively reverses direction. Now I can just ask students, if I reverse direction twice, in what direction am I going?

I look forward to trying this on my anonymous e-students soon and seeing how much trouble I can start. (I have already been blocked by Math Stack Exchange.)

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Jason Dyer
January 23, 2014 - 12:18 pm -
I don't suppose we could take something extra-“boring” and try to do a makeover? Sort of like Dan's makeover series except start from the hardest point possible?

I am having to currently teach working out polynomial inequalities like \( 2x^5 + 18x^4 + 40x^3 < 0 \). There's an intense amount of drudge and fiddly bits and the extra pain of having a lot of steps to do. Any ideas?

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James Key
January 23, 2014 - 1:02 pm -
Hey, Dan. So your blog posts come with a bibliography now? You should be in, like, a grad school program or something.

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josh g.
January 23, 2014 - 2:49 pm -
I'm going to second Jason's suggestion on a boredom makeover. Although on thinking more, I'm not sure what it would look like. Would the makeover just end up being another three-act? Could we get into more detail, even if we need to
hypothesize a bit? (eg, like a lesson plan with some “here's how we respond to this hypothetical student reaction”.)

Polynomial inequalities is painful enough. Or maybe trig proofs?

Michael Pershan

January 23, 2014 - 6:16 pm

Unverified Opinion: The really “boring” stuff is pretty much the stuff that isnâ€™t well-connected to the rest of the math you’re studying, and the solution is almost always to carefully embed and connect it with other topics in the curriculum. This involves a great deal of careful previewing, emphasizing and sequencing, and making these topics shine almost always falls under the purview of curricular design, not lesson design. So they wouldn’t make great candidates for makeovers, unless you’re going to makeover the entire unit.

(As for polynomial inequalities, I obviously have little helpful to say, but I know two things that help. First, teaching inequalities of all sorts instead of polynomial inequalities, and using graphing technology to give pretty quick feedback on tasks.)

Kevin

January 23, 2014 - 8:39 pm

To the list, though I don't know of research to back it up, I would add “teacher comportment with math”. If the teacher is bored with the topic, and shows it, either overtly or subtly, imagine how the kids feel.

On the other hand, unabashed and overt curiosity on the part of the teacher, with concomitant modeling of problem-playing (with real problems that the teacher does not know the answer to) tends to usher out the putative boredom.

Plus, it's funner.

Jason Dyer

January 24, 2014 - 6:49 am

The really â€œboringâ€ stuff is pretty much the stuff that isnâ€™t well-connected to the rest of the math youâ€™re studying, and the solution is almost always to carefully embed and connect it with other topics in the curriculum.

@Michael: I don't necessarily disagree here, and it's what I try to do in general, but — if there's elaborate computational stuff which foul up the students enough to an extent that 90% of the task is on the “boring” stuff, then the interesting framework doesn't contribute much. If all you're trying to get to is, say, combining like terms, each portion of work is small enough you can get the narrative/context vs. mathy work ratio about equal, but even for a good student a single polynomial inequality can take 10 minutes to resolve. I can get things snappier if I cut down to single steps (rather than starting from scratch — here's the graph, now write out the inequality) but to meet the requirements of the state-mandated test they have to be able to wade from the beginning to the end.

Could you elaborate on what you'd do with “teaching inequalities of all sorts”? The only things I can think of (that I've used with other parts of the curriculum) are things that get the concept of inequality in general down ok, but don't help much with the multi-step process of polynomial inequality.

Robert Kaplinsky

January 24, 2014 - 8:41 am

The part of this that resonates the most with me is creating open middle problems. To me, the most important distinction between that type of problems and open ended problems is that with open middle, they ultimately conclude with the same answer and students can explore the different paths that students took to solve the problem. By exploring this, students have great discussions, are forced to justify their reasoning, and make additional connections to other students’ strategies. With open ended problems, students may also take different paths, but because they don't necessarily end in the same place, making comparisons and the conversations that follow are more challenging and often more abstract.

Thanks again for making me rethink what I thought I knew.

Joe Schwartz

January 25, 2014 - 2:44 pm

Lots more to think about, as if we didn't have enough already! I've thought this week about what makes things “boring”. From my experience in the elementary classrooms (K-5) I see, and from anecdotal reports from my 13 year old daughter (middle school, pre-algebra) and 15 year old son (sophomore, geometry), I think I can draw a direct connection between the level of student boredom and the amount of time the teacher spends talking. The more teacher talking, the more student
boredom. Much of this (again, at least from what I see at the elem level) stems from the fact that the teacher wants to be absolutely sure that everybody understands exactly what to do so that when they go off to do the journal page or the worksheet no one has any problems. So things get repeated over and over. Of course kids still have problems, and meanwhile much of the class time has been frittered away with the teacher talking and the students sitting there with glazed over looks. For the large majority of teachers not plugged into the MTBoS, who are just turning the next page in the manual, a good first step is to stop talking so much.

Roberto Catanuto

January 27, 2014 - 2:27 am -
Thanks for this post. It's thought provoking.

You quote:
“Stimuli that are too familiar are boring. Stimuli that are too novel are scary.”

I've seen tens of students spending hundreds of hours clicking thousands of times their mice, shooting bullets in first-hand shooters games. The game is not just familiar, it's obsessively the same, over and over. Yet they get bored only after many, many years, even decades.

I think they're just interested in stimuli producing immediate gratifying feedback in their brains. I won't go into details on that.

You give thoughtful hints about how igniting “their” curiosity.

But their curiosity might well not be “his” or “her” curiosity.

An exciting question for this student might be a boring one for the other. So you're talking about an “average” curiosity, I think. Am I correct?

What suggestions (if any) about personalizing curiosity over each student?

Roberto.

Dan Meyer

January 27, 2014 - 1:32 pm -

My apologies for neglecting the comments here, team and my thanks for pitching in some insightful questions and comments. I've added several to the featured section of the main post. (Thanks, blink, Evan, Jason.)

blink:

I wonder, though, if declaring some content “boring bits” gives up the game.

Yes! The first step toward redeeming these “boring bits” is to convince yourself they aren't irredeemable.

Matthew Oldridge:

-it is unlikely that this textbook will generate any interest at all

For all the trash I talk about textbooks, I'm not ready to go quite this far. The print medium makes some of these strategies very challenging, however.

Michael Pershan:

Even if this is the purpose of math class, we aren’t operating in a universe where math class has only one purpose. For one, different teachers/parents/students/citizens have different goals. For another, push comes to shove I think we all probably agree that we want our students to have the opportunity to go to college.

To one extent, sure, I'm speaking Platonically about my ideal and the world isn't Platonic. To another, though, I'm looking for organizing principles for a math class that accomplish as many useful goals as possible. The overarching goal for math class should be to puzzle and unpuzzle ourselves not just because it's the Platonic ideal but because it gets us so many of the other goals for free. (Including the very best "real world" applications.)

Jeff Layman:
Since curiosity isn't content-specific, do you see the lessons Learned you wrote about working in other areas?

The researchers almost certainly would since their papers don't explicitly pin any of their theories or research to math. I've tried to instantiate a lot of their recommendations with math curriculum here. I can't imagine I'd be any help to other disciplines, though. Your turn!

Jason Dyer:

*I don't suppose we could take something extra-boring and try to do a makeover? Sort of like Dan's makeover series except start from the hardest point possible?

*I am having to currently teach working out polynomial inequalities like $2x^5 + 18x^4 + 40x^3 < 0$. There's an intense amount of drudge and fiddly bits and the extra pain of having a lot of steps to do. Any ideas?

You're basically picking a fight with Goliath here.

josh g.:

*I'm going to second Jason's suggestion on a boredom makeover. Although on thinking more, I'm not sure what it would look like. Would the makeover just end up being another three-act?

Nope. The three-act structure draws a lot from the literature I cited here (and from some other citations one can find in Loewenstein) but it's largely geared towards modeling the material world with mathematics, a practice with some very specific challenges. What does a fifth-degree polynomial model? (Rhetorical. Please please please don't answer.)

Before I give it a shot, let me agree with Michael Pershan that a good curriculum sequencing won't position fifth-degree inequalities as any different from fourth-, third-, or one-degree polynomials.

Here's an answer that will prove unsatisfying to many students:

"Okay guys. Find a number that makes this inequality true."

(Start with a short, clear prompt that anyone can attempt; Create an open middle; Give students exactly the right kind of feedback in the right amount at the right time.)

"Find as many more numbers as you can in four minutes."

This starts to get really old.

(Break their old tools.)

"Can I show you guys a faster way to find every single solution much faster than this?"

I have a post coming up this week that admits this will be an unsatisfying solution for a lot of teachers. The post claims that culture beats curriculum, that a class that orients itself towards "real world math" for interest will not sustain this kind of approach. A class whose culture has been oriented towards the puzzling / unpuzzling drum I've been banging on will have a very different experience with the "lesson plan" I just outlined.

Thanks, Jason, for the suggestion. Get back to me here, team.

Jennifer F.

February 2, 2014 - 12:42 am -

Wow! Thank you for the thought provoking insight. I am new to your blog, but I am flooded with so many ideas just from reading a few of your recent posts. This particular post has inspired me to incorporate your recommendations into my lessons and forward this blog post to my co-workers. Secondly, I see so many kids get bogged down in the problem that they forget they actually have many of the tools they need to solve the problem. By shortening the prompt and making it accessible may remove their thought of "I can't do this." You wrote, "So not only can arguments stir your students' curiosity but they're an essential part of their math education. That's winning twice." I agree with you, but I would add that it is essential for all of their education and life. Without curiosity, technology (and many other things) would
Dan E.

February 2, 2014 - 9:33 pm

As our district math teachers delve into the modeling aspects of common core standards, your words come as a refreshing insight—“the real world-ness of [an engaging real-world] task is often its least essential element.” We were trying to force every standard into having a real world application—including 5th degree polynomials. I should have known better. 24-years inside the math classroom has shown me that learning math is 3/5 about the content and 3/5 about those tensions you discussed—novel vs. familiar and comprehensible vs. confusing. Who says that content and technique are mutually exclusive? Your recommendations are the perfect short clear prompts our teachers need to continue discussions on how to better engage students in the classroom. Those same recommendations will also be used to help expand our teacher’s use of technology in and out of the classroom.

Andrew Blair

February 7, 2014 - 11:50 pm

You write that to provoke curiosity requires “keeping several lines tight but not so tight they snap.” This is an illuminating way to represent the dynamic nature of an open middle. However, the idea of lines is underdeveloped. When you say that the teacher has to be clear about the beginning and end points of an activity, I take you to mean that the “lines” act like guy ropes anchoring a tent to the ground. In this analogy, the tent is already erected in the mind of the teacher and the students are left with some decisions about which pegs to bang into the ground first. Notice, the teacher decides where the tent goes and how it will look, and, most importantly, is the only one who knows why it is being erected. In my experience, all this dampens curiosity. Yes, we must offer students mechanisms for getting out of a frustrating impasse; yes, a prompt balances the novel with the familiar and the comprehensible with the confusing; but, no, curiosity does not flourish in classrooms in which pre-determined lines allow students little room to inquire.

“Curiosity does not flourish in rooms in which pre-determined lines allow students little room to inquire.”

Andrew has made an interesting connection with the lines analogy. Too many classroom scenarios are led by “the standard we have to teach today” and students are not allowed to process discovery and connect thoughts and understandings. Students have not been allowed to follow their curiosity in class, i.e. Don't get off task! So they have learned not to ask, not to think. It is our gift as teachers to awaken and encourage that which has previously been forbidden.

I am more and more convinced that good education is not in the standards but in the mathematical practices. Those eight little goals are more important than any specific topic we teach. If we can place those first, keeping them in our sight as we present ideas new and old to our students, they will begin anew to find their interest and curiosity.

Clara

February 8, 2014 - 5:18 am

“Curiosity does not flourish in rooms in which pre-determined lines allow students little room to inquire.” Andrew has made an interesting connection with the lines analogy. Too many classroom scenarios are led by “the standard we have to teach today” and students are not allowed to process discovery and connect thoughts and understandings. Students have not been allowed to follow their curiosity in class, i.e. Don't get off task! So they have learned not to ask, not to think. It is our gift as teachers to awaken and encourage that which has previously been forbidden.

I am more and more convinced that good education is not in the standards but in the mathematical practices. Those eight little goals are more important than any specific topic we teach. If we can place those first, keeping them in our sight as we present ideas new and old to our students, they will begin anew to find their interest and curiosity.

Dan Meyer

February 8, 2014 - 8:09 pm

You write that to provoke curiosity requires “keeping several lines tight but not slack” This is an illuminating way to represent the dynamic nature of an open middle.

Hi Andrew, I'm not sure where you're finding my recommendation that teachers should be “the only one who knows why [the tent] is being erected” or that teachers should “allow students little room to inquire.”

You're applying an early metaphor in my post to a much later concept, which perhaps explains the confusion. The tensions I mentioned at the beginning are between the novel and the familiar and the comprehensible and the confusing.

Andrew Blair

February 9, 2014 - 1:21 am

Thanks, Dan. I am not sure I am any the wiser after your reply. I find the idea of productive tensions very appealing.
perhaps, the metaphor of 'lines', rather than clarifying the idea, detracts from it. I understand you to be recommending the open middle as one way to maintain those tensions. If that is the case, then you yourself make the link from the lines metaphor to the later concept (i.e. the open middle). You go on to say that the teacher has to be "exceptionally clear about ... where [your students are] going." From this sentence, I don't think it is at all fanciful to extend my analogy of erecting a tent to saying that the teacher is the "only one who knows why it is being erected", although, of course, the teacher might share her intentions on the way. To conclude, I return to a point I made in my first response: the idea of 'lines' is underdeveloped and that, perhaps, accounts for my confusion.

Dan Meyer

February 9, 2014 - 10:47 am

You go on to say that the teacher has to be "exceptionally clear about where [your students are] going." From this sentence, I don't think it is at all fanciful to extend my analogy of erecting a tent to saying that the teacher is the "only one who knows why it is being erected", although, of course, the teacher might share her intentions on the way.

I'm just not sure extending the lines to tents has been all that productive here.

The tension I'm trying to resolve with an open middle is between an underspecified and overspecified task. This tension (and one possible resolution) is nicely illustrated by Sudoku.

Underspecification starts with a blank game board and the instructions to make a game board that satisfies the constraints of Sudoku. This can result in excessive cognitive load and a certain sense that one is flailing. It's too open.

Overspecification starts with an entirely full game board and the instructions to check its correctness. This can result in a lack of self-determination, a sense that you're wandering down a narrow path prescribed by others.

Sudoku instead offers a partially-completed game board and invites students to complete the rest. The initial state is clear. The goal state is clear. But the middle is calibrated so that players feel self-determined but not overwhelmed. That task clarity, rather than undermining a student's curiosity or sense of agency, has enhanced it.
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