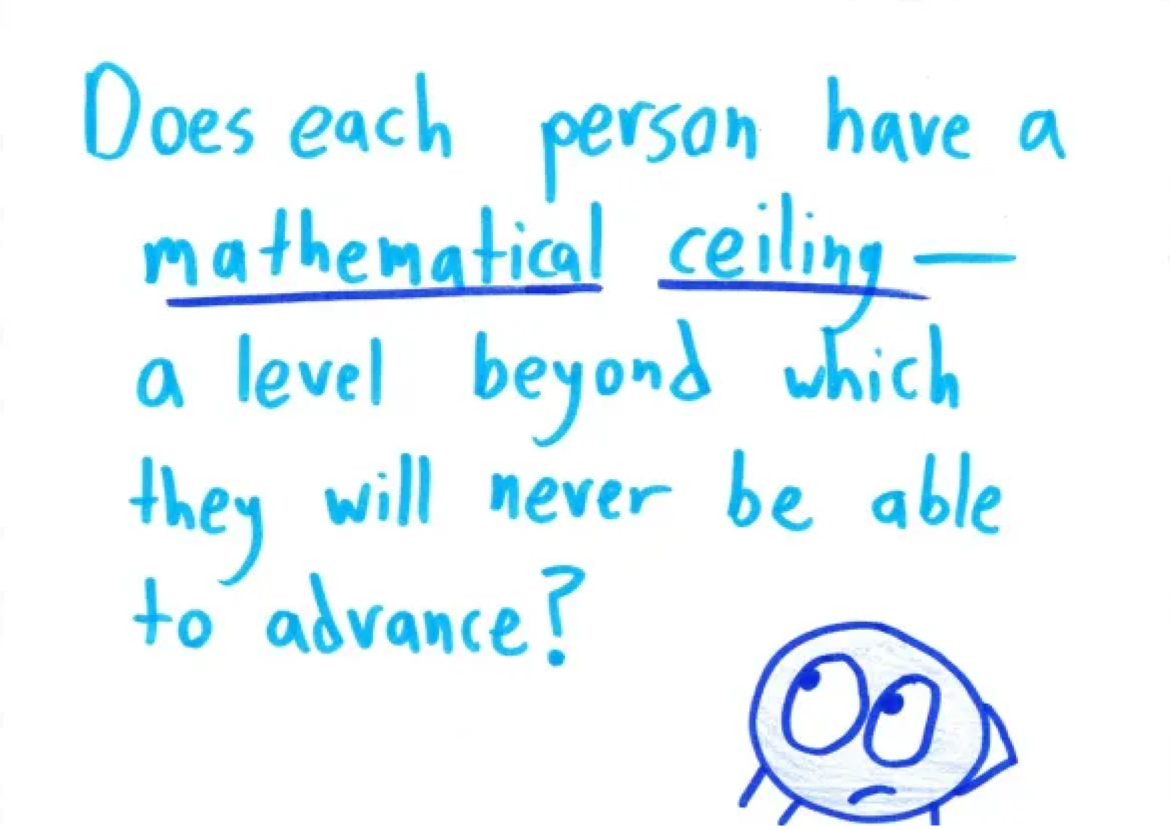
The Math Ceiling: Where’s your cognitive breaking point?

mathwithbaddrawings.com/2015/04/08/the-math-ceiling-wheres-your-cognitive-breaking-point

April 8, 2015

One afternoon, the head of my department caught me in the staff room and posed a musing question.



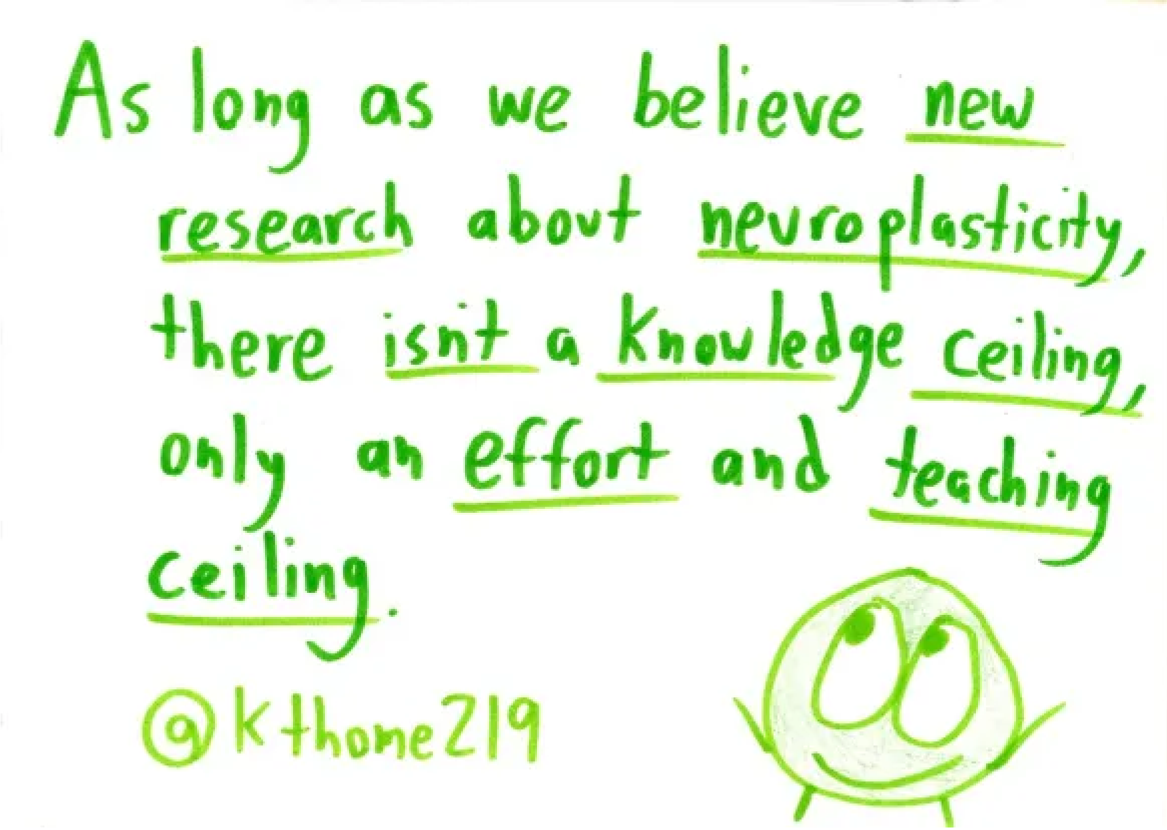
(He later confessed that he was just curious if he could play puppet-master with this blog. The answer is a resounding yes: I dance like the puppet I am.)

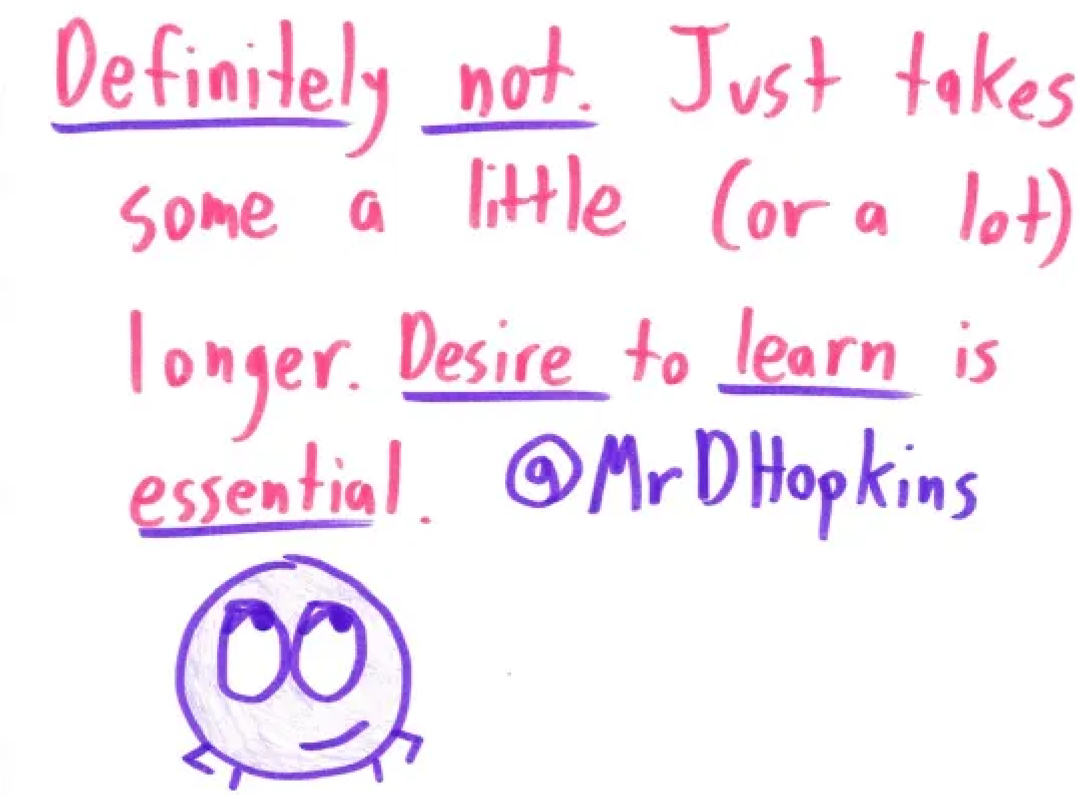
So, do we have ceilings?

The traditional orthodoxy says, “Absolutely yes.” There’s high IQ and low IQ. There are “math people” and “not math people.” Some kids just “get it”; others don’t.

Try asking adults about their math education: They refer to it like some sort of NCAA tournament. Everybody gets eliminated, and it’s only a question of how long you can stay in the game. “I couldn’t handle algebra” signifies a first-round knockout. “I stopped at multivariable calculus” means “Hey, I didn’t win, but I’m proud of making it to the final four.”

But there’s a new orthodoxy among teachers, an accepted wisdom which says, “Absolutely not.”



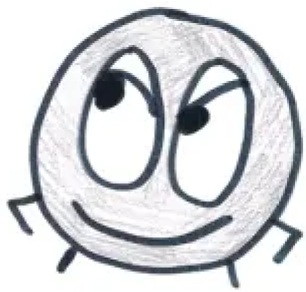


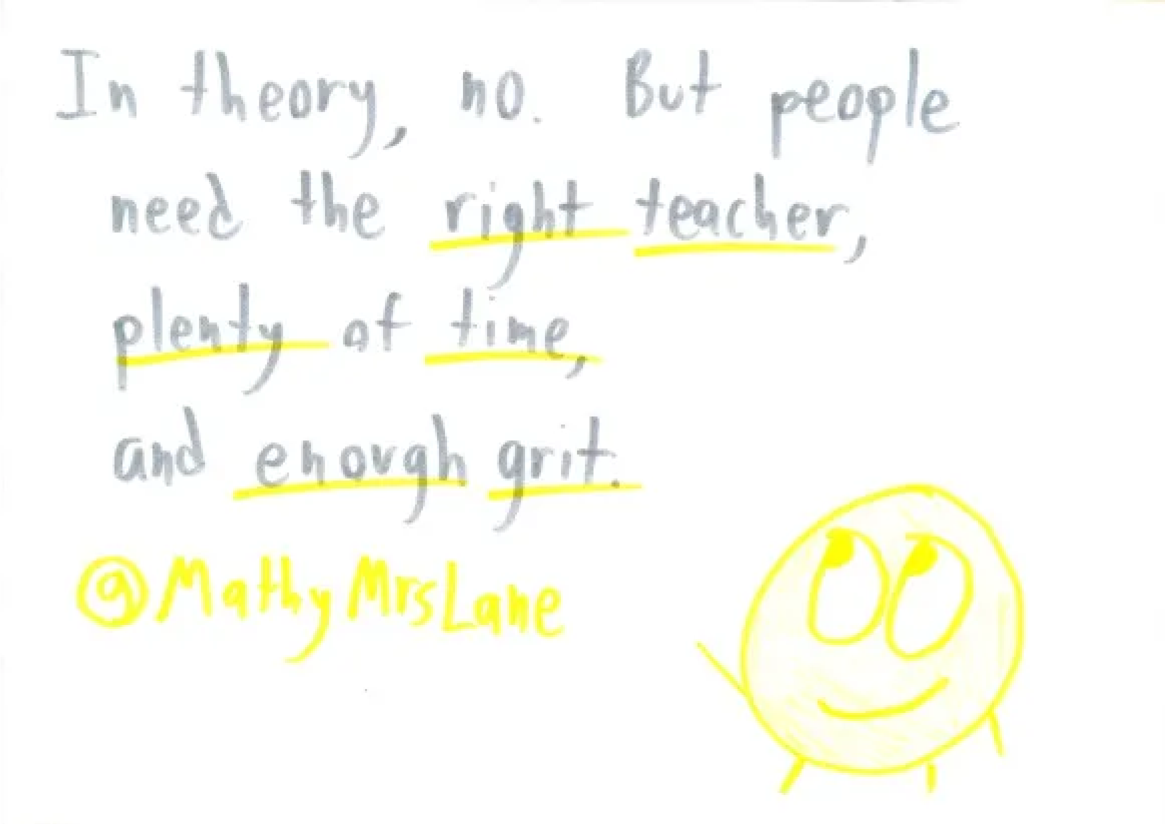
I think the only ceiling is in the learners' evalvation of their own ability to do new things.

@AndersonOZB

No, because I reject the idea that even with time and persistence there are things that I couldn't learn.

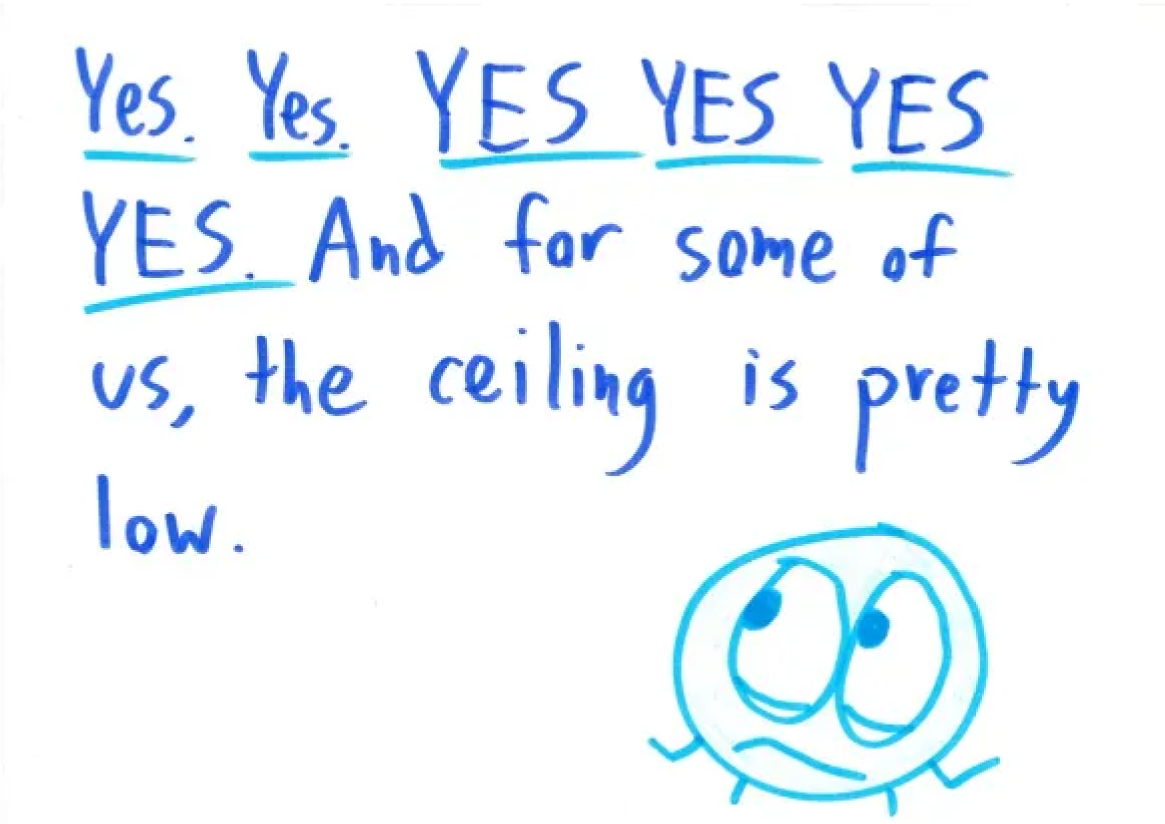
@Mythagon

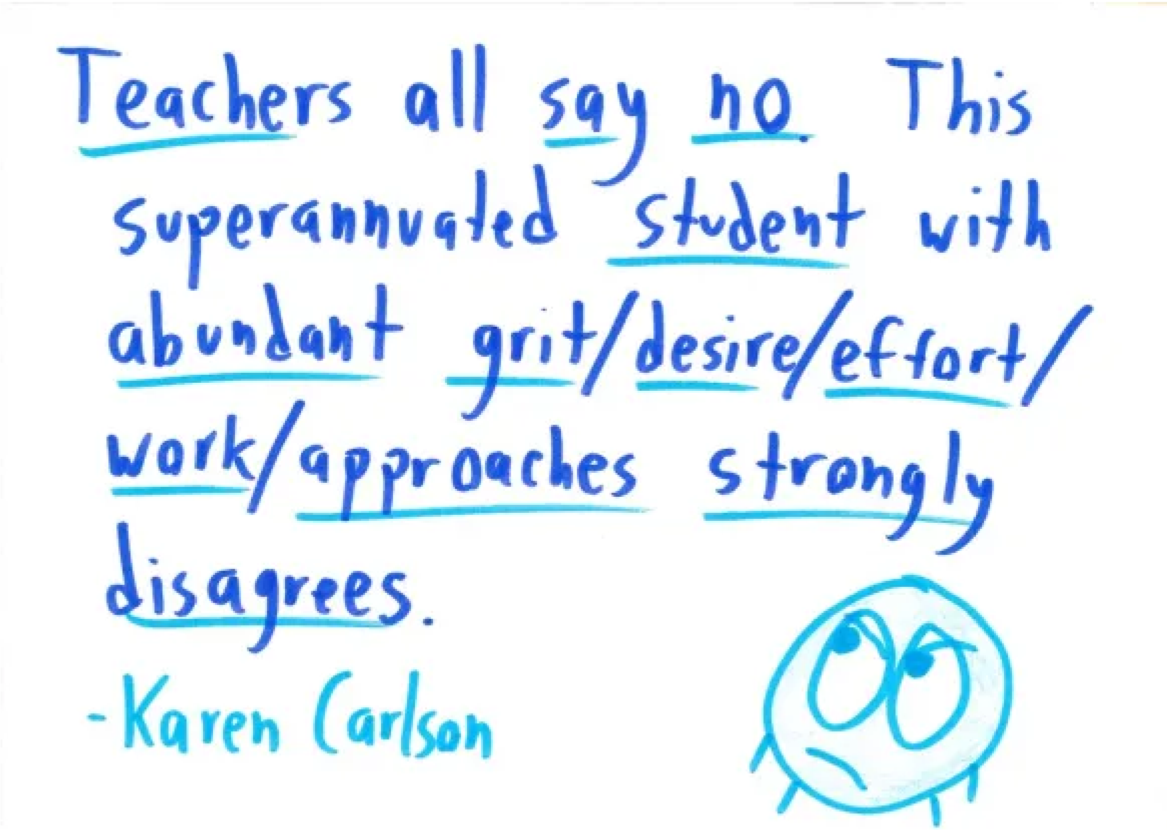




You've got to love the optimism, the populism. (Look under your chairs—*everybody* gets a category theory textbook!) But I think you've got to share my pal Karen's skepticism, too.

Do we have a ceiling, Karen?

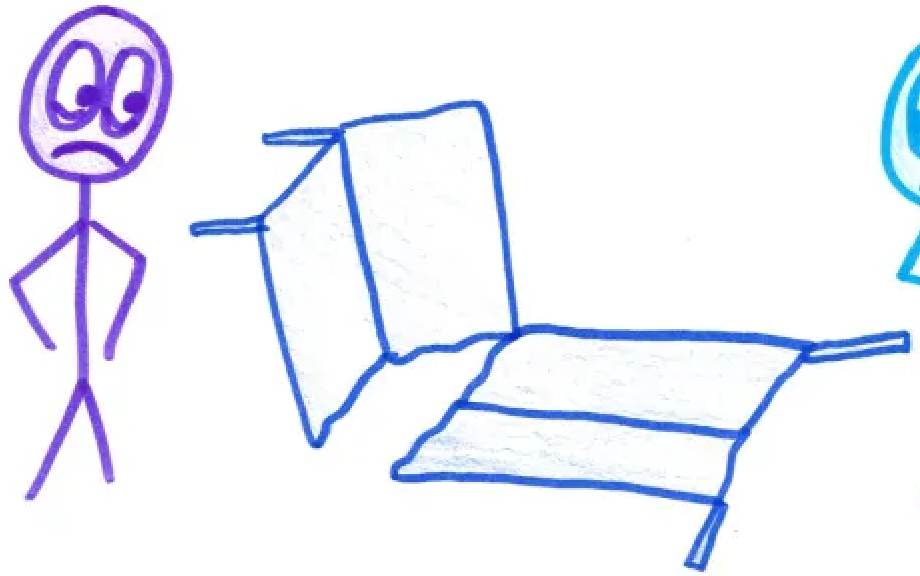




Karen works hard. Karen asks questions. Karen believes in herself. And Karen still feels that certain mathematics lies beyond her abilities, above her ceiling.

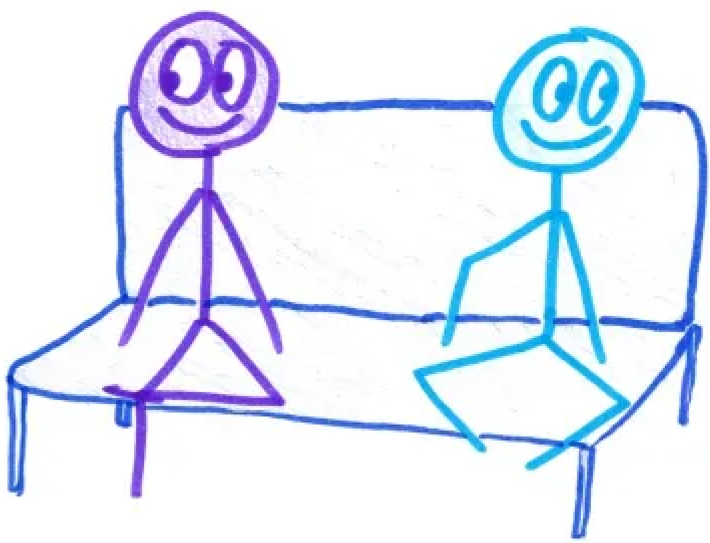
The chasm between students ("everybody's got a limit") and teachers ("anyone can do anything!") seems unbridgeable. A teacher might say "You can do it!" as encouragement, but a frustrated student might hear those words as an indictment of their effort (or as a delusional falsehood). Is there any way to reconcile these contradictions?

I believe there is: the **Law of the Broken Futon**.

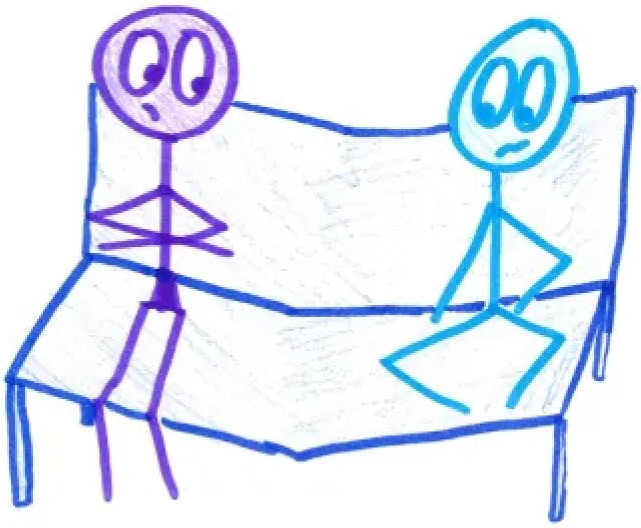


In college, my roommates and I bought a used futon (just a few months old) off of some friends. They lived on the first floor; we were on the fourth. Kindly, they carried it up the stairs for us.

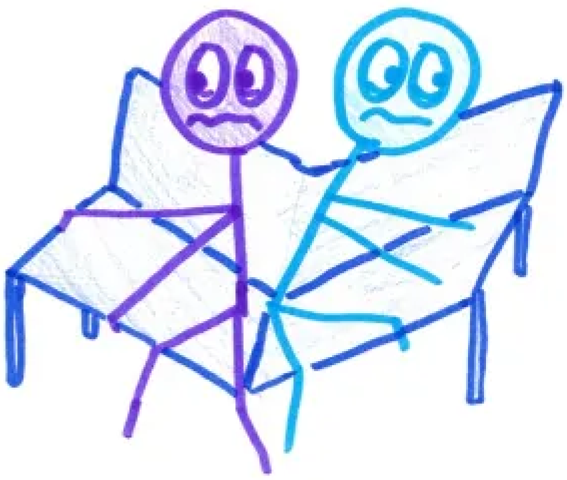
As they crested the third-floor landing, they heard a crack. A little metallic bar had snapped off of the futon. We all checked it out, but couldn't even figure out where the piece had come from. Since the futon seemed fine, we simply shrugged it off.



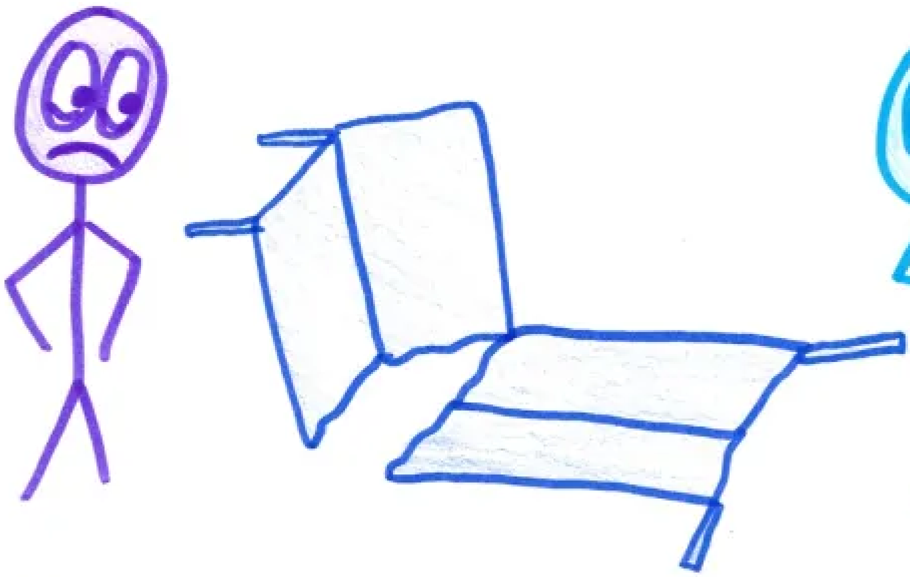
After a week in our room, the futon had begun to sag. “Did it always look like this?” we asked each other.



A month later, it was embarrassingly droopy. Sit at the end, and the curvature of the couch would dump you (and everyone else) into one central pig-pile.



And by the end of the semester, it had collapsed in a heap on the dusty dorm-room floor, the broken skeleton of a once-thriving futon.

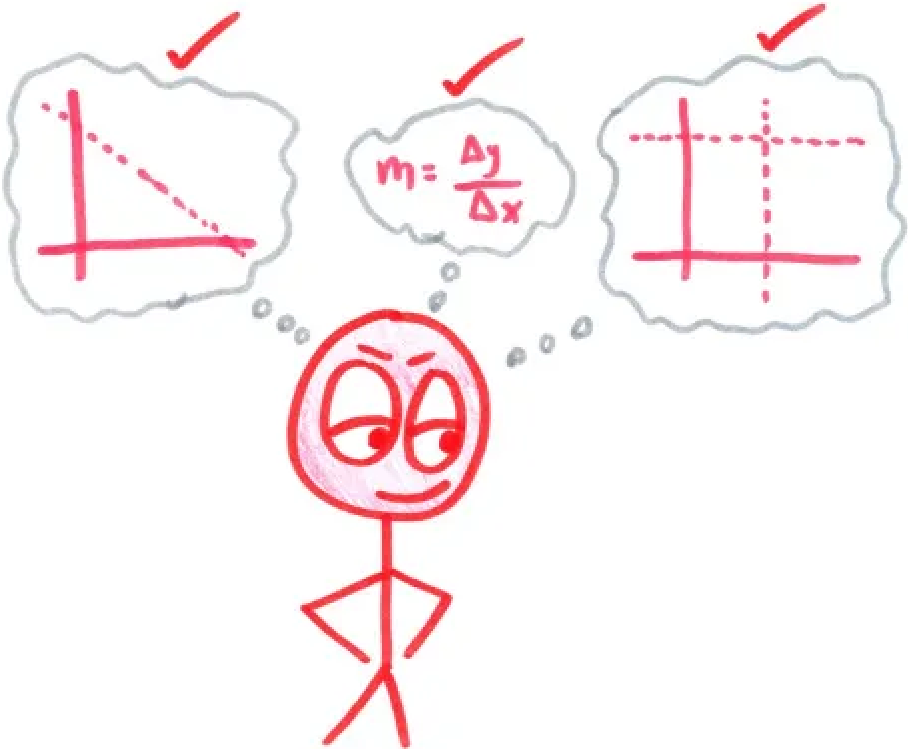


Now, Ikea furniture is the fruit-fly of the living room: notoriously short-lived. There was undoubtedly a ceiling on our futon's lifespan, perhaps three or four years. But this one survived barely eight months.

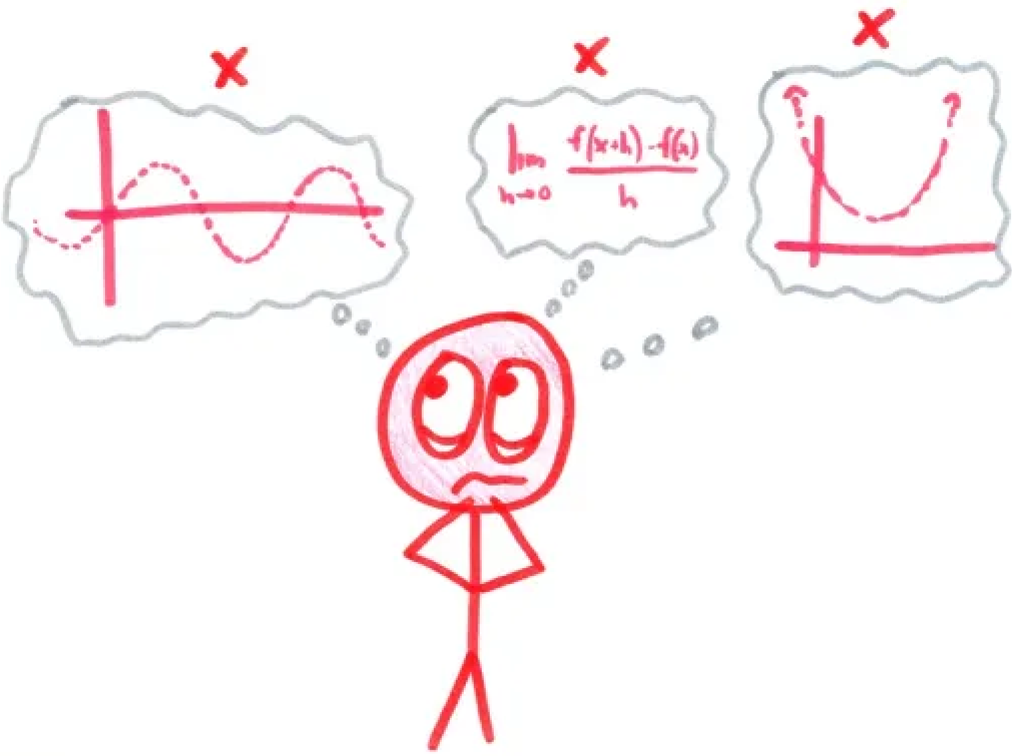
In hindsight, it's obvious that the broken piece was absolutely crucial. The futon *seemed* fine without it. But day by day, with every new butt, weight pressed down on parts of the structure never meant to bear the load alone. The framework grew warped. Pressure mounted unsustainably. The futon's internal clock was silently ticking down to the moment when the lack of support proved overwhelming, and the whole thing came crashing down.

And, sadly, so it is in math class.

Say you're acing eighth grade. You can graph linear equations with perfect fluidity and precision. You can compute their slopes, identify points, and generate parallel and perpendicular lines.



But if you’re missing one simple understanding—that these graphs are simply the x-y pairs satisfying the equation—then you’re a broken futon. You’re missing a piece upon which future learning will crucially depend. Quadratics will haunt you; the sine curve will never make sense; and you’ll probably bail after calculus, consoling yourself, “Well, at least my ceiling was higher than some.”



You may ask, “Since I’m fine now, can’t I add that missing piece later, when it’s actually needed?” Sometimes, yes. But it’s much harder. You’ve now spent years without that crucial piece. You’ve developed shortcuts and piecemeal approaches to get by. These worked for a while, but they warped the frame, and now you’re coming up short. In order to move forward, you’ve got to *unlearn* your workarounds – effectively bending the futon back into its original shape – before you can proceed. But it’s well nigh impossible to abandon the very strategies that have gotten you this far.

Adding the missing piece later means waiting until the damage is already underway, and hellishly difficult to undo.

This, I believe, is the ceiling so many students experience. It’s not some inherent limitation of their neurology. It’s something we create. We create it by saying, in word or in deed, “It’s okay that you don’t understand. Just follow these steps and check your answer in the back.” We create it by saying, “Only the clever ones will *get* it; for the rest, I just want to make sure they can *do* it.” We create it by saying, “Well, they don’t understand it now, but they’ll figure it out on their own eventually.”

In doing this, we may succeed in getting the futon up the stairs. But something is lost in the process. Sending our students forward without key understandings is like marching them into battle without replacement ammo. Sure, they’ll fire off a few rounds, but by the time they realize something is missing, it’ll be too late to recover.

A student who can answer questions without understanding them is a student with an expiration date.

EDIT, 4/15/2015: What a response! The comments section below is infinity and beyond. It's like eavesdropping in the coffee shop of my dreams. I wish I had time to reply individually; please know that I read and enjoyed your thoughtful replies and discussion.