

Proof of Concept

Uncategorized

Proof of Concept

For math majors

Math Anxiety

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I have math anxiety. So, perhaps, may you. It is the flood of stress hormone in response to a mathematical challenge. For me, it takes the form of fear of being wrong in front of my colleagues or students. For you, it may make its appearance when you are called upon in class, have to confront a group worksheet, when you are sitting an exam, or when you are alone with your textbook.

Are you surprised that your professor has math anxiety? Don't be. The truth is, many or perhaps most mathematicians have math anxiety in some form or other. Mathematics is challenging, and there are right and wrong answers. That's right, I won't baby you

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Caesar Cipherer

by pretending there are no wrong answers. Instead, the key to surviving math anxiety is to **embrace error**. Error is your friend, and you should be proud of your mistakes. Bear with me.

It is natural and human to be concerned about how others view you, and this is a principal source of anxiety. We all want to be wunderkinds, who immediately and impressively jump to the right conclusions to complex problems. I am going to try to convince you that this is not actually what you should be aiming for and comparing yourself to. Instead, you should demonstrate, for yourself and others, your *courage*, *perseverance* and *creativity* in the face of challenges. These are far more important traits to aspire to than looking like a slick genius.

Learning mathematics, and doing mathematics, is, by definition, to be confused. Confusion is a necessary part of the process. Even the most impressive mathematical feats, which seem to come from nowhere, have as their source a stretch of frustrating confusion. The greatest mathematical theorems are born of many hours of hopeless head-banging, as any great mathematician will tell you. My job description, as a research mathematician, is to spend all day, every day, hopelessly confused.

Except that it is not hopeless. Instead, every confusion is an opportunity for enlightenment. Every mistake is an opportunity for learning. This is not simply a cliché. Being confused is an opportunity to ask a question. And asking a question brings new understanding (sometimes by itself, sometimes by its answer).

I have a great variety of students in my class every year. One of them, let's call her Jane, is the student who believes she understands everything I am saying. She seemingly always has the correct answer to questions posed to the audience, and may volunteer them frequently, leaving you with the impression that she, or perhaps everyone except you, understands the lecture easily. However, Jane does not question her understanding. Her confidence blinds her to the opportunity to discover fuzzy corners of her understanding where she may err. Her familiarity with the concepts leads her to mentally “check them off” instead of

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Math Anxiety

Who is that professor at
the board, and what does
she want?

examining them with any dedication. Jane finds homework easy and always sees the solution right away. Until sometimes she doesn't. And then she doesn't know how to proceed.

Another student is Anne, who is intimidated by Jane. Anne doesn't understand things immediately in lecture and is often afraid to ask the question that is buzzing about her head. However, she forces herself to ask (sometimes in office hour instead of lecture). Before asking, she carefully and slowly formulates the question. In so doing, she often discovers the cognitive dissonance that has caused her misunderstanding and resolves it. But if she doesn't, she then produces a careful, precise question which will elicit exactly the missing information she needs to keep building. Anne forces herself to face her fear of speaking up, she perseveres if she doesn't understand something at first, and she tries many approaches to a problem. She often seeks help with homework, but she always works on it until she's understood it all.

Anne is an example of "slow and steady wins the race." Jane eventually comes across something she doesn't understand and her reaction is to bluff a little, or comfort herself with a surface understanding. She doesn't know how to proceed. Anne, by contrast, is an expert in resolving her own misunderstandings by now, and she has become meticulous in her thought processes. She is able to call on her sense of creativity and ability with precision to face a new challenge.

My moral is this: Anne is your role model, not Jane. Focus on being a model of courage, perseverance and creativity in the face of challenges. Don't focus on the outcome (knowing the answer), but instead on the process (the skills of learning). They are simply more important.

After all, your trajectory in life will inevitably and eventually test your limits, wherever they may be. You need to be prepared.

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