Math Teachers Suck

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1 Introduction

If you are like most, you believe there exist two types of people. On one hand, there is the math person or maybe you say "the person who is good with numbers", on the other there is the creative type of person, who you might say, is "good with words". This duality comes in many other forms. One such form can be found at American Universities all over the country in the ceaseless discussion of hard verse soft sciences. In Tedtalks, it might be known as the left-brain versus the right-brain dualism. Intellectuals and academics are beginning to throw away this dialectic, as they should, but it still lingers in you, college professor, highschool teacher, and most significantly, parent.

The apparition of "either" festers in the minds of students everywhere, and it is anxiety inducing for them. This "eitherism" perhaps could also be tied into the gender disparity we see in certain math based technical fields. In a survey of 3,106 architects and engineers from the Bureau of Labor Statistics, only 14.2 percent of the respondents reported themselves as female. In "Computer and mathematical occupations" that percent is 25.5 percent of 4,601 people surveyed. It is difficult to say what factors are at work. The best comparison we can make, is to female participation in the sciences, particularly those less math intensive. This will hopefully help isolate the presence of math as being one of the only major factors that account for the gender participation disparity.

Consider the following numbers. From the survey, about 10 percent of electrical engineers reported as female, still only 7.8 percent of aerospace engineers, and just 6.4 percent of mechanical engineers. There is no lack of math in these subjects. But if we look at biology we find that 43.4 percent of respondents were female, 46.9 for medical sciences, and 67.5 percent of psychologists. These subjects are primarily less math intensive, but arguably just as technical. All these fields are scientific in nature, in that they either employ the scientific method to answer questions or they apply science to solve problems, so they should each equally attract people curious about science. Yet we find major discrepancies in those more math intensive fields and those less so. Certainly, much can be argued as to whether the data paints an accurate picture of the situation and whether what we have gleaned from the data is accurate. That is perhaps a paper for another time. If you would like to peruse the data more, feel free to: https://www.bls.gov/cps/cpsaat11.htm.

Much anecdotal evidence can also be given. At the school, where I am pursuing my PhD in math, of 25 of the research and teaching assistant, only two are female. One can easily type in the name of most universities and then "math TAs" into Google and get similar results. In my recitation section only about four of my 34 students were female. I say about, since one of them dropped out halfway through. I have a friend, who works in a mentorship organization in an inner city middle school in Philadelphia. One teacher there said something along the lines that girls are not supposed to be good at math. I have also tutored female high school students who said they were no good at math. Male students say it too, but less often. No one will probably be surprised to learn that many of the impressions we get about math come from our parents and I encourage anyone interested to read further in this New York Times article: https://www.nytimes.com/2017/04/24/well/family/fending-off-math-anxiety.html.

Now why should we have the impression that some people are math people and others are not? Why should we see math as being a left-brain subject as opposed to a right brain one. There are many reasons for these pervasive attitudes towards math in our culture and no one idea can fix it. One idea though is to compare the subject Math to subject English. If we can show that these subjects are and should be viewed and taught more similarly then they are, then perhaps we can change people's minds about what the subject is a bit. We could have the power to make math into a creative subject,but which is as technical as ever. Perhaps students will enjoy their experience more, and parents may be surprised at what their children can do and know. These surprises could change something in the minds of people most importantly parents that might lead to their thinking of math, not as something there kid is bad at, but actually has creative ability in.

To inspire some of us and probably offend others I want to share a tiny story about a famous mathematician David Hilbert. We take it with a grain of salt of course, but its counter intuitive position will hopefully loosen some of our false yet foundational beliefs.

"It seems that there was a mathematican who had become a novelist. 'Why did he do that? people in Gottingen marvelled. How can a man who was a mathematician write novels?' 'But that was completely simple,' Hilbert said. 'He did not have enough imagination for mathematics, but he had enough for novels.'"

Before we get into a critical comparison of math and English, lets warm up with some experiences with Math I had that I think will be informative to the conversation. In kindergarten, I remember learning about this strange concept called multiplication. I somehow found out that "3 times 3" is 9. What a perplexing idea. I knew that "3 plus 3" is 6, and I wondered how was it that 6 and 9 were related. Maybe they were cousins. They do kind of look the same, maybe that is why 3+3 =6 and 3*3=9. These ideas that were clearly wrong, lead me to the right one, because when one says or thinks "three times three", "three times "three, "three times....three", enough times, one begins to realize the answer is in the words. Three times three is just an archaic sounding way of

saying three, three times, which is like saying three and three and three that is 3+3+3, which is 9. Excited, I blurted it out to my sleepy kindergarten teacher. "Yes" she said underwhelmed.

One other experience I had, while in second grade, we were learning the multiplication table. What a pain it was to memorize and so I wanted to find shortcuts. As a second grader I thought I had discovered something novel, when I realized that I never needed to memorize any multiplication by 5 again. Instead, if the number was even, I could divide by 2 and put a 0 at the end. If the number is odd, I could subtract 1, divide by 2 and then put 5 on the end of the result.

What trivial ideas you came across, you must be thinking to yourself. You probably figured these facts out in kindergarten and second grade respectively as well, and if you didn't but were ever forced to memorize the multiplication table, probably figured out some other trick to assist you. But listen, when a child tells you they know what the word dinosaur means do you say to them, "what a trivial concept" or when a highschooler writes a paper about the racism in Huck Finn, do you say "what an unoriginal paper". What if a middle schooler writes a story about Zombies, do you say, well "walking dead already did it". No, absolutely not. As a teacher, you know that the experience of writing a story or paper, no matter how unoriginal the idea is, will help the student excel later in life, because when it comes time to write that original paper, or book, they will be prepared.

In my experience of English class on a high school level, there were two main activities we did. We read primary sources and then we wrote papers. Do you think it is a good idea to have an English class where the students only read and never write. I don't think so, so in math class does it make sense that we teach people math, but never have them actually do math? Yes, there are tests. There were tests in English class too, but an important part of developing as a student is learning how to learn. There are other ways of a putting it. An important part of being a student is learning to ask the right questions. An important part of being a student, is learning to use what you have learned to produce something new, not necessarily original, but something different than that which has already been fed to you. An important part of being a student is learning to convey what you know effectively to others. An important important part of being a student is learning to create something. You see how I could go on, and I could list how every subject has some mechanism for this kind of teaching except math. There are science projects in many science classes. There are papers in English class. In art class, you make a painting, in creative writing you write a poem, in computer science you build an app, in history, you write an essay. What do you do in math? As far as I can tell, you take tests and maybe do homework. No wonder kids sit in math class bored to death. What would a a soccer player be like, if she did drills 1 hour everyday for 10 years, but never played a game?

Let's think a little bit about the process a student writing a paper for an English class goes through. Clearly the student did not just start reading the Odyssey. The student had at some point learned to read and has to have

developed an extensive vocab at that. This is kind of like in elementary and middle school when you learn the rules of arithmetic and algebra. I emphasize rules because, despite being logically constructed, they were made by humans and function in the same way a word might. They have to be understood how they are best used. Then, in order to write the paper, the student learned grammar, which is another set of rules. There is also spelling. All this is analogous to the learning of the rules of math as a child. It feels different and can be harder since as a child, your parent probably read to you more than told you about numbers.

Ideally, a student, who knows they will be writing a paper on the Odyssey, throughout reading, will be asking themselves questions in preparation for the paper. For example they might notice that when Odysseus goes to (dead place), he is able to interact with dead people, but he cannot hug them. This might lead to the question, what role does death play in the Odyssey. Is it motivational because it puts time limits of the types of things characters can do. Is it something to be feared and thus hinders characters' actions. Is the attitude toward death something else entirely? The student then begins to analyze the text for clues and evidence. One might consider that Odysseus leaves Calypso, who promises eternal life to him so long as he stays. This would seem to suggest that family ties are stronger than the fear of death in his culture. The student might do some outside research. For example, the student might find a book regarding the attitudes toward death in ancient Greece. This could reveal in Greece, it was perhaps better to die a hero, than to live as a coward. These are all curious questions because, they have implications like how do these attitudes affect characters. How does it reflect their satisfaction in life and understanding this might help the student understand what it is like to be alive now. The research paper can teach the student many things and I refer to the list of "an important part of being a student" from up above.

Even though most likely the student will not say anything original and even though the argument may be flawed or incomplete, the experience of writing the paper is essential to the students education. The student for one thing, has learned to ask questions and not just any question, but questions that are answerable in a paper. The student has learned a little bit how to ask questions that help them get a bit further in their knowledge. The student learned how questions can have implications and perhaps be useful. The student, then learns how to find evidence to construct, their own new ideas. Finally the student sees the implications in what they have learned, and even if these implications are trite, overstated, and unnuanced, they have still learned. It would really be astounding were the student able to actually write anything even good in their first paper. The point of the paper wasn't to change the worlds view on role of rentier states in geopolitcal affairs, rather it was to understand the subject matter more deeply and in a more creative way. For some reason, nothing like this has ever existed in the math classes I have taken. Maybe because that whether something has been proven true or not in math is so well documented that it seems to be a waste to find it out again. But people still solve rubiks cubes, even though someone has solved it before. Maybe, it would be too

difficult, but if it is too difficult, it is only because we have never taught it. To show it is possible, I want to show you, as an example, a highschool or perhaps early college level math paper. Then I will fake grade it. The result or mathematical fact is well know to mathematicians, but perhaps not to the reader. But I had never considered it until was thinking about what an average highschool math paper might look like. Something that, which did not take anything too advanced and was still fun to ponder.

First though, an example of what the assignment may look like. *Due in four weeks at the end of the term: think about what you have learned over the course of the semester and try to deduce something we haven't learned in class. Then explain your result in a paper that is at least 3 pages long (including relevant diagrams or pictures). Try to be concise yet clear. Yes, grammar is important. Come to me with questions about the direction of your paper and whether your question is feasible at your level. An example paper is below.*

In such a paper, a student must try to convey what they know, which is one of the best ways to learn a subject since it forces one to have it clear in their mind. In the paper Gimp, a free open source image manipulation tool, was used to create images that go along with the ideas. The images could have just as easily been hand drawn. This use of visual aid in expressing ideas, is also an important skill to learn and math is a great landscape in which to practice the skill since, the expression of ideas in non-verbal ways is ubiquitous in the subject. The paper has more to it than solving a problem. The paper is an attempt to a coherent expression of ideas. It attempts to show how one got somewhere and where one could go. In this particular case, the paper started with a very specific question in mind. A tool was developed and exemplified and then used to answer the question. The tool helped the question be thought of in a new way. Then once the question was answered, the student could explore implications of the questions. All this is much deeper than solving a homework problem and reflects more accurately what mathematicians do. Not only what mathematicians do, but also problems solving in general and logical reasoning.

It is difficult to say, whether making students write math papers can really help the education of students or whether it can help with gender discrepancy in math related fields. Why should writing papers be more attractive to women, whereas men still participate. In math class rooms across the country there is fear of failure, atychiphobia, and one could hypothesise that for historical and cultural reasons, this fear is worse for women and so the idea of a math paper is supposed to be a confidence building and exploratory process. It is in opposition to the type of quick mental math that one might use to calculate tax on a bill and which all to quickly becomes the qualification for being a math person. In other words, the judgements we make about ourselves and others and our ability to do math, is formed from experiences which are not really good indicators when it comes to being able to math. The big picture idea for the math paper, is to introduce something which is a better indicator and ultimately a more use full skill. Now more then ever technical creativity is needed, especially since computers and calculators are able to do essentially all the math you learn through high school anyways.