

Overcoming Stereotypes through a Liberal Arts Math Course

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Abstract

“I’m just not a math person.” We’ve heard this comment countless times from our students. It is a mentality that both paralyzes and strangely comforts them. In this paper, I will describe how I use my liberal arts Joy of Mathematics course to help students address and overcome stereotypes. In particular, I will discuss a specific assignment as well as share some student comments and perspectives on how this course helped change their viewpoint on more than just math.

1 Introduction

When I tell people that I teach math I typically get one of two reactions: “Ew, I hate math!” or “Wow, you must be so smart!” What is even worse is that people do not realize how inappropriate both responses are. It has become widely accepted that math is hard and you have to be really “smart” to succeed at it. It is overwhelming to think about overcoming this mindset. How do we even begin tackling this monumental problem?

As I always tell my students, when you are faced with a problem that seems too difficult, try to solve a smaller related problem. I can not change everyone’s view of mathematics. However, studies show that math anxiety comes from a variety of places, two of which are parents [6] and teachers [1]. I am a parent and a teacher and this is my smaller related problem to try and solve. Though the responsibility of a parent is greater, my job in promoting a growth mindset in mathematics is much easier, in a way, with my little boy than with my students. My little boy is a clean slate, so to speak, while my students come with a lot of mathematical baggage. So how do we, as educators, remove this baggage and start with a clean slate? I think one solution is through a liberal arts math course—a course unlike any other students have taken. Eugene Northrop developed one such innovative course for freshman at the University of Chicago in the 40s. He said that a liberal education is one which “liberates the student’s mind” [4]. I think we can all agree that our students need to have their minds liberated, especially when it comes to mathematics.

I have created such a course at Winthrop University entitled Joy of Mathematics and have seen really positive results. I have seen student perspectives changed and minds liberated from the bondage of math stereotypes and it has been so encouraging. But then I asked myself some questions. If we can get students to overcome stereotypes about mathematics why stop there? Why not use their positive experience with mathematics to help them overcome other stereotypes, to see that getting to know someone (or something) can be eye opening and life changing? This is

the motivation for my final assignment in my Joy of Mathematics course at Winthrop University. In this paper I will give you a small taste of this course, both the content and the population, describe a final reflection paper I give involving math and stereotypes, and discuss results I have seen over the past two years.

2 Setting

Winthrop University is a public liberal arts university in Rock Hill, South Carolina. As a believer it can be frustrating teaching at a public school. Many of my colleagues have vastly different views than I do. I can not read scripture or pray with students in the classroom. However, as Paul describes in 2 Corinthians, my goal is to be a “living letter” shining God’s light and love to all I encounter. One way I share God’s love is by showing my students that I care about them as people. I want them to succeed inside and outside the classroom. This desire for student success was one of the catalysts for designing Joy of Mathematics.

For years at Winthrop University, there has been only one general education math class other than college algebra/pre-calculus and statistics-Introduction to Discrete Mathematics. This notorious class has had one of the highest D/F/W rates of the entire university. Just the name of the course strikes fear and dread into our students. There are several reasons this course has such a high failure rate, one of which is that there are too many students who take it. The class is only required for our early childhood education majors, so many students taking the class do not need this specific course. They typically sign up for this course for one or both of these two reasons: they think it will be easy as it is one of the lowest numbered courses and it is not algebra, which many of them have had negative experiences with in the past. Students take Introduction to Discrete Mathematics to simply check a box in their degree checklist and nothing more. This problem became abundantly clear to our department. So we set out to solve it. A colleague of mine designed a 100-level course called Every Day Mathematics and I created Joy of Mathematics. Though the two courses are extremely different in content they have a common goal-to help students develop an appreciation for mathematics.

How does one develop an appreciation for something? The answer may be different depending on the person. However, I think we can all agree on things that will *not* develop an appreciation. These include rote memorization of formulas, methodical procedures for solving problems, and learning other mathematical topics seen in a vacuum. Morris Kline, when writing about liberal arts mathematics, said “to separate mathematics from other human subjects and endeavors is to lead to a hollow shell and...a perversion of the subject” [3]. In both Everyday Mathematics and Joy of Mathematics we show connections between mathematics and the world.

2.1 The Course

As mentioned above, Joy of Mathematics is a 100-level liberal arts math course. I use the *Heart of Mathematics* book by Burger and Starbird, and we cover a variety of topics. I always start the semester with fun problem solving. Day one is spent discussing the importance of a growth mindset and questions such as “what does it mean to be smart?” and “how do you know you’ve learned something?” After we discuss these topics together we start a fun problem-the problem of the zombies and hats. I include it here for your pleasure as well!

The Problem: Suppose you are out walking with some friends and are suddenly confronted by zombies. These are zombies who love problem solving so they decide to give you a challenge. They are going to put you all in a line and put either a black hat or a white hat on your head. You can see the color of everyone's hat in front of you but not your own and not anyone behind you. They will start in the back of the line (or wherever you want them to) and ask the color of the hat on your head. You can say only one word-black or white. However, you can discuss a strategy beforehand with your friends. If you say the right color you live. If not, your days of fun mathematics are over. The question is: how many people can you save?

Of course this is an overwhelming question to start with and they always try to find loopholes like using accents, coughing, stomping your feet, etc. none of which are allowed. I encourage them to start by trying to save just one person. We easily do that. Then I challenge them to try and save half, then $2/3$. Then I ask can you save everyone? If not, how many can you save and how? This is a challenging question, but the students really enjoy it! I bring in two different types of party hats and we act it out so they can be a part of the problem. This forces everyone to actually think and understand the solution to the problem. This sets the tone for the entire semester. Students immediately see two crucial things: the content of this class will be different from ones they have had in the past and they will be expected to participate.

The next couple of days are spent solving other fun problems, many of which come from chapter one of the Burger and Starbird book. Other topics I cover include Fibonacci numbers, the golden ratio, modular arithmetic and cryptography, voting theory, exploding dots (which is based on activities created by James Tanton for the Global Math Project), and infinity. My last unit has varied. I have tried math and art, rubber geometry, graph theory, and this semester I might try math games. There is no set curriculum for the course but there are set goals.

My overall goal in this course, which I tell students on day one, is to change their perspective on mathematics. Most students (even beginning math majors) do not really know what math is. I want to give them a glimpse into the beauty and creativity of mathematics and help them develop an appreciation for mathematics. Overall, I have been successful in this endeavor. Below are two student quotes from my first time teaching this course in the spring of 2017.

“Even if I never use the methods that were taught to me in Math 112 I still left with an understanding that math is something that grows every single day, and even though I may think that I won't use math outside of class it's all around me no matter what.”

“The Joy of Mathematics course is a course that truly allows for students to embrace mathematics to its full extent and have enough knowledge to spread its appreciation.”

2.2 The Students

The students that typically take Joy of Math come into the course with feelings that are the opposite of the title. They enter with years of built up fear and anxiety towards math. They all classify themselves as “not math people”, as if there was such a thing. In fact, just as we have axioms that govern our mathematics I believe we, and our students, should share the following axiom for our lives.

Axiom 1. $\{x \mid x \text{ is not math person}\} = \emptyset$

I often wonder to myself why this term is so widely accepted. No one would classify themselves as “not a reading person” or “not a writing person” . To believe that there are some people who are programmed for mathematics is precisely having a fixed mindset about mathematical ability. In *Mindsets and Math/Science Achievement*, Carol Dweck discusses this very issue. She indicates that the source of such a mentality comes from parents and teachers using this label as a source of comfort for students [2]. In fact, some of my own students have mentioned this phenomena. They use the label “not a math person” as a safety net for any struggles or failures they may face in mathematics. Below are a handful of student quotes regarding this issue.

“I’ve found myself saying ‘I’m just not good at math’ a lot because of how hard I’ve actually tried to understand it but could never understand.”

“It’s just easier to say ‘I’m not a math person’ than to explain that, try as I might, I can’t understand math. Or it’s easier to state so that people don’t think down on me because of how bad I am at math. It’s a blanket statement to hide behind I guess.”

“I absolutely hate failing so I often find comfort in telling my teachers and friends that I am not a math person.”

While I respect the honesty and introspection from these students it saddens me that they feel so hopeless in their mathematical abilities that they label themselves in this way. I try very hard to be sensitive to my students’ misconceptions of themselves and mathematics. I work all semester to stay positive, encourage a growth mindset, and show students that getting the right answer is not what is most important. I know I have not had complete success in this endeavor, but I have seen so many students change their perspective on math by the end of the semester. After seeing such positive results the first time I taught this course I decided to dream bigger. I wanted students to realize that if they can overcome their stereotype of mathematics, then they can overcome other stereotypes as well. This led to a final reflection assignment which I will now describe.

2.3 The Assignment

When you think about the problems with stereotypes you probably do not think about mathematics but there are many stereotypes associated with the subject. Our students stereotype math as hard, boring, and formulaic. They stereotype themselves as not math people and certain ‘types’ of people as good at math. I decided to ask students to seriously reflect on these issues, along with other stereotypes, in a final reflection paper. For this paper, I ask students the following questions.

- What stereotypes did you have about mathematics before this course? How have these stereotypes affected your view and/or performance in mathematics courses?
- Now that you’ve seen a different side of math do you think that stereotype has changed? If so, how?
- Now think about any stereotypes you may currently have towards other people, whether it be based on race, gender, religion, etc. Why do you think you have these stereotypes? How do these stereotypes affect the way you interact with this group of people?
- Do you believe that getting to know this group of people better would change the stereotype?

Another thing I ask students is to give a score from 1 to 5 to four questions, with 5 being the most extreme (i.e. 5 would mean very hard or very beautiful). The results are given below with $N = 48$.

Question	Pre-Survey Average	Post-Survey Average	t -score	p value
How hard is math?	3.64	3.5	.96	.18
How creative is math?	3.63	3.92	1.36	.1
How scary is math?	3.58	2.92	3.77	.000
How beautiful is math?	2.79	3.35	2.83	.004

I conducted a one-tailed t -test for a single population with two means. The null hypothesis was that the difference between the pre and post survey ratings would be zero. For the question “how hard is math” I had a t -score of .96 giving $p = .18$. This is not statistically significant and it was the question with the smallest change. However, as mentioned I am satisfied with this result because I do not want to convince students that math is not hard. I want them to believe that they can succeed despite how hard it is. Next the t -score for “how creative is math” was 1.36 giving $p = .1$. The last two questions had the most statistically significant results. The question “how scary is math” gave $t = 3.77$ and $p = .000$ and “how beautiful is math” gave $t = 2.83$ and $p = .004$. These results are exactly what I wanted. My main goal in this course is to change student perspective on mathematics, to help them overcome their fixed mindsets and believe that they can succeed in math. I want students to see the beauty of mathematics and develop a newfound appreciation for the subject and these results show that is exactly what is happening.

3.2 Student Quotes

Next, I will include some of my favorite quotes from the end of the semester reflection assignment on overcoming stereotypes.

“Math 112 taught me numbers are actually a small part of math ... The reason why my view changed is because I was forced to open my mind to new things, and to critically think in order to find a solution. Outside of math, I’ve found myself having other stereotypic views. I believe the reason why I have those views is because I have not yet opened my mind into trying to understand new things.”

“I had no idea that this math course would so heavily influence my opinions about a topic I had so intensely despised.”

“I feel like [math 112] helped me in life also. I walk into situations with wider eyes and an open mind. I used to look at math and say “Math, That’s hard. I can’t do it.”. You can’t go into every situation saying that you can’t. Past experience and stereotypes are hard to overcome but all you have to do is try.”

“I never thought that a math course would teach me about stereotypes and how to overcome them, but I am glad for it. Sometimes learning lessons in unexpected places can be more impactful than learning them where you would expect.”

“Most of the fear in my life is because of the little amount of knowledge I possess about it. My previous fear of math worked the same way.”

“Much like my stereotypes in math I think that my stereotypes towards others come from a misunderstanding of who they are. I believe that if I learn more about the people I stereotype I will end up connecting with them. I could make new connections and become a more open-minded person much like how I have become more open to learning about mathematics through learning and understanding more about the subject.”

These results and student quotes go to show that perspectives can be changed, labels can be removed, and minds can be liberated.

4 A Call to Action

As I close this paper I have a challenge for all of us. The problem of stereotypes goes beyond our students and mathematics. We need to ask ourselves some serious questions and take time to genuinely consider them. How are we stereotyping our students? Do we go into our 100-level courses with a bad attitude already believing that our students are going to fail? I know it can be difficult teaching these lower level courses where we do not usually get to know the students very well. The sections are large and the students are typically uninterested. It is hard to stay excited when you care more than the students do, especially when you have been teaching for years, but I challenge you to enter the classroom with joy and excitement that is contagious. Infect your students with your love for mathematics!

Are we letting a bad past experience with a specific student influence how we view and interact with that student in a different course? I have personally been guilty of this before and have learned so much. Sometimes students, just like faculty, have a bad semester. We can not let past performance define who they are. We must show grace and believe that they can and will improve. God continually looks past our failures and sees us for who we are in Him. Let us all strive to do the same for our students.

Lastly, are you stereotyping yourself? Whether we would like to admit or not, almost everyone struggles with some sort of imposter syndrome. We believe we are not good enough as research mathematicians or as teachers and this influences how hard we try and how willing we are to fail. We need to humble ourselves and believe in the abilities God has given us. We can not do anything in our own strength but with Him we can do amazing things, in all areas. I close with one of my favorite verses. Let this verse inspire us to be the best we can in all classes, with all students, and in our lives.

*“Whatever you do, work at it with all your heart as if for the Lord and not for man.”
(Colossians 3:23)*

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