

Society's calculation error: The effects of social stigmas in the secondary mathematics classroom

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## Abstract:

Research has shown that all too often there is a significant drop in interest in mathematics at the secondary level, grades 7-12. This is an alarming issue for a world growing ever more technology dependent, as the mathematics and other sciences take center stage among the skills employers need. While this drop is due to numerous factors, many of these reasons stem from the school community in which the students are immersed in, and the social stigmas that come with it. These stigmas promote an environment where it is a positive trait to be bad at math, and a negative trait to be more than average at it. Students desire to fit into this school community drives them to purposely stop trying in math, often even when they have a natural aptitude for it. In this paper I have examined three categories of these mathematical social stigmas, the fact that students have been told that it is socially acceptable to be bad at mathematics, gender issues in mathematics, and labels such as “Geek” or “Nerd”. With these social stigmas I have also offered solutions for both teachers and society as a whole.

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Imagine you are walking through the bustling halls of a high school. Students are everywhere, walking, running, texting, talking, listening to music, or working on homework. Imagine listening to their conversations; what subjects are they excited for and which ones do they hate? Maybe they are hurrying to English, or Art, excited and ready to learn and show off their knowledge, but maybe they are grumbling down the hall, complaining about last night's math assignment. At the transition to the secondary level, there is all too often an alarmingly high drop in students' interest in mathematics. There are many factors in this drop, but one that is highly overlooked is the role of the social community of the school in creating mathematical stigmas. Students feel excluded from mathematics due to a perception that they are simply bad at mathematics, and it is socially acceptable, or even normal to, feel this way. On the other end of the spectrum, students with a natural aptitude for mathematics often draw away from it because they do not want the labels of "Nerd" or "Geek". These social stigmas are a major issue in today's society as more and more jobs require advanced mathematics. Society as a whole has failed to recognize this rise in mathematics related jobs, even as we continue to enjoy the technology and services produced by these jobs. There is a social problem in secondary mathematics education, and it stems from the entire school community, from the teachers to the parents and on down to the students. Students ages 12-18 feel excluded, and exclude themselves, from mathematics due to the social stigmas surrounding the subject, and this must be addressed in the form of social changes within the classroom.

In recent years legislators in the United States and around the world are searching for answers as to why the test scores in mathematics are continuously falling. In a scramble to have the brightest students the United States has passed law after law on everything from a national

curriculum, to teacher evaluations. Different theories and methods are colliding, and the students are the ones taking the hit, and yet all of this boils down to a blame game. This has to stop, and it is time to recognize that no matter what curriculum you put in front of a teenager, no matter what kind of song and dance you put on to teach them the material, if they are convinced that it is socially unacceptable for them to enjoy mathematics then they will not even try to do so. If they have been falsely led to believe that they will never need the mathematics they learn beyond elementary school, then we are creating a generation of students that will be desperately trying to catch up on years worth of material once they hit college and beyond. The reason there needs to be a social change is not because curriculum is unimportant, but because it is the social community that the students are immersed in that will determine the effort they put forth in mathematics, no matter what kind of material is put before them. Students need social support, and this social competence is one of the most important factors in their psychological well-being during their school years (Holopainen, Junttila, Lappalainen, Savolainen, 2012). Because of this we cannot simply convince students that their social connections are not important, and so we must make social changes that are from the top down, starting with the perception that it is okay to be bad at mathematics.

Somewhere in history mathematics began to become something for the few, rather than for the many. Instead of being taught alongside rhetoric, music, and languages, it became something for the scientists, and then moved in perception to its own branch, separate even from science. But this perception does not reflect reality, as mathematics is found in careers in physics, biology, chemistry, finance, accounting, computer science, nutrition, medical professions, business, musical composition, and even psychology. Despite reality, perception still overrules, because it is coming from the people that the students trust. Children start forming

social habits at an extremely young age, and from the time they learn to count they are forming their mathematical habits. The perception that it is okay to be bad at mathematics often stems first from the parents. As students struggle with early math homework the parents, who often hated math themselves, let the child believe it is okay and that mathematics is not as important as other subjects. The value a child places on mathematics will determine their effort put in and their ultimate success. Teachers certainly have their role as well in this, but according to Chouinard, Karsenti and Roy "Parents exert a strong influence on their children's values regarding mathematics while the nature of teachers' influence also exerts its impact on students' self-perceptions" (2007, P. 513). In other words, the teacher can influence a child's confidence in their own abilities, but the parents set the standards on valuing mathematics.

That is not to say that a child with parents who do not value mathematics cannot be influenced otherwise; however, that is up to their teachers. According to Stein and Smith, "Student achievement in mathematics can be predicted by the nature of the classroom environment" (National Council of Teachers of Mathematics, 2010, P.359). If a child is told in elementary school that they are simply bad at math, and that this is okay, then they will hold onto this belief until it is corrected, possibly for the rest of their life. I am a living example of this, as I was told over and over again by my teachers as an elementary school age child that I simply could not do math, that I was just bad at it, and that it was okay. My parents did hold a higher value of math than many, and encouraged me to try, but also reflected that it was not truly necessary that I be good at it. I held on to this belief until seventh grade, when I had a teacher that simply would not give up on me, and convinced me that I could do math if I simply put the effort in. I still did not hold a high view of math for several years to come, but I knew that I could do it, and it was this boost in ability such as Chouinard, Karsenti, and Roy talked about

that ultimately led me to accept that I was actually good at math. Today, I am proof that these social stigmas can be combated. I am a math education major because I want others to see their potential, to see that they can learn despite what they might have been told before they reached me. A child's social perceptions can be changed, if they are exposed to the right ideas and given a teacher who will not give up on them, or perhaps more importantly that will not let them give up on themselves.

The perception that it is okay to be bad at math ultimately leads to other issues as well, and two of these issues are confidence and competence. Students who think that they are bad at math will have confidence issues in the mathematics classroom, and this will ultimately lead to competence issues. Teachers who can create a space in their classroom where it is okay to make mistakes, but also refuse to let students stop trying, will be able to raise students' confidence in class. Lisa Darragh argues that an increase in confidence is necessary for an increase in competence, but that then it is a cycle, confidence leads to competence, which leads to a higher confidence (2013, P. 215). Darragh urges teachers to use this to their advantage, and says that "By encouraging students to act confidently (regardless of any internal feelings, such as uncertainty) we may prompt them to judge themselves as being mathematical" (2013, P. 215). Students need confidence in their mathematical ability in order to overcome the social stigma that they are bad at math. They have been told this, and now it is up to all of us to correct it, and to tell them otherwise.

The solution to students' thinking that it is okay to be bad at mathematics is to clearly demonstrate otherwise. We must show them they can do mathematics if they try, but it is more than that, we must show them why. We have to stop pretending that math is not all around us, that it does not go into our cell phones, our cars, our finances, even our understanding of health

and fitness. When a student asks that question all teachers dread, “When am I ever going to use this?”, then teachers must not be afraid to pounce on it and show them all the ways that it can be used. We have to stop being afraid of going over their heads, and tell them where things are used. If they ask where they will use slope, do not be afraid to tell them that they could use it in calculus with derivatives, and in turn in physics and engineering to build rollercoasters. The teacher does not have to explain the calculus or the physics, but by presenting to them the possible applications they can see that it is not useless. If they ask where they will use wave functions, ask them what their favorite song is and then talk about how sound waves are calculated based on the math that they are doing, and explain that the differences found in the waves on the page represent the physical differences between sounds of different instruments. There are so many ways to show students that math is not something abstract, but is woven throughout their lives. This is how we can teach them that it is not okay for them to give up on mathematics, this is how we can convince them to try.

Another major social stigma in mathematics is a gender issue. Many people believe that boys are innately better suited to mathematics, and some go even as far as to say that girls are innately bad, or simply not cut out for mathematics. This is a flat out myth, and yet one study out of Victoria, Australia showed that 9.8% of society feels that boys are better at math than girls, and that a whopping 63% said that they do not know, while only 22.8% feel that they have the same ability level (Forgasz, Jackson, Leder, 2014, P.11). In a world that is supposedly making giant leaps towards equality, we certainly seem to still hold major prejudice against females’ abilities and skills. But more than this, this stigma extends to the classroom in a very direct way. Teachers who hold the belief that boys are better at mathematics will promote this in their own classrooms by differing treatments and expectations between genders. Some might argue and say

that there truly is a gender difference in mathematical ability, and the test scores show it (Forgasz, Jackson, Leder, 2014, P.3), but I would argue that this perceived difference in ability stems from this difference in treatment and attitude. If teachers treat boys differently, calling on them more, or giving them more support, then the girls will quickly fall behind. Also, girls are often discouraged from mathematics and science at a young age by being told that certain toys are “Boys’ toys” such as Legos and scientific kits. Parents and teachers influence their students, and thus by the time a student reaches their teenage years the social stigma that math is for boys is well ingrained. According to Darragh, many young girls have a love for mathematics, but this dampens in the transition to secondary school because the students begin to care how they are perceived by their peers and their teachers (2013). For these young girls their confidence falters once they reach a level where peer support declines, and when we show them the job market in STEM fields as primarily a man’s world, we cheat them of the opportunity to explore and see for themselves if mathematics is something they enjoy.

Part of these gender assumptions come from a historical precedents that limited women to mainly secretarial or assistant jobs in mathematics and related fields. Once again the false assumption that math is only useful in a very limited number of fields causes parents to discourage their daughters from math because they feel that their only option would be to teach. The school system has failed to teach of the many female role models in mathematically related fields, preferring to teach on their husbands, as with Marie and Pierre Curie, and only mentioning them in an assistant role when in reality they had as much to do with the discoveries as their husbands. This merely perpetuates the stereotype that women do not belong in mathematics. Even advertisements for jobs, pictures in textbooks, and diagrams on toys more often than not feature male figures. Young women are often flat out told that in order to have a career in

mathematics or the sciences they will have to work harder and do better than any of their male counterparts. It is in this lack of support from society, in being told that it is the road less traveled, that causes female students to rapidly drop interest in mathematics.

The solutions to gender issues in mathematics may start in the classroom with purposely equal attention and encouragement, as well as demonstrations of female role models, but the real change in gender issues will come from society as a whole. Society needs to recognize that it is okay for a female to pursue mathematics or a related field. It is okay for that to be her favorite subject in school, and that some of the brightest contributors to scientific history have been female. This has to start early; we must allow young girls to play with dolls and building blocks. So often kids are told to aspire and dream, that they can be anything they want to be, and then we shatter that when they reach the secondary level by telling them to “Be more realistic about what they could actually achieve”. The support has to start with society, if it does not then there cannot be lasting change in mathematics. If the United States truly wanted girls to succeed in mathematics as much as they spout from the rooftops that they do, then they would make an effort to demonstrate that it is more than socially acceptable for women to fill the roles that come from a love of mathematics. Also, the female mathematics teachers have to show their students that there is more to mathematics than teaching; it all goes back to the widely varying fields that use mathematics, and showing students that it has value.

Finally, students feel excluded from mathematics due to the labels that come from being good at it. Think back to hallway you entered earlier, how are the students grouped? Among the many clubs, sports teams, band students, and artists, you have the popular crowd, the group that every student wants to be in, whether they admit it or not. Then you have the geeks, the nerds, and the “smart” crowd that everyone looks down upon. This is the group where students who

excel at mathematics are relegated in the common high school, and it is a group of social outcasts. Many students would avoid falling into one of these labels at all costs, including faking that they are bad at math simply to fit in. Once a student falls into a pattern of purposely trying not to care about mathematics, they fall further and further behind, until the act becomes reality. This often ties back to the attitude that it is socially acceptable to be bad at mathematics, but has more of an implication than that. Mathematics is a subject that most students find more difficult than other classes, and this often causes a confidence issue. Students then find solace in the fact that the majority struggle with mathematics, and choose to ostracize those who actually have a natural aptitude for it. This creates a social fear, that if a student shows themselves to be good at mathematics, they then might be kicked out of their social group.

The labels of “Geek” and “Nerd” often start as derogatory terms shortly after the transition to the secondary level around sixth or seventh grade. This age group marks a sharp decline in perceived social support in mathematics from peers (Barth, Guadagno, Rice, McCallum, Smith, 2013, P. 7). The idea of being different from the social norm is scary to students, and this fear is what perpetuates the social stigma. Teachers often do little to help this because they all too often believe themselves that mathematics is for the select few. They also have a tendency to assume that they cannot change a student’s mind about a deeply ingrained belief once they reach their teenage years. This however, is not true. Multiple studies such as one by Barth, Guadagno, Rice, McCallum, and Smith, show that teacher support greatly influences student learning and sense of confidence (2013).

Fear of labeling and being socially ostracized also comes in a perceived lack of support across the board, from parents, to teachers, to peers. The following graph is from a study on how social support affects mathematical ability by Barth, Guadagno, Rice, McCallum, and Smith. It

shows that the perceived social support levels drop after elementary school, and do not regain solid ground again until college, once a student has made the choice to go into mathematics for themselves.

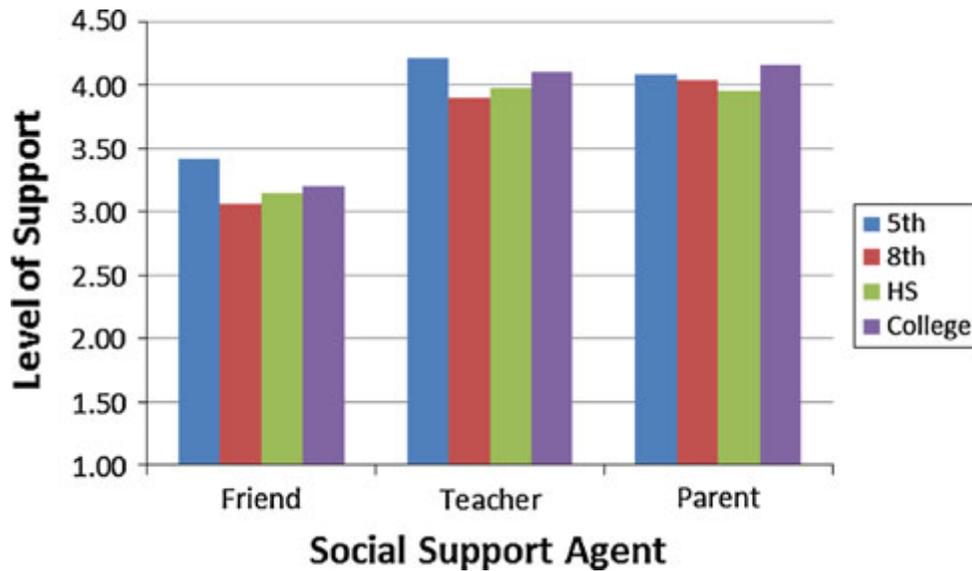


Image from: *The Role of Social Support in Students' Perceived Abilities and Attitudes Toward Math and Science*. Barth, Guadagno, Rice, McCallum, Smith, 2013, P. 7

This chart demonstrates that students feel like their social support drops in all three areas once they hit the eighth grade. Support for math is at its lowest during this crucial formative time where students are determining what they want to do with their lives, and this is why interest in mathematics drops at this age. This is the age where students begin to find their identity, to discover who they are, and this is the time when they are being labeled as different if they are good at math. The drop in interest in mathematics is truly a social problem, and it is coming from students trying to find their place in the world.

One key note to this is the fact that the groups that are labeled as geeks and nerds do exist, and there are students who break the social norms despite the consequences. One study

suggests that the reason we see a gender gap in mathematics is actually due to a personality difference in those who are willing to put in the effort to succeed in mathematics (Alcock, Attridge, Inglis, Kenny, 2014). This is an interesting side of the argument because it implies that some students are willing to break social norms to succeed in mathematics, and yet this is a crucial aspect of solving social mathematics problems. It is with these students that teachers, as well as the rest of society, can begin to break down these social stigmas. As we have young women bravely pursuing careers in STEM fields, we can use them as role models. As we have talented young athletes, musicians, and artists speak out that mathematics is not only for those considered social outcasts, students will see that being good at one, being accepted in one, does not mean surrender of the other. If society is to progress down the road it is going in regards to technology and science, we must convince students that these social labels are nothing but humans trying to make themselves feel better. However, we must start one step at a time, convincing students that belonging to one group does not automatically exclude you from another.

One current educational practice that has to stop if we are going to succeed in creating a sense of belonging in mathematics is ability grouping, (Darragh, 2013). Ability grouping shatters a student's sense of belonging to the group by giving them a label of advanced, average, or remedial. These labels are driven into our students, and cause them to fall into the categories listed earlier of either being bad at math without hope, or as the advanced "Nerd." Or perhaps, to tell them that they are simply average, and allow them to remain that way, with no incentive to try any harder. Sometimes students are put into the advanced category and then unable to keep up, such as one young girl that Darragh interviewed who was placed in the advanced group, only to quickly fall behind (2013). According to Darragh, and also the Virginia department of

education, ability grouping has harmful effects on a student's confidence and competence levels, with lowered expectations and thought processes in lower levels (2013). The Virginia department of education found that ability groups unfairly stereotyped students, and caused them to enter tracks as early as eighth grade that did not allow them to take classes that they would need for certain college majors such as calculus (1992). If we are going to break the social stigmas that allow labels to determine mathematical ability, then we have to stop perpetuating them by forcing students into an ability mold, especially one far too often based on unreliable standardized test scores.

As I briefly mentioned earlier, belonging is important to a child's psychological well-being. We cannot ignore the social stigmas in the mathematics classroom and ever hope for students to regain interest in it. Ignoring a student's social well-being can lead to depression and "burnout" (Holopainen, Junttila, Lappalainen, Savolainen, 2012). The social side of learning is key because it is what will allow us to truly change the lives of these teenagers. One teacher cannot make an all-inclusive difference in the curriculum a student receives in the entirety of their schooling, but one teacher can make a difference in the attitudes and values held by that student. A school community is a complicated web of ideas, facts, activities, and knowledge, but when we change the angle of the web, we reflect a different light in all of these things. If we want to see students succeed in mathematics, then we have to acknowledge the effects of a positive student-teacher role, and be willing to listen to what the students are saying (Aelterman, Keer, Petegem, Rossel, 2014).

It is time for the world to listen to what our teenagers are saying, and to realize that what they want, what they need to be successful in mathematics, is not another curriculum change, not another high stakes standardized test, or even more practice in the form of homework, they need

social changes. If we want to see students feel included in mathematics then we must show them how it will be used in their lives. It is time to stop teaching abstract concepts, and begin to form a relevant, logical, flow if ideas. It is time for teachers to connect with their students, and to show them that not only can they do the math, but that it is crucial to their future they learn to do so. Society must stop perpetuating the idea that it is okay to be bad at mathematics, and especially that mathematics is only for guys. Instead we must allow students to find their passions, while encouraging them to explore all of their possibilities. My desire as a future teacher is to see every child that passes through my classroom reach their full mathematical potential, regardless of whether that leads them to be a math major, or simply allows them to see the beauty of the mathematics in the world around them in whatever field they enter into. We must inspire a generation of mathematically confident and competent students, and promote a classroom setting that encourages them to speak up and find their identity in the classroom and the world beyond (Gregson, 2007). There is so much more at stake here than the next generation of mathematicians, and the shockwaves of failing to curb this generation's disdain for mathematics would ripple well beyond math and science fields. Curriculum changes will come and go, as will tests, and even teachers, but changing students' social perceptions is a ripple effect that could change the world. What would a world be like in which every child was truly free to dream of reaching their full potential? What would happen if society finally decided to recognize that just because they do not like something does not mean that it is not important? What kind of discoveries, inventions, or cures could be found if every student was given a fair chance to discover for themselves if mathematics was for them? I do not know about you, but I would like to find out.

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