

## Addressing Diversity in the Stanford Math Classroom: Suggestions and Resources

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Originally authored by Abigail Ward. Modified by Melissa E. Ko (mesako@stanford.edu). This is a product of VPTL's Identity in the Classroom Learning Community (ICLC) 2017.

When we think about how to teach mathematics at the university level, we often model the math classroom as a place where a homogeneous audience receives mathematical knowledge from an impersonal source. But this idealized homogeneity is not reflected in the outcomes across distinct groups; instead, we see differences in outcomes in mathematical education that are highly correlated with race, gender, and class [3]. This disparity in educational outcomes suggests that in order to be more effective mathematics instructors at Stanford, we should address our attention to the diversity of the students in our classrooms, and study the effects that aspects of our students' identities may have on their experiences in the classroom.

Indeed, there is a wide archive of research about how students' differing identities can affect their education in general and mathematics education in particular. In this document we present some highlights of some of this research and when possible provide links to the original research. Stanford also makes available to its graduate student instructors a wide range of resources that can help teach a diverse classroom; we also link to some (but nowhere near all!) of these resources. We hope that by providing this information, we help graduate students become more informed instructors.

We also present some suggestions that math graduate students can implement in their classrooms. Many of these suggestions ask graduate students teaching to speak more often and more explicitly about the process of learning math than they might otherwise do; it is our belief that an important part of creating a more welcoming mathematics classroom is creating a more transparent classroom.

In this document we consider student's identity among familiar axes — gender, race, disability, and so on — and these categories are indispensable in understanding differences between individual students that can shape each student's experience in their math classes. Of course, these categories that we can use to describe someone's identity are not isolated, but can intersect and interact; the categories can also fail to fully describe each student's individual experiences that will shape their experience in a Stanford mathematics classroom. But we hope the suggestions provided can be helpful for all students, regardless of how they self-identify—we encourage the instructor to use the information below as a starting point to encourage a more flexible style of teaching and a more expansive view of mathematical ability. The ultimate aim of this document is to help Stanford math graduate students create a more welcoming and more human environment in the classes they teach, while maintaining high standards and expectations of all students.

## Using the Concept of “Growth Mindset”

There is a large body of literature studying the effect of a student’s personal beliefs about the mutability of intelligence on the student’s performance in an educational setting, much of it conducted by Stanford professor Carol Dweck. In her work, Dweck distinguishes between students with a “fixed growth” mindset who believe that intelligence is fixed, and those with a “growth mindset” who instead believe that it is possible to become more able with time. This distinction can be measured by asking how much students agree with statements like “you have a certain amount of intelligence, and you really can’t do much to change it” [2] (an affirmative answer signifies a fixed mindset). According to Dweck’s research, the possession of a growth mindset is correlated with greater educational success.

**Research:** “Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention” by Blackwell, Trzesniewski, Dweck, online here [2]. From the abstract:

In Study 1 with 373 7th graders, the belief that intelligence is malleable (incremental theory) predicted an upward trajectory [in mathematics achievement] in grades over the two years of junior high school, while a belief that intelligence is fixed (entity theory) predicted a at trajectory. [...]

The application of this concept of the growth mindset to mathematics education has been researched extensively by Jo Boaler, also a professor at Stanford. In her book *Mathematical Minds: Unleashing Students’ Potential Through Creative Math, Inspiring Messages, and Innovative Teaching*, Boaler explores how these different philosophies impact how effective mathematics instruction is. She has shown that teachers with growth mindsets see better performances in their classes than teachers with fixed mindsets – suggesting that the beliefs of the instructor can be transferred to their students.

From Boaler’s research, we know that emphasizing the growth mindset is particularly important in improving the outcomes of minority groups in mathematics, including female students and black students [2].

Professor Boaler’s research is geared towards students in primary and secondary education and some of her ideas for improving the mathematics classroom are less practical for the university setting. However, the basic idea – that to improve incomes, math instructors should avoid propagating the idea that math ability is fixed, and instead to emphasize the possibility of mathematical improvement – can be successfully implemented in any level of mathematics instruction.

**Suggestions:**

- Emphasize that making mathematical mistakes is okay and is in fact key to thinking successfully about math.
- Deemphasize the idea that there is such a thing as “math people,” or “non-math people.”
- If possible and appropriate, tell students about any of difficulties you have faced in studying mathematics, and emphasize how you have been able to improve and learn.

**Stanford VPTL Resources:**

Further suggestions for using the concept of the growth mindset in your teaching can be found here: <https://vptl.stanford.edu/faculty-staff-student-instructors/diversity-inclusion/resources/teaching-toolkits/growth-mindset>

**Emphasizing Concepts and Connections**

Jo Boaler’s research has also explored how emphasizing different aspects of mathematics has led to different outcomes among students. She has found that student outcomes can improve when the “big picture” is prioritized over rote technique — and that this shift in teaching perspective can be especially effective in maintaining the engagement of female students:

**Research:** “Mathematics and science inequalities in the United Kingdom: when elitism, sexism and culture collide,” by Jo Boaler, Lori Altendor and Geo Kent, is online here <http://www.tandfonline.com/doi/abs/10.1080/03054985.2011.595551?src=recsys&journalCode=core20> [4]. An excerpt:

In both studies the girls did not want easier versions of physics or mathematics — the versions of mathematics and science they wanted required considerable depth of thought — but they wanted opportunities to inquire deeply, and they were averse to versions of the subjects that emphasized rote learning. This was true of boys and girls but when girls were denied access to a deep, connected understanding, they turned away from the subjects.

Of course, in most Stanford math classes students will ultimately be evaluated on their ability to perform calculations; however, it may still be helpful for instructors to dedicate some time to more in-depth explanations, focused on over explanations of technique of the mathematics they present.

**Suggestions:**

- Dedicate some time to explaining what is “really going on” in your lectures – and make clear to your students that if they want to understand the bigger picture, they can talk to their instructors about the math in the course in office hours.
- Emphasize connections between different parts of the subject. For example, in Math 51, you can set aside some time to make explicit why linear algebra and multivariable calculus are placed in the same course.

**Addressing Stereotype Threat**

There are cultural pervasive stereotypes surrounding certain disadvantaged groups in math – for example, the stereotype that women are generally less capable of doing mathematics than men. Claude M. Steele, a professor in the Stanford Graduate School of Education, has written about how these stereotypes can harm students: research has demonstrated that students perform less well on assessments when they are conscious of the fact that the assessments could confirm negative stereotypes about groups they belong to. For example, in one study, when black students were told that an English test was diagnostic of intelligence, they underperformed relative to white students, whereas when the same test was presented as nondiagnostic, students from the different racial groups performed approximately equally [7]. Importantly, the students do not necessarily believe negative stereotypes about themselves – their performance suffers when they are conscious of the fact that others may hold these stereotypes. Some literature on stereotype threat is presented below.

**References:** Whistling Vivaldi: and other clues to how stereotypes affect us, by Claude M. Steele, is available at Green Library.

**Resources:** A video lecture by Claude Steele on stereotype threat:

<https://www.youtube.com/watch?v=XVcqlxrvFos&list=PLEnKK2QoIn5PFbOrizf25cplrZmXaMEdN&index=60>

**Stanford VPTL Resources:**

VPTL has a page addressing how to support vulnerable students, including how to combat stereotype threat, found here: <https://teachingcommons.stanford.edu/resources/teaching-resources/interacting-students/supporting-vulnerable-students>

**Suggestions:**

- De-emphasize the role of assessments in measuring things like raw mathematical ability, since students from underrepresented groups in mathematics may be aware of negative stereotypes around their groups possessing such ability.
- Grade work anonymously—for example, if you have students submit homework online, you can ask them to omit their names from it. Make it clear to your students that you will be grading anonymously.
- If you choose to address structural issues in math (disparities among gender, etc.) be thoughtful, and above all be careful to distance yourself from these beliefs — make it clear that you do not hold such stereotypes.

### **Addressing Disability, Accessibility Issues, and Mental Health**

The work of making a classroom accessible for all of its students can expose the limits and problems inherent to math pedagogy. Many of our usual ways of measuring mathematical knowledge are inappropriate for

students with disabilities (for example, dyslexic students may be unable to demonstrate their knowledge of material on timed exams, or students with severe social anxiety may not be able to answer questions if cold-called on in class).

**Reference:** In *How Did You Get Here?: Students with Disabilities and Their Journeys to Harvard*, Thomas Hehir and Laura Schifter explore how Harvard students with disabilities conceptualize their disability as part of their identity, and discuss (among other things) how technology can be used to help such students. This book is not yet available at in the Stanford library but is available at Amazon here.

<https://www.amazon.com/How-Did-You-Get-Here/dp/1612507816>

### **Suggestions:**

- During the first lecture, address how disabilities can be accommodated. Know about how the accommodations process works.
- Explicitly allow for and encourage the use of technology to assist in class.
- Emphasize the different resources available to learn the material in different ways. For example, in Math 51 students can learn from reading the textbook, from attending lectures, and from watching videotaped lectures.
- Downplay the importance of speed in doing mathematics; emphasize instead the importance of understanding things in depth.

It is also possible that instructors will be presented with students who are struggling with mental illnesses.

**Stanford VPTL Resources:**

A guide to informally counseling students (e.g., distressed students that come to office hours) can be found here. The document also provides information about when to refer students to CAPS. <https://teachingcommons.stanford.edu/resources/teaching-resources/interacting-students/counseling-students>

**Supporting First Generation and Low-Income Students**

Students who are their first in their family to attend college or who come from low-income backgrounds (at Stanford, this includes students from households with annual incomes of less than \$80,000 [1]) can face unique challenges at Stanford, and they may not be sure how to take advantage of the support structures that Stanford has in place. For example, such students may not understand what office hours are or what purpose they serve.

**Stanford VPTL Resources:**

A guide to supporting first generation and low-income students with many more suggestions than the ones above can be found here. <https://vptl.stanford.edu/faculty-staff-student-instructors/diversity-inclusion/resources/teaching-toolkits/first-gen-and-low>

**Suggestions:**

- On the first day, go into detail about the structure of the course, even though the structural features may seem obvious to someone experienced in taking college courses (explain things like what office hours are).
- Be explicit about what practices can lead to success in the course (from a “growth mindset” perspective whenever possible).
- Avoid equating knowledge gained in the past with mathematical ability.

**Final Notes and Conclusions**

There are common threads that connect many of the suggestions above: most of them point to the pedagogical benefits of developing a more expansive idea of mathematical ability and a more transparent approach to mathematical achievement. This is an approach to mathematical education that leads away from the

concept of innate and unexplainable mathematical talent or genius. As shown in the 2015 Science paper “Expectations of brilliance underlie gender distributions across academic disciplines”, the emphasis on raw talent within an academic discipline is correlated with the field’s lower representation of women [6]– thus the ideological move away from this concept of genius, suggested implicitly in this document as a way of improving outcomes in the classroom, could lead to the increased mathematical success of underrepresented groups more generally.

**Research:** “Expectations of brilliance underlie gender distributions across academic disciplines”, Leslie et al. This is available online here [6]. From the abstract: <http://science.sciencemag.org/content/347/6219/262>

We hypothesize that, across the academic spectrum, women are underrepresented in fields whose practitioners believe that raw, innate talent is the main requirement for success, because women are stereotyped as not possessing such talent. This hypothesis extends to African Americans’ underrepresentation as well, as this group is subject to similar stereotypes.

Indeed, many of the concepts in this pedagogical guide point to broader cultural issues within the field of mathematics. We note that this document is intended as a “first-pass” guide to each of the issues or ideas addressed above to enable Stanford math graduate students to become more effective teachers, and it is not intended to present an in-depth discussion of the political aspect of each of the issues discussed. There is extensive academic study and criticism of each of the ideas discussed in this document: for example, the concept of growth mindset has been criticized as to erase the effects of institutionalized oppression by emphasizing individual mindsets over structural issues. We provide a references to some of this criticism in the section below.

## References

- [1] Supporting first gen and low income students, available at <https://vptl.stanford.edu/faculty-instructors/diversity-inclusion/diversity-inclusion-related-topics/supporting-first-gen-and-low-income-students>.
- [2] Lisa S. Blackwell, Kali H. Trzesniewski, and Carol Sorich Dweck, Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention, *Child Development* 78 (2007), no. 1, 246–263.
- [3] Richelle M. Blair, Ellen E. Kirkman, and James W. Maxwell, Statistical abstract of undergraduate programs in the mathematical sciences in the united states: fall 2010 cbms survey, American Mathematical Society, 2013.

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- [7] Hazel Rose. Markus, Paula M. L. Moya, and Claude M. Steele, In the air between us: Stereotypes, identity, and achievement, Norton, 2010.