

NYC STEM STUDY TOUR

Fostering Growth Mindset and Grit within Students in the Mathematics Classroom

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The capacity for learning and achievement in mathematics is neither static nor predetermined. Intelligence is adaptive and can be developed through structured support and pedagogical methods within the classroom. Alfred Binet, the creator of the IQ test, posited that individuals could enhance their intellectual abilities, including focus, memory, and judgment, through deliberate practice, training, and the correct methodology (Binet, 1909). Despite this, many students seem to hold a fixed belief that their intelligence is determined by genetics or innate ability, leading to self-defeating behavior in the face of mathematical challenges (Merseth, 1993). As educators, it is crucial to address and counteract this mindset to foster a more resilient and growth-oriented approach in students.

As children progress through different stages of cognitive development, they begin to compare their abilities with those of their peers and to evaluate their own performance. External feedback from parents, teachers, and peers often reinforces the notion that success is praiseworthy, while failure is undesirable. This dynamic can breed fear of challenges and lead students to believe they are inherently less capable than others. Consequently, students may avoid meaningful opportunities for learning, internalizing failure as a reflection of their personal worth rather than viewing it as a valuable learning opportunity (Dweck, 2006). In contrast, students who adopt a growth mindset view intelligence as something that can be developed and instead turn challenges into learning opportunities. They cultivate their abilities through mindful effort and commitment

as well as support from others. This persistence yields mastery, and studies consistently provide evidence that students who have a growth mindset tend to perform better academically (Blackwell, Trzesniewski, & Dweck, 2007) and socially (Yeager et al., 2014) than those who have a fixed mindset.

In addition to fostering a growth mindset, the concept of grit, defined as combination of passion and perseverance towards a goal by Angela Duckworth in 2016, is elemental to academic success. Angela Duckworth's research highlights that students who exhibit grit are more likely to succeed academically because they demonstrate resilience and adapt their strategies when faced with challenges (Duckworth, 2016). These students do not repeat ineffective approaches; instead, they seek new methods and continuously assess how to achieve their objectives. Through grit, students persist in the face of difficulty, exhausting all available resources until they find a solution.

Anyone can develop a growth mindset and practice grit with the proper support and methodology (Jaffe, 2020). Elisabeth Jaffe's article "Mindset in the Classroom: Changing the Way Students See Themselves in Mathematics and Beyond" details various methods to promote growth mindsets and grit in students in the mathematics classroom. During the 2024 Spring STEM Study Tour, I observed Professor Jaffe in her Intermediate Algebra and Trigonometry course at the Borough of Manhattan Community College (BMCC). Her teaching methods illustrate effective ways to foster these traits in students, and several key strategies are outlined below.

One approach Professor Jaffe employs at the start of each semester is to read and assign passages on grit, prompting students to reflect on personal experiences where they demonstrated perseverance. This can include everyday challenges such as commuting to school or learning a new language (Jaffe, 2020). Throughout the semester, students are regularly reminded that they possess both grit and the ability to solve math problems with patience and practice. By encouraging students to recognize their own resilience, Professor Jaffe helps them realize that their intelligence is not fixed and that they have the capacity to develop through persistence. She believes that new self-awareness nurtures a growth mindset, empowering students to face challenges with confidence rather than fear.

Another significant aspect of Professor Jaffe's teaching is her emphasis on presuming confidence in and holding high expectations of all students. Regardless of a student's prior academic performance, she provides challenging material that requires critical thinking and application of mathematical concepts. This creates a mandate for grit; students must adapt to the degree of difficulty. Simultaneously, her use of scaffolding techniques, such as posing a difficult problem and guiding students through the process of breaking it down into smaller, simpler steps, help maintain high academic standards while making achieving and applying conceptual understanding for students much more manageable.

An illustrative example of this approach occurred when Professor Jaffe posed the question: "How many times do you need to fold an 8.5" by 11" sheet of paper in half for it to be taller than the Empire State Building?" Initially, students made intuitive guesses, ranging from several hundred to several thousand folds. Professor Jaffe then provided key information, including the height of the Empire State Building (1,250 feet) and details about a ream of paper such as the height per ream (2 inches) and how many sheets of paper per ream (500 sheets). Students were tasked with determining the height of a single sheet of paper, then using logarithmic equations to solve the problem. This challenge pushed students to draw upon their prior knowledge, collaborate, and persevere until they arrived at the surprising answer of 22 folds. This exercise not only illustrated the power of exponential growth but also reinforced the importance of grit and persistence in problem-solving.

Another example of Professor Jaffe's approach to fostering perseverance occurred when a student left an exam question blank and attempted to submit it early. Instead of accepting the incomplete exam,

Professor Jaffe returned it to the student, challenging them to reconsider the problem using the knowledge they had acquired throughout the semester. Although initially discouraged, the student eventually solved the problem, demonstrating to them that they could push through initial struggles by persevering. While this doesn't mean that all students are able to solve difficult problems through perseverance alone, the idea is that by holding students to high standards and encouraging them to push through difficulties, Professor Jaffe cultivates an environment where students learn to embrace challenges and see failure as an opportunity for growth, which in turn may increase the chances of success.

If grit and growth mindset can be cultivated in adult students ages 18 and older at the community college level, then it might be possible to develop them in adolescent students during secondary education. Math teachers can implement the various approaches demonstrated by Professor Jaffe in their classroom. For instance, they can have students keep journal entries of when they have demonstrated grit throughout the school year. Teachers can further nurture this grit by offering high-level, challenging math content and problems to all students in conjunction with proper scaffolding, guidance, and encouragement. By having students apply grit in persevering through difficult tasks, a message can be sent to students that achievement and learning depends more on grit and effort than on genetics or innate talent. This sends a message to students that intelligence is not fixed – that their own intelligence is improvable through grit and effort. This in turn promotes growth mindset in students and prepares them to persist through challenges and problems later in life without shying away from obstacles at the first sign of difficulty.

Teachers must help students come to the realization that effort and grit play more of a role in long-term success than genetic predisposition and innate talent. However, grit and growth mindset by themselves cannot guarantee success. They are not substitutes nor solutions to problems and inequities in education such as overcrowded classrooms, inadequate curriculum, and unqualified teachers. Neither do they replace nor supersede all other support systems that schools must provide for their students (Jaffe, 2020). Learning and achieving in the mathematics classroom are shared responsibilities between the teacher and student as well as the overall educational community. Grit and growth mindset must be taught with proper support systems in place. At the same time, issues in equity and

other problems in the educational system still need to be addressed. Just as students should be held responsible for their own learning, we as educators hold an equal responsibility to ensure high quality education for all students. After all, learning and achieving in the mathematics classroom should be a universal right of all students and not a privilege reserved just for the few.

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