DEVELOPING MINDSETS FOR STEM TOOLKIT

Florida-Caribbean **Louis Stokes** Regional Center of Excellence

MindSetsForSTEM.org

SCIENCE TECHNOLOGY ENGINEERING MATH

Contents

About Us

Our Mission:

The FL-C LSRCE is a collaborative research-practitioner partnership between Santa Fe College and the University of the Virgin Islands to broaden participation in science, technology, engineering and mathematics (STEM) by developing, testing, and disseminating mindset intervention practices that enhance growth mindsets when encountering academic challenges.

In conjunction with the Laboratory of Intergroup Relations and the Social Mind at Columbia University and the Learning, Research & Development Center at the University of Pittsburgh, FL-C LSRCE administrators and faculty from several Louis Stokes Alliance for Minority Participation (LSAMP) projects, will participate as implementers of the research to practice activities and serve as consultants to the center.

Florida-Caribbean **Louis Stokes** Regional Center of Excellence

SF Santa Fe College

University of the Virgin Islands 1962

Funding provided by:

The National Science Foundation Grant HRD 1826532 and the NSF INCLUDES National Network.

NSF

NSF INCLUDES National Network

Our Vision:

Designing a customized suite of mindset interventions for students

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Faculty development to enhance growth mindset, self-affirmation, motivation, and attitudes

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The FL-C LSRCE will support and enhance students' STEM identities, attitudes, and motivation.

This toolkit was made possible with contributions from:

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- **Lawanda Cummings, Ph.D.**, Research Partner/Co-Director, University of the Virgin Islands
- **Camille McKayle, Ph.D.**, Co-Principal Investigator, University of the Virgin Islands
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Training Description

This toolkit emphasises the interrelationships between theory and applied research to create a classroom environment that will cultivate positive growth mindsets, sense of belonging, and STEM identity among students. Provided is a general review of psychosocial barriers that impact student success, persistence, and sense of belonging for underrepresented minorities found in STEM education literature.

An overview of growth mindset, as well as related theories pertaining to the role of cognitive and non-cognitive factors in student success are also included. This toolkit is intended to serve as a guide to introduce faculty to the psychosocial barriers and interventions to counter select barriers. Please utilize this information as a framework to promote growth mindset among faculty peers on your respective campuses.

Training Learning Outcomes

Upon successful completion of this course, participants will be equipped to:

- **Identify** elements of psychosocial barriers that contribute to STEM attrition of underrepresented minorities (URM).
- **Distinguish** between the roles of cognitive and non-cognitive factors in learning theory as it relates to student persistence.
- **Formulate** strategies to apply growth mindset and psychosocial interventions in STEM classrooms.
- **Develop** a network of support and accountability with other faculty participants to facilitate long-term application of growth mindset and related theories in their classrooms.

Why Are We Here?

In 2012, the President's Council of Advisors on Science and Technology identified low STEM attainment as a threat to U.S. global competitiveness. They concluded that low baccalaureate completion rates of STEM majors - less than 40% in 6 years - was a cause of this shortfall.

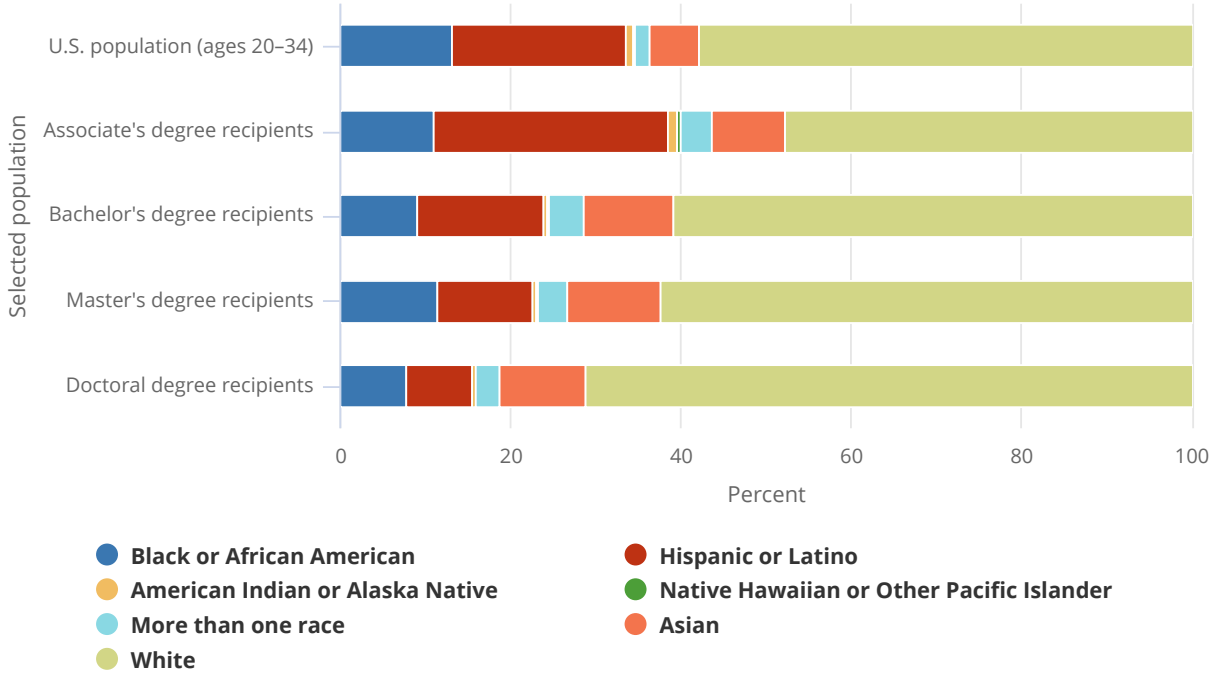
Furthermore, the completion rate was particularly low for underrepresented minorities:

- **37.5% for White and Asian Students**
- **22.1% for African American Students**
- **18.4% for Hispanic students**

National Science Board | *Science & Engineering Indicators* | NSB-2019-7

FIGURE 2-8

Representation of racial and ethnic groups in the U.S. population and among S&E degree recipients: 2017

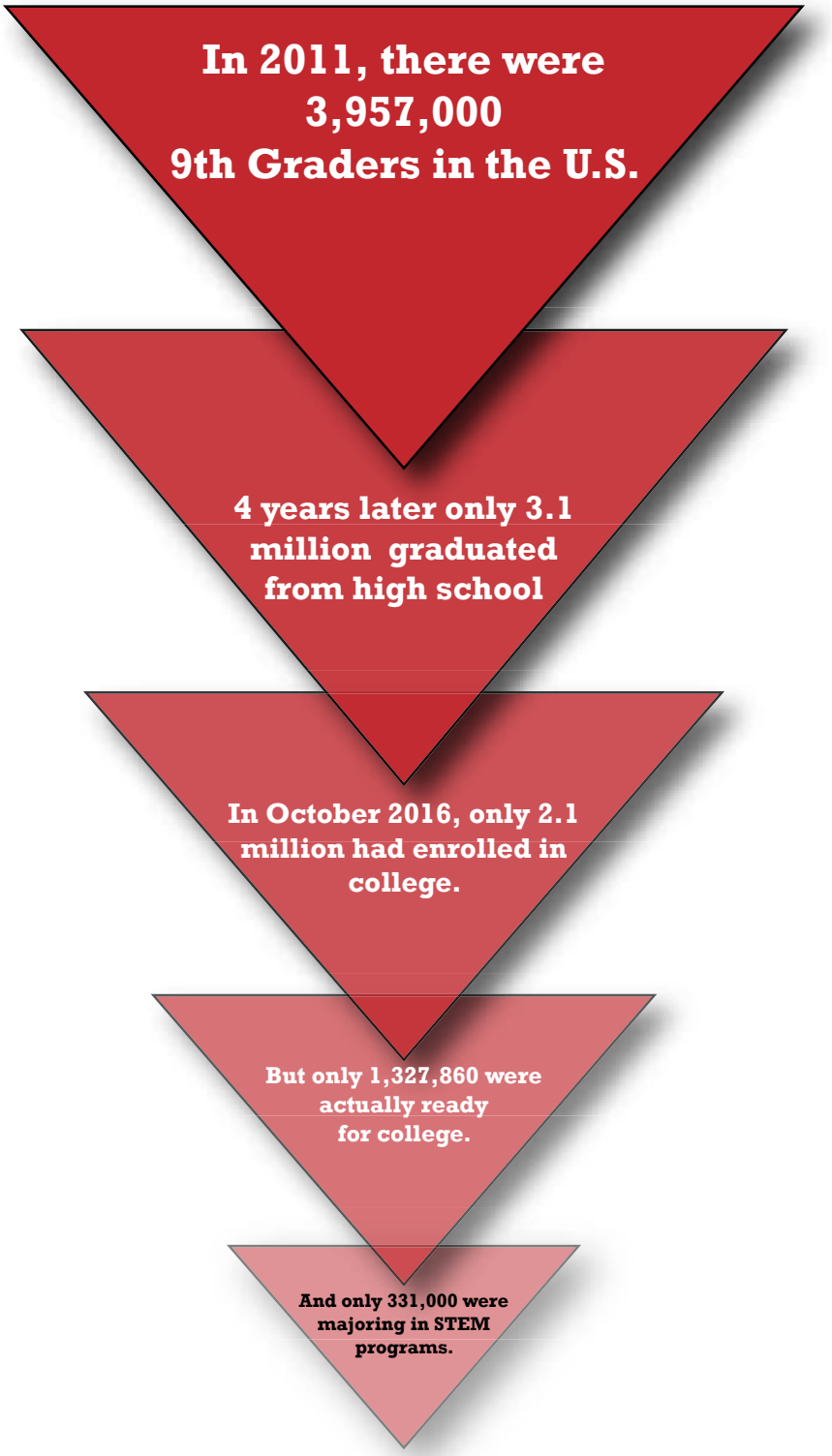


Note(s)
Hispanic may be any race; race categories exclude Hispanic origin. U.S. population data reflect the percentage of people in each racial and ethnic group in the U.S. population between ages 20 and 34 on 1 July 2017. Degree totals may differ from those elsewhere in the report; degrees awarded to people of unknown or other race were excluded.

Source(s)
U.S. population data from the U.S. Census Bureau. Degree data from National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Completions Survey.

Science & Engineering Indicators

According to the National Center for Education Statistics…



National Center for Education Statistics (2018)

STEM Career Data and Trends

"Employment in STEM occupations grew by 10.5 percent between May 2009 and May 2015, compared with 5.2 percent net growth in non-STEM occupations.

93 out of 100 STEM occupations had wages above the national average at $87,570 compared to $45,700 for non-STEM positions.

From 2018 to 2028, it is expected that STEM occupations will increase 8.8% vs 5% for non-STEM occupations."

Bureau of Labor and Statistics (2019)

UNIT 1 - OBJECTIVES

- To introduce psychosocial barriers that contribute to under-representation of minorities in STEM.
- To distinguish between cognitive and non-cognitive skills.

Factors that Contribute to Attrition of Underrepresented Minority Students

- **Stereotype Threat**
- **Fixed Mindsets**
- **STEM Identity**
- **Influences**
- **Sense of Belonging**

Alabi (2015); Hernandez, et al., (2013); Jones & Abes (2013); Smith, Hung, & Franklin (2011); Steele (1997); Strayhorn (2012); Sue, et al., (2007)

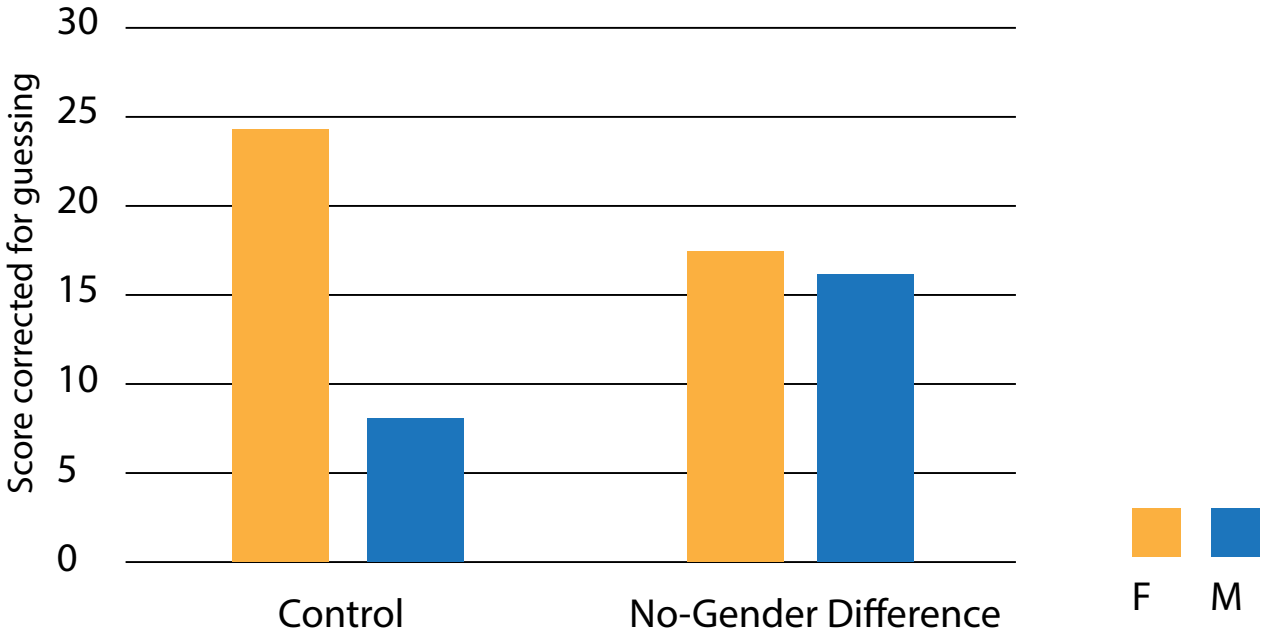
Stereotype Threat

Stereotype Threat:

The worry or concern about being perceived through the lens of a negative stereotype in the minds of others. This worry and concern can place an undue burden on members of underrepresented groups.

Earliest Stereotype Threat Study

Female and male college students took a difficult math test under a treatment and control condition.
Control: Instructions included with gender performance references.
Treatment: True instructions, no gender reference.



Negative stereotypes raise inhibiting doubts and high-pressure anxieties in a test taker's mind which are constant reminders that one belongs to a group stereotyped as inferior in academics, which impacts test performance. At all levels of education, the racial achievement gap in performance between Black and Latino students and their White peers stubbornly persists. While the causes of this gap are numerous and interrelated, one theory posits that students from underrepresented racial groups may face stereotype threat, meaning that fear of failing and thereby fulfilling negative group stereotypes leads to anxiety and suboptimal cognitive performance.

Baker, et al., (2019); Spencer, Steele, & Quinn (1999); Steele (1997)

Mindsets

"I can't do this!

This is hard!

I'm stupid!"

Mindset:

A set of beliefs or a way of thinking that determines one's behavior, outlook and mental attitude.

Fixed Mindset Belief:
You are born with a set level of skills, talent or IQ.

Fixed Mindset Focuses on:
Performance, outcomes and not looking bad

Growth Mindset Belief:
My skills, talent or IQ can be developed.

Growth Mindset Focuses on:
Improving, learning, growth

Individuals with a fixed mindset in a domain such as academics respond negatively to challenge in the domain. They respond to challenge with anxiety, withdrawal, and a reduction in adaptive behaviors.

Dweck (2006, 2016)

STEM Identity

"Girls can't be astronauts!

I could never learn physics!

I'm no good at math..."

STEM Identity is…

- How an individual visualizes their life as a scientist (technology user, engineer, or mathematician) - a salient identity of particular interest in STEM.

- The development of a scientific college student identity is a complex process. Students enter college with a core identity consisting of the abiding characteristics and attributes they apply to their everyday lives. This mean student identity and STEM identity development compete with societal assumptions related to matters of social class, race or sexual identity which can be strongly influential depending on a student's environment.

"A lot of black males don't really have the people to look up to in STEM.

They need examples of people who look like them who are successful and doing positive things."

Ryan Charles Hynd, The Chronicle of Higher Education

Chronicle of Higher Education (2014); Grossman & Porsche (2014a); Jones & Abes (2013)

Benefits of STEM Identity

Benefits of STEM Identity

Students with a strong scientific self-identity exhibit positive outcomes in task and performance-approach goals over time. A scientific identity facilitates underrepresented students' integration into the sciences. Studies have found that undergraduate students who engage in research exhibit growth in scientific self-efficacy and scientific self-identity and develop more refined scientific career goals.

Developing a STEM identity is related to a sense of fit with other students and academics in the STEM field, however identity development can be a challenge for underrepresented minorities. There is often an identity struggle for underrepresented minority students to balance social identities and academic identities, which will require some identity fostering or programs from faculty and colleges.

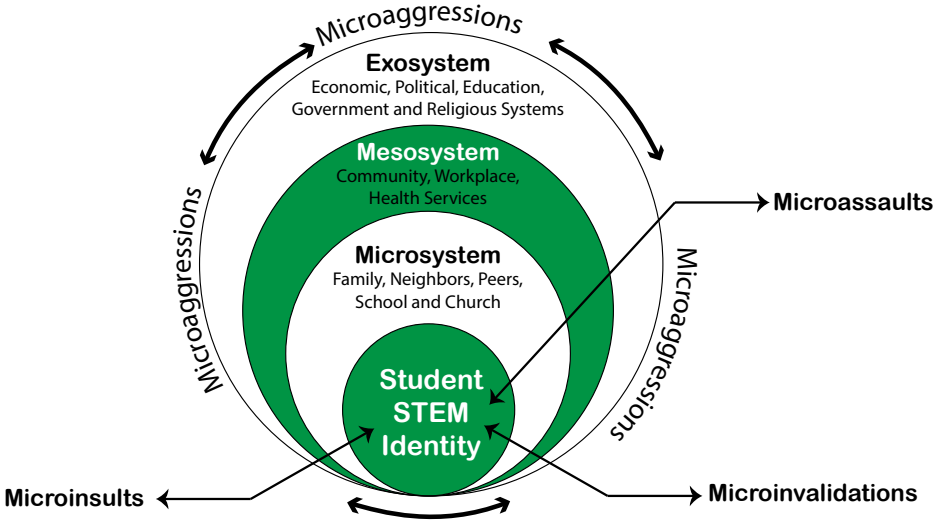
Underrepresented minorities who identify strongly with academic role identities have greater persistence to degree completion than do underrepresented student who identify more strongly with their social identities. Student and professional organizations that intersect with the academic and social identities of students have proven to be successful in promoting STEM identity and persistence to graduation for underrepresented STEM students.

Estrada, et al., (2011); Hurtado, et al., (2009); Laursen, et al., (2010); Syed, et al., (2018)

Influences of Students' Environments

Microaggressions

Racial microaggressions are brief and commonplace, interpersonal exchanges—***intentional and unintentional***—that communicate denigrating and disparaging messages to ethnic minority Individuals.



Bronfenbrenner's Ecological Theory

Messages from students' environments influence the way they identify themselves or develop a STEM identity. Underrepresented minorities often experience negative interactions in society that impact their identities as students or scientists. These are referred to as microaggressions. **Microaggressions** take the form of **microassaults**, **microinsults** and **microinvalidations** enacted primarily by those who are members of the dominant culture toward people with disabilities, people of color, or sexual minorities. When microaggressions target racial minorities, they are labeled racial micro-aggressions. In predominantly white institutions (PWI), where there are few URMs, racial micro-aggressions can lead to racial battle fatigue (RBF) for racial minorities in response to frequent micro-aggressions.

Alabi (2015); Smith, Hung, & Franklin (2011); Sue, et al., (2007); Torres, Driscoll, & Burrow (2010)

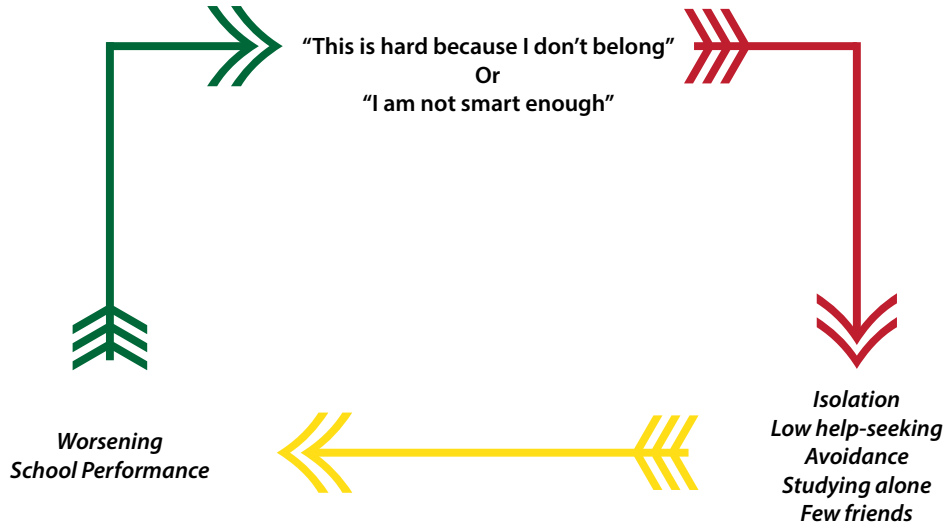
Sense of Belonging

In terms of college, sense of belonging refers to a student's:

- Perceived social support on campus
- A feeling or sense of connectedness
- The experience of mattering or feeling cared about, accepted, respected, valued by, and important to the campus community or others on campus such as faculty, staff and peers.

Feelings of not fitting in that make adjusting to college life a challenging for many underrepresented minorities in higher education, particularly in STEM. Adjusting to new a academic life while balancing family/friend connections can impact a student's ability to feel they belong in a STEM discipline. Greater attention to minority students' subjective sense of integration in campus life and STEM disciplines is important to ensure students are retained in STEM.

The Recursive Process of Sense of Belonging



Cohen & Sherman (2014); Storms & Nisbett (1970); Strayhorn (2012); Walton & Cohen (2011); Wilson & Linville (1985); Yeager & Walton (2011)

It takes more than SMARTS

Trying harder isn't enough - The power of psychosocial interventions

Much of the previous work to promote student academic success has focused

on learning STEM content (cognitive factors) and psychosocial skills (non-cognitive factors.)

Learning theory continues to stress the importance of student development focused on the non-cognitive skills needed in the 21st century STEM industry. Non-cognitive factors include:

- Motivation
- Effort and self-regulated learning
- Self-efficacy
- Academic self-concept
- Antisocial and prosocial behavior
- Coping and resilience

Alismail & McGuire (2015); Rosen, Glennie, Dalton, Lennon, & Bozick (2010)

Unit 1 Activity.....

1. **Please complete the Mindset Assessment/Questionnaire below. What is your total score? _____**

MINDSET CHECK UP

Take a minute or two to answer these questions. There are no right or wrong answers here. Just circle the button that you think works best for you!

PART #1

CIRCLE THE BUTTON THAT YOU THINK BEST FITS!

1. You can always change your talent a good amount, no matter how much you have.

1 disagree big time — 2 disagree — 3 kind of disagree — 4 kind of agree — 5 agree — 6 agree big time

2. I like work the best when it makes me think hard.

1 disagree big time — 2 disagree — 3 kind of disagree — 4 kind of agree — 5 agree — 6 agree big time

3. I like doing things that I'll learn from even if I make a lot of errors.

1 disagree big time — 2 disagree — 3 kind of disagree — 4 kind of agree — 5 agree — 6 agree big time

4. When something is hard, it makes me want to spend more time on it, not less.

1 disagree big time — 2 disagree — 3 kind of disagree — 4 kind of agree — 5 agree — 6 agree big time

PART #1 TOTAL _____

PART #2

NOTICE WE CHANGED THE SCORING FOR THIS PART. READ CAREFULLY:)

5. You can always learn things, but you can't really change how smart you are.

1 agree big time — 2 agree — 3 kind of agree — 4 kind of disagree — 5 disagree — 6 disagree big time

6. I like work the best when I can do well without putting a lot of effort in.

1 agree big time — 2 agree — 3 kind of agree — 4 kind of disagree — 5 disagree — 6 disagree big time

7. I like doing work that I can do perfectly almost all of the time.

1 agree big time — 2 agree — 3 kind of agree — 4 kind of disagree — 5 disagree — 6 disagree big time

8. When I have to put extra work in it makes me feel like I'm not as good as my peers.

1 agree big time — 2 agree — 3 kind of agree — 4 kind of disagree — 5 disagree — 6 disagree big time

PART #2 TOTAL _____

(NOW ADD THE TWO PARTS TOGETHER!)

GRAND TOTAL

Unit 1 Activity

1. **Your mindset is a malleable set of beliefs that we can each change. Please give a synopsis based on your score of your current mindset:**

   _____
   _____
   _____

2. **You are a scientist, professor, teacher, innovator and/or researcher. Pick one of these STEM identities and list 3 norms or expectations that come with that identity and how each helps you fit into the scientific culture.** *Example: Artist 1) makes original works 2) Is creative 3) reinterprets the world.*

   _____
   _____
   _____

3. **Microagressions can be intentional and unintentional. What is a strategy you plan to use to spot and address microagressions in your students' learning environment?**

   _____
   _____
   _____

4. **For underrepresented minorities and women, the scientific culture can be very unwelcoming. Building a sense of belonging can begin in your class. We must address these factors:**
   - **Isolation**
   - **Low-help-seeking**
   - **Avoidance**
   - **Studying alone**
   - **Few friends**
   - **Worsening school performance**

   Pick one factor and share a strategy to combat this among your students.

   *Factor:*_____
   *Strategy:*_____

5. **Students who persist in STEM need more than intelligence. Critical non-cognitive skills include:**
   - **Motivation**
   - **Effort and self-regulated learning**
   - **Self-efficacy**
   - **Academic self-concept**
   - **Antisocial and prosocial behavior**
   - **Coping and resilience**

   Select 3 non-cognitive factors from above and share how they may impact student learning:

   *Factor:*_____ *Impact on Learning:*_____
   *Factor:*_____ *Impact on Learning:*_____
   *Factor:*_____ *Impact on Learning:*_____

UNIT 2 - OBJECTIVES

- To formulate strategies to apply growth mindset and psychosocial interventions in STEM classrooms.

- To develop a network of support and accountability with other faculty participants to facilitate long-term application of growth mindset and related theories.

Psychosocial Interventions

Psychosocial Interventions:

Psychosocial interventions attempt to mitigate stress and threat so that people's true capacity can shine through. They are used in schools, universities and workplaces across the globe.

Growth Mindset and Academic Success

Considerable research has shown that growth mindset is related to improved student performance.

Middle school students with growth mindsets

- Outperformed fixed mindset students in math.
- Are more motivated to learn / applied more effort.

High school students with growth mindsets

- Outperformed those with fixed mindset in language and math.

College students with growth mindsets

- First year students who watched 45 minute presentation that described brain's ability to grow and rewrite itself as a result of challenge and setbacks had higher GPAs.

> "Most people don't know that when they practice and learn new things, parts of their brain change and get larger, a lot like muscles do when they exercise...And the more a person learns, the easier it gets to learn new things - because their brain "muscles" have gotten stronger!"

Blackwell, et al., (2007); Claro, et al., (2016); Grossman & Porsche (2014b); Mindset Works (2016); Paunesku, et al., (2015)

Developing Mindset Interventions

There are typically three models that you can use to develop and implement mindset strategies at different stages in your course:

- Apply an initial mindset intervention early in the term.
- Create an environment of support where students can thrive.
- Use boosters throughout the term.

Initial mindset intervention:

- Early in the term, and
- Follow with a challenging activity.

Create an environment of support and belonging that fosters a growth mindset:

- Formal practices (grading, credit for revisions), and
- Informal practices (praise, criticism, encouragement)

When confidence wanes, use a "booster":

- Quick interim activities to spark motivation

Developing your own Mindset Intervention

Initial Mindset Interventions	Creating an environment of support and belonging	Boosters
Add mindset wording to syllabus.	Formal practices (partial credit for work done correctly, credit for revisions of essays or homework.)	Encourage students to write a self-motivating letter from their future self - explaining how they achieved their goals and overcame difficulty.
Set mindsets early in the term - share a short growth mindset article and discuss what this means for their class performance.	Effective feedback: Informal practices (praise, or encouragement.)	Positive messaging on exams and quizzes.
Provide an inspirational model who narrates an experience overcoming hardship and demonstrating perseverance. (Ex. Neil deGrasse Tyson)	Show Carol Dweck's growth mindset videos and quotes in class. (See Resources list.)	Former student testimonials via letters, postcards or videos.

Other ideas for Mindset Interventions?

Unit 2 Activity

1. **A psychosocial intervention for students seeks to _____ the impact of stressors and threats to academic engagement.** *(Fill in the blank.)*

   1) Shift
   2) Decrease
   3) Increase
   4) Eradicate

2. **Let's practice growth mindset intervention development for your class.**

   Initial mindset intervention (e.g. changing the working in your syllabus):

   _____

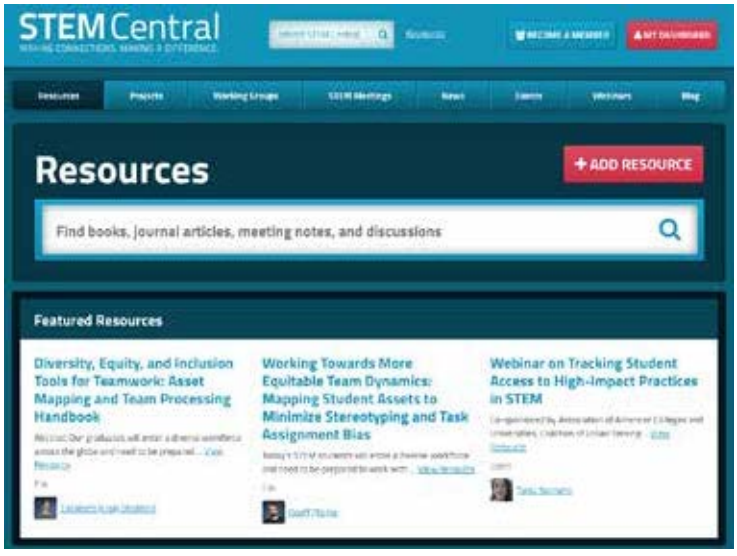
   Create an environment of support and belonging (e.g. praise):

   _____

   Boosters (e.g. letters from pervious students):

   _____

3. **Go to** *STEM-Central.net* **and become a member.**



4. **Just as students need a place for inclusion among peers, teachers need a network to be their most effective. Your network of growth mindset peers is a critical resource for strategies for your classroom and accountability for ethical application. Fill out contact information for 2 people (1=trainer, 2= colleague/peer).**

Starting My Mindset Network		
Name	**Contact Information**	**Role In My Success**

Wrap it Up

- *In one word, describe something you learned or experienced today.*

- *Name one growth mindset strategy that you would like to try in your class.*

Additional Resources

Books:

Dweck, Carol S. (2006, 2016) Mindset: The New Psychology of Success New York : Ballantine Books

Websites: See *MindsetsForSTEM.org* for additional links.

Teaching tools for growth mindsets:

- *EverydayPower.com/carol-dweck-quotes*
- *MindsetsForSTEM.org*
- *MindsetWorks.com*
- *STEMTeachingTools.org*
- *TrainUgly.com*

Networking:

- *STEM-Central.net*
- *STEMConnector.com*
- *Tallo.com* (Formerly *STEMPremier.com*)
- *TwoMentor.com*

Additional Resources

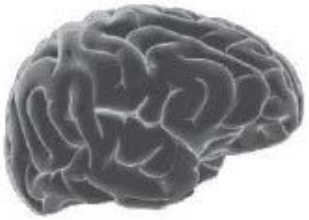
You Can Grow Your Intelligence

New Research Shows the Brain Can Be Developed Like a Muscle

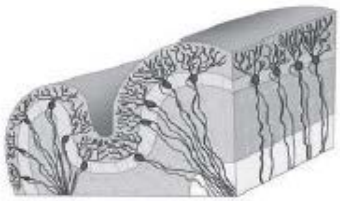
Many people think of the brain as a mystery. They don't know much about intelligence and how it works. When they do think about what intelligence is, many people believe that a person is born either smart, average, or dumb—and stays that way for life.

But new research shows that the brain is more like a muscle—it changes and gets stronger when you use it. And scientists have been able to show just how the brain grows and gets stronger when you learn.

Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who can't lift 20 pounds when they start exercising can get strong enough to lift 100 pounds after working out for a long time. That's because the muscles become larger and stronger with exercise. And when you stop exercising, the muscles shrink and you get weaker. That's why people say "Use it or lose it!"

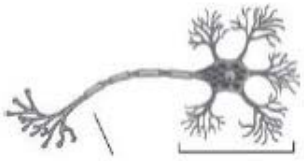


But most people don't know that when they practice and learn new things, parts of their brain change and get larger a lot like muscles do when they exercise.



A section of the cerebral cortex

Inside the cortex of the brain are billions of tiny nerve cells, called neurons. The nerve cells have branches connecting them to other cells in a complicated network. Communication between these brain cells is what allows us to think and solve problems.



A typical nerve cell

When you learn new things, these tiny connections in the brain actually multiply and get stronger. The more that you challenge your mind to learn, the more your brain cells grow. Then, things that you once found very hard or even impossible to do—like speaking a foreign language or doing algebra—seem to become easy. The result is a stronger, smarter brain.

Additional Resources

How Do We Know the Brain Can Grow Stronger?

Scientists started thinking that the human brain could develop and change when they studied animals' brains. They found out that animals who lived in a challenging environment, with other animals and toys to play with, were different from animals who lived alone in bare cages.

While the animals who lived alone just ate and slept all the time, the ones who lived with different toys and other animals were always active. They spent a lot of time figuring out how to use the toys and how to get along with the other animals.

Effect of an Enriched Environment

Nerves in brain of animal living in bare cage

Brain of animal living with other animals and toys

These animals had more connections between the nerve cells in their brains. The connections were bigger and stronger, too. In fact, their whole brains were about 10% heavier than the brains of the animals who lived alone without toys.

The animals who were exercising their brains by playing with toys and each other were also "smarter"—they were better at solving problems and learning new things.

Even old animals got smarter and developed more connections in their brains when they got the chance to play with new toys and other animals. When scientists put very old animals in the cage with younger animals and new toys to explore, their brains also grew by about 10%!

3

Children's Brain Growth

Another thing that got scientists thinking about the brain growing and changing was babies. Everyone knows that babies are born without being able to talk or understand language. But somehow, almost all babies learn to speak their parents' language in the first few years of life. How do they do this?

The Key to Growing the Brain: Practice!

From the first day they are born, babies are hearing people around them talk—all day, every day, to the baby and to each other. They have to try to make sense of these strange sounds and figure out what they mean. In a way, babies are exercising their brains by listening hard.

Later, when they need to tell their parents what they want, they start practicing talking themselves. At first, they just make goo-goo sounds. Then, words start coming. And by the time they are three years old, most can say whole sentences almost perfectly.

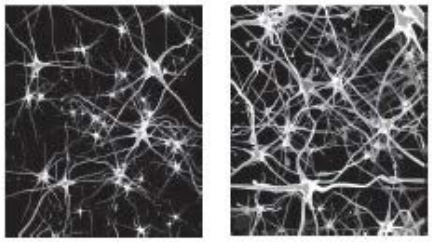
Once children learn a language, they don't forget it. The child's brain has changed—it has actually gotten smarter.

This can happen because learning causes permanent changes in the brain. The babies' brain cells get larger and grow new connections between them. These new, stronger connections make the child's brain stronger and smarter, just like a weightlifter's big muscles make them strong.

4

Additional Resources

Growth of neuron connections in a child from birth to 6 years old



At birth At age 6

The Real Truth About "Smart" and "Dumb"

No one thinks babies are stupid because they can't talk. They just haven't learned how to yet. But some people will call a person dumb if they can't solve math problems, or spell a word right, or read fast—even though all these things are learned with practice.

At first, no one can read or solve equations. But with practice, they can learn to do it. And the more a person learns, the easier it gets to learn new things—because their brain "muscles" have gotten stronger!

The students everyone thinks as the "smartest" may not have been born any different from anyone else. But before they started school, they may have started to practice reading. They had already started to build up their "reading muscles." Then, in the classroom, everyone said, "That's the smartest student in the class."

They don't realize that any of the other students could learn to do as well if they exercised and practiced reading as much. Remember, all of those other students learned to speak at least one whole language already—something that grownups find very hard to do. They just need to build up their "reading muscles" too.

5

What Can You Do to Get Smarter?

Just like a weightlifter or a basketball player, to be a brain athlete, you have to exercise and practice. By practicing, you make your brain stronger. You also learn skills that let you use your brain in a smarter way—just like a basketball player learns new moves.

But many people miss out on the chance to grow a stronger brain because they think they can't do it, or that it's too hard. It does take work, just like becoming stronger physically or becoming a better ball player does. Sometimes it even hurts! But when you feel yourself get better and stronger, all the work is worth it!

6

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