Building a Math Environment That Promotes Positive Math Attitudes

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This presentation is available from the Regional Educational Laboratory website at https://ies.ed.gov/ncee/edlabs_regions/northwest/events/.
Learning objectives

By the end of this session, you will be able to:

1. Describe your own math identity.
2. Describe how math identity impacts students’ engagement and learning.
3. Identify the role adults play in creating math environments that support the development of a positive math identity.
4. Apply several kernels of practice that provide supports to students and promote math identity and achievement.
Activity

Take a few minutes to write your “math autobiography”:

The last math course I took was __________.

When I think about doing math, I feel ______.

An early experience in a math class that stands out for me was when______________.

One math teacher I remember is __________, because ____________.

My family’s attitude toward math was ________.

I think I learned my present attitude toward math when ____________________.

I believe I have been successful in math because ______________.
Would you describe your relationship to math as mostly positive, mostly negative, or somewhere in between? Why?

How do you think your experience with math as a young person shaped your "math life?"

In what ways does your relationship to math influence or impact your work as a math teacher?
Overview of Math Identity and Agency
Elements of math success

- Conceptual understanding
- Mathematical reasoning ability
- Procedural skill and fluency
Elements of math success

- Math agency
- Conceptual understanding
- Math identity
- Procedural skill and fluency
- Mathematical reasoning ability
- Supportive environment
Elements of math success

Math identity

Math agency
What is math identity?

- Beliefs about one’s self as a math learner.
- Beliefs about how one is perceived by others as a math learner.
- Beliefs about math and the nature of math abilities.
What is math identity?
• Beliefs about one’s self as a math learner,
• Beliefs about how one is perceived by others as a math learner,
• Beliefs about math and the nature of math abilities.

What is math agency?
• Outward expression of math identity.

Content source: Aguirre, Mayfield-Ingram, & Martin, 2013
Why should we care about identity and agency?
What’s so special about math?
Amongst adults

- 93 percent report experiencing some level of math anxiety

Content source: Luttenberger, Wimmer, & Paechter, 2018
Prevalence of negativity about math

Amongst adults
• 93 percent report experiencing some level of math anxiety

Amongst students taking PISA
• 59 percent report worrying math will be difficult

Content source: Luttenberger, Wimmer, & Paechter, 2018
Prevalence of negativity about math

Amongst adults

- 93 percent report experiencing some level of math anxiety

Amongst students taking PISA

- 59 percent report worrying math will be difficult
- 33 percent report getting very tense when completing math homework

Content source: Luttenberger, Wimmer, & Paechter, 2018
Prevalence of negativity about math

Amongst adults
• 93 percent report experiencing some level of math anxiety

Amongst students taking PISA
• 59 percent report worrying math will be difficult
• 33 percent report they get very tense when completing math homework
• 31 percent report getting very nervous when doing math problems

Content source: Luttenberger, Wimmer, & Paechter, 2018
Negativity about math

Math, more than other domains, carries baggage that can result in negative attitudes and beliefs.

I’m just not a letters person.

I’m just not a numbers person.

I’m so bad at reading.
Google image search for “Math Genius”

What do you notice about these images?

What cultural assumptions are reflected?
Stereotypes about math

Math ability is a “gift”

Certain people are more likely to get the “gift”

Content source: Chestnut, Lei, Leslie, & Cimpian, 2018
Stereotypes about math

Math ability is a “gift”

Certain people are more likely to get the “gift”

Some students will be less likely to develop strong math identities

Content source: Chestnut, Lei, Leslie, & Cimpian, 2018
Which groups does our society associate with brilliance?

Thanks, Mom and Dad, for All Your Support

By BILL MARSH  JAN. 18, 2014

THE DISCONNECT BETWEEN PARENTS’ WEB SEARCHES AND REALITY
“Boys do not pursue mathematical activities at a higher rate than girls do because they are better at math. They do so, at least partially, because they think they are better.”

Shelley Correll, Stanford sociologist
Stereotypes emerge early

- Children endorse the stereotype that math is for boys as early as second grade.
- Gender stereotypes emerge before differences in math achievement.

Content source: Bian, Leslie, & Cimpian, 2017
What’s the harm?

• Math is a gateway and a gatekeeper
  • Access to advanced courses
  • Entrance to college
  • Access to math-dependent careers
• Evident at a young age – early math skills are the strongest predictor of later academic outcomes

Content source: Douglas & Attewell, 2017; Duncan et al., 2007
What role do adults play?
Adults’ attitudes matter

• Children whose parents are anxious about math are more likely to:
  • Have math anxiety themselves
  • Show lower math achievement

• This is particularly true when math anxious parents provide frequent math homework help

Content source: Casad, Hale, & Wachs, 2015; Maloney, Schaeffer, & Beilock, 2013
Children whose teachers are anxious about math are more likely to:
- Have math anxiety themselves
- Endorse negative math stereotypes
- Learn less in math

Teachers with math anxiety spend less time teaching math and rely more on teaching skills and facts

Content source: Beilock, Gunderson, Ramirez, & Levine, 2010; Sloan, 2010
Adults’ attitudes matter

Math ability is a “gift”

Certain people are more likely to get the “gift”

Teachers prescribe positive identities to particular students
Teacher expectations for student achievement in math influence future student outcomes

Teachers’ implicit attitudes are related to classroom achievement gaps

“Be careful how you interpret the world; it is like that.”

Erich Heller

Content source: Jamil, Larsen, & Hamre, 2018; Van den Bergh, et al., 2010
What factors do you consider – consciously or not – when you first encounter a student?

What influences a teacher’s perceptions of a student’s potential?

How do educators’ perceptions of student potential influence their expectations and student performance?
Key aspects of math identity and agency
Key aspects of math identity

Math anxiety

Math Identity

Sense of belonging
Growth mindset
Perceived utility
Promoting math identity in the classroom

Video source: Inside Mathematics, n.d.
What is belonging?

Feeling like an accepted, valued, and legitimate group member.
Belonging is a fundamental need

The need for social connections is innate and universal. It is a need, not a want.

Content source: Baumeister & Leary (1995)
Exclusion is painful

Psychological consequences

• Sadness, anger
• Decreased self-esteem
• Impaired self-regulation
• Poorer cognitive function

Physical consequences

• Brain science suggests social pain and physical pain are experienced in overlapping brain systems
• Loneliness poses the same health risks as smoking, drinking, and obesity

Content source: Baumeister & Leary, 1995
Belonging in school: So what?

Positive Health Outcomes
- Substance abuse
- Early sexual initiation
- Violence
- Suicidal ideation
- Eating disorder development

School Belonging

Positive Academic Outcomes
- Self-efficacy
- Motivation
- Attendance
- Persistence
- Achievement

Content source: Goodenow, 1993; Osterman, 2000
Belonging as a “Psychological Hub”

- Belonging
  - Persistence
    - Performance
  - Motivation
    - Interest
Lack of belonging saps concentration and focus

Do I belong here?

I’m not sure ...

More vigilant

Assume the worst

Classmate didn’t say “hi” in hall

Bad grade on math quiz

Teacher didn’t call on me

Content source: Walton & Cohen, 2007
Do I fit in socially?

I’m not sure I belong …

No one at this school likes me.

Less effort toward relationships.

Classmate didn’t say “hi” in hall

Interpretation

Yes, I belong!

It was loud in the hallway.

Be more direct next time.

Content source: Walton & Cohen, 2007
Belonging is multidimensional

Content source: Lewis & Hodges, 2015
Do I fit in intellectually?

I’m not sure I belong …

I hate math. I’m not cut out for this.

Disengagement

Response

Negative critique from partner in math class

Interpretation

Yes, I belong!

I need to be more precise when I describe my ideas.

Rephrase ideas
Olivia is an eighth-grade girl who enjoys school and considers herself to be smart. She lives in a small town and hopes to be the first person in her family to attend college. Olivia has always excelled in math and has mostly earned A’s, with an occasional B.

During seventh grade, Olivia’s teacher encouraged her to enroll in an advanced math class, setting her up to take algebra in eighth grade. Olivia has found the work challenging and earned her first-ever D on the first unit test.

Olivia’s teacher asked her to stay after class to discuss her performance. When they spoke, her teacher said that maybe algebra was too hard for her. If her grades don’t improve, her teacher will consider moving her into the regular eighth-grade math class.
What is perceived utility?

Belief that math is useful, worthwhile, and relevant to life outside of school, now and in the future.

Content source: Hulleman & Harackiewicz, 2009
Math – why bother?

“What I find difficult in school is to understand the concept of learning advanced math. When I grow up, the job I want to do will have nothing to do with radicals, algebra, imaginary numbers, and all this other complicated stuff. I understand why we learn basic math, but why all this extra stuff? My job will never require any of that. Yes, you might say, "Well you'll need it later in life", but I always have a calculator for that. In fact if you go to your local supermarket, they use a cash register with a built-in calculator. Besides occurrences with money (and I'm sure I'm not going to have questions dealing with radicals), why are we taught this stuff?”

Letter to Dr. Math, from mathforum.org

Content source: National Council of Teachers of Mathematics, Math Forum, 2005
Why does perceived utility matter?

• Students are more motivated when they see the connections between what they are learning, how it relates to their own life and goals, and how it might be useful later in life.
Why does perceived utility matter?

- A simple classroom intervention was designed to help students identify the connections between math materials and their daily lives.

- Results from that intervention included:
  - Increased interest in the topic
  - Increased confidence
  - Better academic performance

- It was also effective to have parents help promote the utility of math.

Content source: Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Hulleman & Harackiewicz, 2009
Kernel of Practice: Interest Interviews
Typical problem:
• A particular assembly line in an automobile company plant can produce 13 cars every hour.

Problem based on student interests:
• A recent video blog that you posted on YouTube gets 13 hits every hour.
• Your favorite restaurant, Steak ‘n Shake, sells 13 caramel pretzel shakes every hour.

Interest interviews

Students perform better and learn faster when given personalized problems, especially when the problems are difficult and are for students identified as struggling in math.

Content source: Walkington, 2013; Walkington, Sherman, & Howell, 2014
Interest interviews

Step 1. Assign interview questions for homework.
• This allows students time to think about their answers.

Step 2. Students interview each other in pairs during class.
• Ask students to record each other’s answers using a phone or recorder.

Step 3. Students submit interview recordings to the teacher.

Content source: Matthews, 2018; Walkington, 2013; Walkington, Sherman, & Howell, 2014
You now have rich, student-generated data to use in your instruction throughout the year!

Use these data to personalize learning:

• Create powerful examples
• Facilitate discussions
• Connect math with students’ lives and interests
• Foster a sense of belonging in the math classroom

Interest interviews

Content source: Matthews, 2018; Walkington, 2013; Walkington, Sherman, & Howell, 2014
Interest interviews

You now have rich, student-generated data to use in your instruction throughout the year!

Only do it if you plan to use it!!

Content source: Matthews, 2018; Walkington, 2013; Walkington, Sherman, & Howell, 2014
Interest interviews

Sample interview questions
• What is your favorite thing to do in your free time?
• What’s something you’re saving up for or that you’d really like to buy? How much does it cost and how do you plan to save the money to buy it?
• What’s something you’re really good at outside of school? How do you use numbers during this activity?
• Where is a place you’d really like to visit?
• Tell me about the last time you used math in your everyday life outside of school.

Content source: Matthews, 2018; Walkington, 2013; Walkington, Sherman, & Howell, 2014
How could you rewrite this problem to incorporate your partner’s interests?

Nathan’s dog weighs 72 pounds. Nathan’s dog weighs three times as much as Brian’s dog. What is the combined weight of Nathan and Brian’s dogs?
Kernel of Practice: Honor Mistakes
Honor mistakes as part of the learning process

Why honor mistakes?

A classroom culture that normalizes struggling and honors mistakes as part of the learning process may alleviate some pressure highly math-anxious students feel.

Content source: Finlayson, 2014; Turner et al., 2002; Walton & Cohen, 2007
1. Give students a test/assignment completed by a fictitious student. This test will have several incorrect answers.

2. Have students correct the test. Ask them to identify the mistakes and explain how they would approach or solve the problems differently.

Content source: Project for Education Research that Scales, 2015a

Inverted test activity
1. Have students complete a set of problems independently.

2. Put students into groups. Each group is assigned one problem to present to the class.

3. During the presentation, each group must make (at least) one intentional mistake in its solution.

4. The rest of the class listens to the group’s presentation and tries to find the mistake(s).

Content source: Ransom, 2015
My favorite ‘No’

1. Have students complete a warm-up problem at the beginning of class and write their solution on an index card.

2. Collect the index cards and sort them into yes’s (correct answers) and no’s (incorrect answers). As you sort, look for your favorite incorrect answer that will highlight the concept you are teaching.

3. Display your favorite incorrect answer, so everyone can see the student’s work.

4. Begin by talking about what was right about the response. This way, the student whose work it is sees that there is something good in their work.

5. Then, use the mistake as an opportunity to clarify the student’s misconceptions. Ask the class to identify where the student made the mistake and to explain how to fix it.

Content source: Project for Education Research that Scales, 2015b
Decide and defend: *Routines for reasoning*

Interpret the work  Decide  Draft  Defend  Reflect on learning

Daniel OtherBull grew up on the reservation. He spent most of his time playing with his friends and doing his schoolwork. Daniel went to middle school and high school on the reservation. In high school, he worked hard to earn good grades and joined many school clubs. During his last year of high school, Daniel applied to several colleges and was accepted to his top choice. Because of his good grades and involvement in school clubs, the university gave Daniel a scholarship to pay for his education. Daniel graduated from college in four years.
Discussion

How can you adapt this activity to focus on belonging and math?

How can you adapt this activity to use with your students?
Kernel of Practice: Utility Reflection
Perceived utility

When students reflect on the utility of math, they show:

✓ Greater utility value of math for daily life, future careers, and future life
✓ Increased math self-concept
✓ Increased effort in math
✓ Increased math achievement

Content source: Brisson et al., 2017; Gaspard et al., 2015
Perceived utility activities

How can you guide students to understand how math is relevant to their lives?

• Discuss math utility with your students.
• Showcase older students who use math in their jobs.
• Incorporate hands-on activities that focus on relevant and engaging problems.

Content source: Brisson et al., 2017; Gaspard et al., 2015
Discussion

What strategies can you use to guide student reflection on math utility?
Bring parents into the conversation!
Bring parents into the conversation!

✓ More conversations with parents about course choices, educational plans, and the importance of math and science
✓ More math and science courses completed
✓ More elective math courses
✓ Improved math and science ACT scores
✓ Increased STEM interest and career pursuits
✓ Increased number of college STEM courses

Content source: Choices Ahead, n.d.; Harackiewicz et al., 2012; Rozek et al., 2017
Bring parents into the conversation!

- Encourage parents to communicate the utility value of STEM topics to their children
- Give parents advice on how best to communicate utility value
- Provide parents with resources and materials to aid these discussions:
  - Making Connections brochure

Relevant factors:
- Belonging
- Mindset
- Anxiety
- Utility

Content source: Choices Ahead, n.d.; Harackiewicz et al., 2012; Rozek et al., 2017
Design your “elevator pitch” about positive math identity

• What topics of math identity will you cover?
• What information will you include?
• How could you guide parents to reflect on their own math identity?

Bring parents into the conversation!
1. Reflect on your thinking during the session about ways to apply the key concepts.

2. For each identity aspect, select a kernel of practice that you think is most relevant for your classroom.

3. Determine a topic/standard that would lend itself to using the kernel of practice. Generate notes on how/when you may explicitly implement this kernel within your instruction.
About REL Northwest

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• Conducting rigorous research and data analysis
• Delivering customized training, coaching, and technical support
• Providing engaging learning opportunities
Content References


Content References


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Image References

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Video References