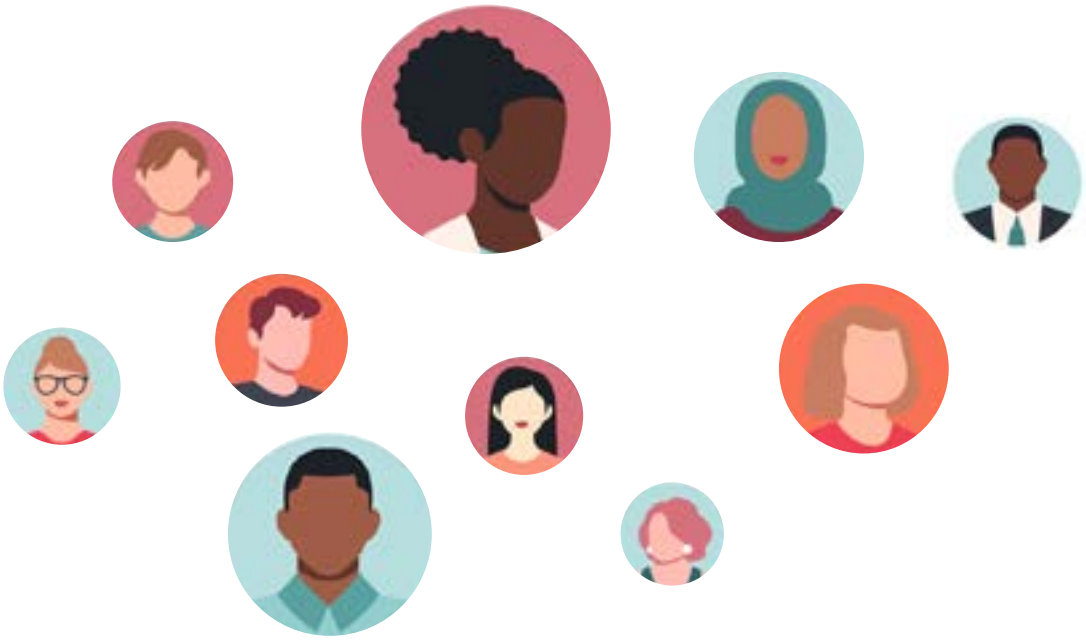
TEACHER-TESTED PRACTICE GUIDES

Error Identification Four-Square



www.shift-results.com | hello@shift-results.com

Why This Work Matters

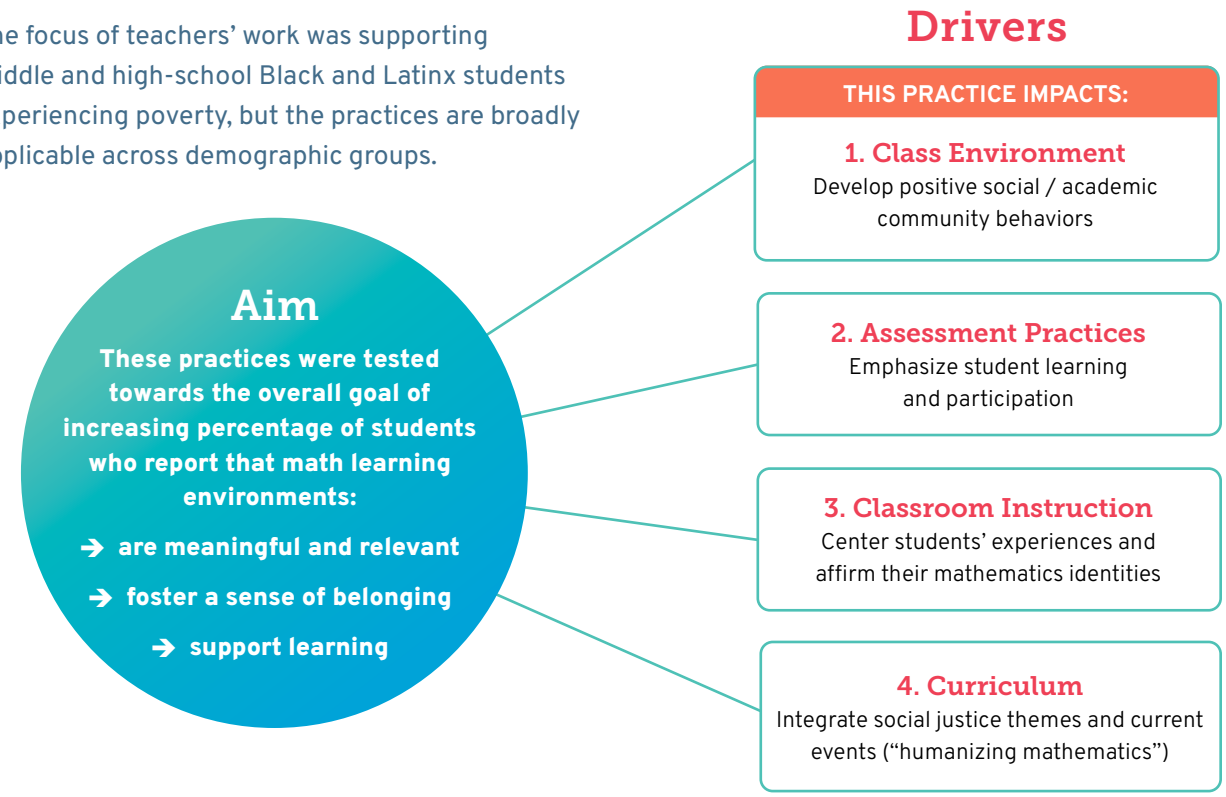
An imperative to center students' experiences in math education

Research points to numerous factors that are instrumental in positive academic outcomes for all students. These include: a positive racial/ethnic identity[1], a sense of belonging[2], and beliefs about their academic abilities[3]. Teachers' expectations are one of the most powerful influences, and these have been found to be lower for Black, Latinx, and Indigenous students due to teachers' biases[4]. Asset-based pedagogy ensures that teachers develop essential knowledge and behaviors that sustain high expectations and promote student identity[5].

This is particularly important in mathematics[6] where some of the most stubborn inequities persist[7]. Special attention is necessary because this subject area has disproportionately negatively impacted students from historically marginalized backgrounds via high-stakes testing, a hyperfocus on skill development, and the abstract nature of the subject disconnected from their day-to-day lives.

However, equity-focused mathematics teachers are innovating and improving ways to support students' identity as math learners, sense of belonging, and beliefs about their academic ability. To learn more about how these practices can be applied in the classroom, Shift partnered with educators across the country to develop a theory of change describing key levers for improving students' experiences in their math classrooms, and to build and test a few of the potentially high-leverage practices they identified. **The purpose of these resources is to provide educators with concrete examples and guidance from educators that have put these strategies into practice in their context.**

The focus of teachers' work was supporting middle and high-school Black and Latinx students experiencing poverty, but the practices are broadly applicable across demographic groups.



Error Identification Four-Square

*Special credit and appreciation goes to **Jaime Higgins** of **Mastbaum High School** who tested this idea in her class in Spring 2022 and contributed to this document.*

1. What it is

This is an activity designed to show students common errors and corresponding solutions for different types of math problems, and to scaffold students' ability to identify errors and describe solutions.

Leveraging activities like this can help to normalize making mistakes as a part of the learning process. This can take some pressure off of students when they are trying to learn new content, and can help them see and understand common errors before making them themselves.

"This strategy helped me learn to identify and correct common mistakes in my geometry class."

9TH GRADE STUDENT

2. Why do it

Using activities like error identification four-square can, over time, contribute to a classroom environment that emphasizes and priorities students' development of positive identities as math learners. By the time they get to high school, many students have developed fixed mindsets about their mathematical abilities, so making mistakes while they're learning can further solidify pre-existing fixed mindsets[8]. Educators have a big opportunity to support students in shifting from fixed mindsets to growth mindsets with every interaction and every activity. This particular activity is fairly low lift and adaptable, and can be a useful reference to students to support their psychological safety as learners.

Why I do this change

"My hope is that in seeing that mistakes happen and happen in a variety of ways that my students will be more confident to sharing their answers regardless of whether they are correct, which will allows us to talk about mistakes and how to fix them as a regular part of our discussions."

9TH GRADE GEOMETRY TEACHER

3. How to do it

Getting Started

1. Make a document with a 2x2 table.
2. In the top half of the table, present students with two different sample setups. While your sample setups can vary, aim to show a common error (cell 1) and a correct solution (cell 2) side-by-side.
3. Then, in the bottom half of the table, leave space for the student to identify the error (cell 3) and describe the possible fixes (cell 4).
4. At the launch of the task, emphasize that making and learning from mistakes is a part of the process of doing math.

STUDENT SAMPLE A

Student Work	Teacher (Peer) Work
If D is the midpoint AB, find the value of x.  x + 8 = 2x + 5 8 = x + 5 3 = x	x + 8 = 2x + 5 3x + 8 = 5 3x = -3 x = -1
Identify the Error In line 1, the teacher added 2x to both sides instead of subtracting 2x.	**Describe the Fix** Subtract 2x from both sides to get -x + 8 = 5. Then, subtract 8 from both sides to get -x = -3. Finally, multiply both sides by -1 to get x = 3.

EXAMPLES OF ERROR IDENTIFICATION FOUR-SQUARE

Note that each example features a slightly different error, and then shows options for how to correct each error.

STUDENT SAMPLE B

Student Work	Teacher (Peer) Work
If D is the midpoint AB, find the value of x.  x + 8 = 2x + 5 8 = x + 5 13 = x	x + 8 = 2x + 5 3x + 8 = 5 3x = -3 x = -1
Identify the Error In line 1, the teacher added 2x to both sides instead of subtracting 2x.	**Describe the Fix** Subtract 2x from both sides to get x + 8 = 5. Then, add 8 to both sides to get x = 13.

STUDENT SAMPLE C

Student Work	Teacher (Peer) Work
If D is the midpoint AB, find the value of x.  x + 8 + 2x + 5 = 180 3x +13 = 180 3x = 167 X = 175 ⅔	x + 8 = 2x + 5 3x + 8 = 5 3x = -3 x = -1
Identify the Error The problem is set up incorrectly. AB is a straight line and therefore equals 180.	**Describe the Fix** To fix the error, the teacher would need to set up the problem so that AD + DB = 180. Then follow the work like I did.

Learning from teacher testing this change idea and possible adaptations

Classroom context from our testing

The high school where this change was tested is in an urban area in the Northeastern U.S. 95% of the students identify as BIPOC, and 100% of the students experience poverty. Their geometry teacher started focusing on building a classroom culture that normalizes mistakes in March. Because BIPOC students experience systemic oppression most acutely, they are more likely to a) experience trauma resulting in school absences and challenges with focusing on work, and b) to develop a 'fixed mindset' because they are typically more likely to be punished for making mistakes than their white peers.

As such, this teacher's testing around what to do to build an environment that does not punish students for making math mistakes was a big challenge. It can sometimes feel like swimming upstream while trying to undo years of harmful learning spaces[9].

This test of change represented just one practice that this teacher utilized to work toward a more just classroom that simultaneously holds students to a high level of academic rigor while supporting them to build confidence in their ability to do math, and can serve as an entry point to additional changes that will help dismantle systemic inequities in math class.

"How I choose the errors I make depends on the class, but in general there are errors that I have seen multiple students make in practice on similar questions, or, in the conceptual cases, they are errors for what we were working on that day to see how quickly they grasped the concept."

After Error Identification Four-Square was implemented two times in one ninth grade math classroom, **90% of students reported a desire to continue leveraging this strategy** to build their comfort identifying and correcting common errors.

Error Identification Four-Square

SEASONALITY:
This is an activity that can be deployed at any time (you can do it tomorrow) in a classroom and benefits students best when developed into a regular routine.

Suggested Measures

➤ **Error Identification**

How many students were able to:

- accurately identify the error?
- accurately fix the error?
- provide appropriate rationale and justification?

➤ **Exit Ticket / Assessment Scores**

- How much did students learn from the activity?
- Were there some problems that were more instructive than others?
- How many students are still making the errors the activity focused on?

➤ **Turn-in Rate**

➤ **Student Perceptions of:**

- Sense of self-efficacy
- Student agency, buy-in, investment
- Relevance/interest in problems

Connection to the Theory of Change

Driver 1: Classroom social/academic dynamics emphasize and prioritize developing a positive identity as a math learner within that community

Change Concept: Normalizing mistakes and creating a culture of inquiry

Want to learn more about other drivers and changes?

Change Package

Theory of Change

Defining Our Terms

Theory of Change

A Theory of Change is a description of how we believe change (or improvement) will happen; illustrating how our collective actions will lead to the desired outcomes.

Aim

An Aim is a shared goal of an improvement initiative that is 'SMARTIE', i.e. specific, measurable, actionable, realistic and time-bound as well as inclusive (with whom) and equitable (for whom).

Drivers

Drivers describe the main factors, leverage points, and/or ideal conditions that would need to be present to accomplish the aim of an improvement initiative.

Change Ideas

Change Ideas describe how you might create the conditions described in your drivers in order to accomplish the aim.

Change Package

A Change Package is both a collection of consolidated learning arising from testing change ideas in a theory as well as a resource for those who wish to test and adapt these change ideas.

Appreciation and References

Thank You

This project was made possible with generous support from the **Bill and Melinda Gates Foundation**.

We also wish to thank Dr. Francesca Lopez and Dr. DeLeon Gray for their many contributions to this work.

References

1. Rivas-Drake, D., Seaton, E. K., Markstrom, C., Quintana, S., Syed, M., Lee, R. M., ... & Ethnic and Racial Identity in the 21st Century Study Group. (2014). Ethnic and racial identity in adolescence: Implications for psychosocial, academic, and health outcomes. *Child development, 85*(1), 40-57.

2. Allen, K., Kern, M. L., Vella-Brodrick, D., Hattie, J., & Waters, L. (2018). What schools need to know about fostering school belonging: A meta-analysis. *Educational Psychology Review, 30*(1), 1-34.

3. Möller, J., Zitzmann, S., Helm, F., Machts, N., & Wolff, F. (2020). A meta-analysis of relations between achievement and self-concept. *Review of Educational Research, 90*(3), 376-419.

4. Papageorge, N. W., Gershenson, S., & Kang, K. M. (2020). Teacher expectations matter. *Review of Economics and Statistics, 102*(2), 234-251.

5. López, F. A. (2017). Altering the trajectory of the self-fulfilling prophecy: Asset-based pedagogy and classroom dynamics. *Journal of Teacher Education, 68*(2), 193-212.

6. Matthews, J. S., & López, F. (2019). Speaking their language: The role of cultural content integration and heritage language for academic achievement among Latino children. *Contemporary Educational Psychology, 57*, 72-86.

7. Hanushek, E. A., Peterson, P. E., Talpey, L. M., & Woessmann, L. (2019). *The unwavering SES achievement gap: Trends in US student performance* (No. w25648). National Bureau of Economic Research.

8. Yeager, D. S., & Dweck, C. S. (2020). What can be learned from growth mindset controversies?American Psychologist, 75(9), 1269–1284. doi: 10.1037.amp0000794

9. Noguera, P., Bishop, J. Howard, T & Johnson, S. (2019). Beyond the Schoolhouse: Overcoming Challenges & Expanding Opportunities for Black Youth in Los Angeles County. Center for the Transformation of Schools, Black Male Institute, Graduate School of Education & Information Studies, University of California, Los Angeles.