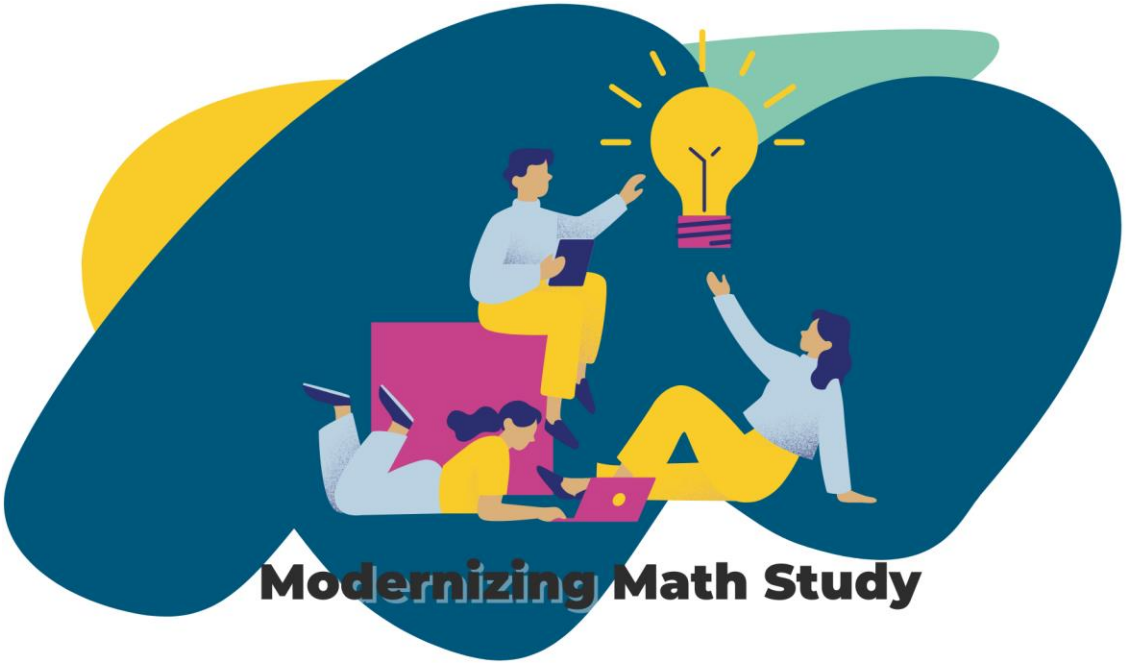


Online Journal Complete Findings

August 2023

This work was written through funding from the Bill & Melinda Gates Foundation. Views expressed here do not necessarily reflect positions or policies of the foundation.

CONTENTS

According to practitioners, the key to modernized math learning contexts is having sufficient awareness of the system's complexity, the necessary inputs for modernization, systemic structures limiting advancement, and needed changes to fundamental thinking in education.

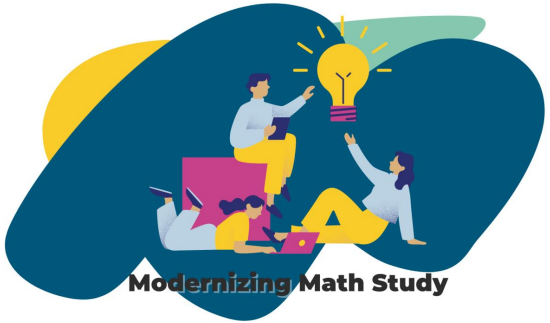
To effectively modernize math:

- **Instructional content needs to be more relevant, center each student's needs, and promote student agency**. This can look like using technology to provide students individualized support, building lessons that draw on student's interests and experiences, and students having more of a say in how they learn in the math classroom.
- **Teachers need the right supports**, such as high-quality instructional materials that center relevancy for students, sufficient time to develop rich math lessons (especially in the elementary context), professional development to feel better prepared to implement high quality and relevant instruction that leverages technology as a tool rather than a crutch, and an assurance that such supports will be offered to all classrooms and districts and not just the more affluent ones.
- **Student and teacher mindsets may need to shift** in a way that encourages having a growth mentality and productive struggle in the math classroom, where students shift from a place of fear to one of inquiry and exploration and teachers build systems of comfort and support.

Practitioners also shared thoughts about contextual factors they see as likely to limit the modernization of math. By being aware of these factors early on, there is more possibility to solve for them.

Attention will be required for the contexts below or a modernized learning context is more likely to remain out of reach:

The Politization Of Education	"I would love to see politics stay out of math instruction. This would allow teachers to teach. Do we need a structure for each grade level – yes but allow teachers to teach for their students. After all, they are the reason we are teaching. I think many forget that reason. Students and teachers need to feel successful. Then, maybe we would not have a teacher shortage." – Elementary School Teacher, Illinois, Public School
Testing And Standards Driving Education	"We need to change and update the standards to make it essential to think differently about how we learn and do mathematics and directly train teachers in how to achieve new, modernized standards." High School Math Teacher, California, Public School
Degree Of Teacher Involvement And Trust	"I would like to see school districts have their teachers help with the decision-making with regard to which programs are being used. So many districts no longer use shared decision making and consider what teachers' thoughts are about new programs or changing programs." - Elementary School Teacher, New York, Public School



OVERVIEW

STUDY PURPOSE & CONTEXT

How do educators define a modernized math learning context and how does it relate to their day-to-day lived experiences as math practitioners? What are the contexts and enabling conditions that will most affect the math classroom of tomorrow?

ResultsLab partnered with Substantial to conduct a rapid study. Emergent findings from this study will help inform Substantial's design of their teacher workshop series and outcomes around how organizations may support the modernization of math in the United States.

Pre-study explorations through Slack focused on the perspectives of math teachers and coaches to center the ideas of those most proximate first, asking them a limited set of categorical and open-ended questions to start uncovering how they might envision a future math learning context. This initial data helped guide development of the instrument that guided the next phase of the study, our online journal.

The online journal captured more depth and breadth of data, by asking practitioners to reflect further on what they'd envision a modern math classroom is like and what enabling or inhibiting conditions might influence getting to that vision. Finally, the summation of findings were shared with Substantial for their integration and triangulation based on additional data they captured with teachers at their workshops.

*Please *see Appendix A for additional methodology details and participant demographics.*

PHASE I ELIGIBILITY

Who was eligible to participate in Phase I of the study?

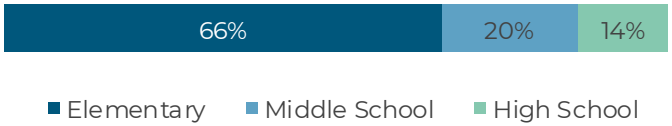
Math teachers and instructional coaches, serving majority underserved students, from all grade bands and states, were invited to engage in Phase I of this study.

Of our study participants:

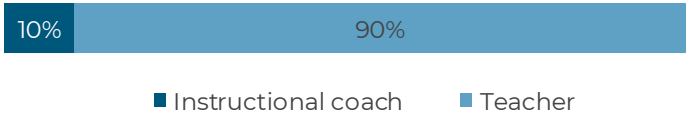
- Most (66%) work at elementary schools.
- Nearly all (90%) are teachers, rather than instructional coaches.

Additional information about the distribution of respondents can be found in Appendix A .

Study Participants by Grade Band Worked With Most Frequently (n=153)



Study Participants by Role (n=153)



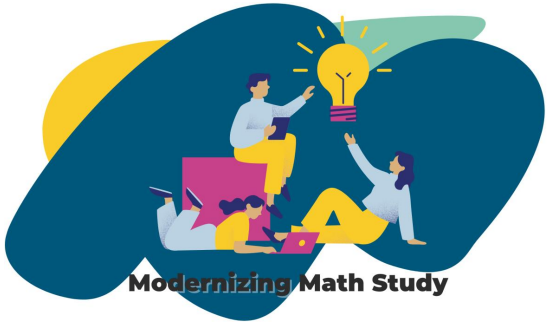
PHASE I ENGAGEMENT

How many people engaged in Phase I of the study?

In July 2023, this study began with an exploration of practitioner perceptions of the modern math learning context through a two-question pulse check survey in our closed Slack channel. Insights from the pulse check data helped inform the development of our next instrument, an online journal comprised of multi-select and open-ended questions. Eligible math teachers and instructional coaches were invited to engage in Phase I of the study by completing the online journal.

Of the 210 people who expressed interest to participate, 145 participants were eligible and submitted online journal responses. The online journal took participants approximately 30 minutes to complete and respondents received an incentive of $50 to Amazon or PayPal in appreciation for their time. The following slides detail the analysis of qualitative findings from the online journal.

PHASE	APPROACH
Pre-Study: July 2023	Slack Pulse Check Questions to refine instrument framing for Phase I inquiries
Phase I: July 2023	Collect insights useful for the Substantial team's planning of teacher workshops taking place in August 2023; Center exploration on the day-to-day lived experiences of math practitioners
Phase II: TBD	Round out community insights for Substantial's Modernizing Math work that center on contexts and enabling conditions for modernizing math in the United States



DETAILED FINDINGS

ENVISIONING THE MODERN MATH LEARNING CONTEXT

"We really need to think about what we are wanting students to learn on their own, versus what they can complete using all of the tools that are available to them. We are still using the past approach of all students need to learn this, when in reality the tools at our fingertips can be a huge asset for many, especially those that are struggling."

-Middle School Math Teacher, Wisconsin, Public School

The Following Section Highlights:

- Practitioner visions for an ideal math learning context ten years in the future
- Priorities of where practitioners think efforts should be invested to effectively modernize math

Key Take-Aways:

1. The **ideal math classroom** of the future is **hands-on**, engaging, collaborative, and grounded in relevant context.
2. The most **relevant and feasible ways of modernizing** the math learning context include:
    - Student-centered learning
    - Blended-learning: classroom and tech integration
    - More sense of relevance
    - Scaffolded and differentiated learning
    - Exploring math concepts more visually and dynamically
3. **Barriers to modernizing math** center around the need for improved diagnostics, a sense of belonging in math, project-based learning, cross-subject integration, and a focus on social-emotional learning competencies.

When describing the ideal math classroom ten years in the future, practitioners most frequently envisioned a hands-on, engaging, collaborative, and relevant environment.

Thinking tactically about how to get to a modernized math classroom, we asked practitioners to sort a list of traits they'd like to see implemented based on their perceived importance and feasibility. This can help identify where might be strong places to direct further research and development efforts.

The visual below was populated based on the top 5 traits practitioners organized into each quadrant.

RELEVANCE

HIGH RELEVANCE & LOW FEASIBILITY • Improved diagnostics • More sense of belonging • Project-based learning • Integration of math with other subjects • Social-emotional learning	**HIGH RELEVANCE & HIGH FEASIBILITY** • Student-centered learning • Blended-learning • More sense of relevance • Scaffolded and differentiated learning • Exploring math concepts more visually and dynamically
LOW RELEVANCE & LOW FEASIBILITY • Content that aligns with after school clubs • Flexible seating in the classroom • Gamification of learning • Social-emotional learning • More sense of belonging	**LOW RELEVANCE & HIGH FEASIBILITY** • Flexible seating in the classroom • Technology and use of digital manipulatives • Gamification of learning • Content that aligns with after school clubs • More emphasis on peer-to-peer collaboration and group work

FEASIBILITY

The top right quadrant represents the traits practitioners feel would be highly relevant and feasible to implement in a modern math classroom. These areas would be a natural point of lift off for further exploration.

The visual below was populated based on the top 5 traits practitioners organized into each quadrant.

RELEVANCE

HIGH RELEVANCE & LOW FEASIBILITY • Improved diagnostics • More sense of belonging • Project-based learning • Integration of math with other subjects • Social-emotional learning	**HIGH RELEVANCE & HIGH FEASIBILITY** • Student-centered learning • Blended-learning: classroom and tech integration • More sense of relevance • Scaffolded and differentiated learning • Exploring math concepts more visually and dynamically
LOW RELEVANCE & LOW FEASIBILITY • Content that aligns with after school clubs • Flexible seating in the classroom • Gamification of learning • Social-emotional learning • More sense of belonging	**LOW RELEVANCE & HIGH FEASIBILITY** • Flexible seating in the classroom • Technology and use of digital manipulatives • Gamification of learning • Content that aligns with after school clubs • More emphasis on peer-to-peer collaboration and group work

FEASIBILITY

Additionally, the ideas that practitioners identified as highly relevant, but less feasible are in the top left quadrant. In comparison to other quadrants, barriers in high relevance, low feasibility have a systems-based theme.

The visual below was populated based on the top 5 traits practitioners organized into each quadrant.

RELEVANCE

HIGH RELEVANCE & LOW FEASIBILITY	HIGH RELEVANCE & HIGH FEASIBILITY
• Improved diagnostics • More sense of belonging • Project-based learning • Integration of math with other subjects • Social-emotional learning	• Student-centered learning • Blended-learning • More sense of relevance • Scaffolded and differentiated learning • Exploring math concepts more visually and dynamically
LOW RELEVANCE & LOW FEASIBILITY	**LOW RELEVANCE & HIGH FEASIBILITY**
• Content that aligns with after school clubs • Flexible seating in the classroom • Gamification of learning • Social-emotional learning • More sense of belonging	• Flexible seating in the classroom • Technology and use of digital manipulatives • Gamification of learning • Content that aligns with after school clubs • More emphasis on peer-to-peer collaboration and group work

FEASIBILITY

High Relevance, Low Feasibility: Many of the barriers that make some of the relevant ideas feel infeasible to implement are systemic and difficult to influence.

Factors Contributing to Infeasibility	Proposed Solutions
Improved diagnostics • Insufficient time available to analyze existing diagnostic data and differentiate instruction accordingly	• Give teachers more spaciousness in their schedules • Develop and improve adaptive learning systems that leverage diagnostic data and can tailor instruction to individual student needs and pace of learning • Tap academic coaches and paraprofessionals for added capacity in the classroom
More sense of belonging • Not all math concepts lend themselves as well to real life application or to students' interests and identities (e.g., Calculus)	• No solutions proposed
Project-based learning • Doesn't lend well to application across all grade levels (e.g., K and 1st) • Can be challenging to implement when there are students of all levels in a class and if there are behavior management issues in the class	• Demonstrate how to do this and do it well across various grade levels, math concepts, and for students of different levels
Integration of math with other subjects • Insufficient time to plan and collaborate with other teachers across subjects • Would need to consider entirely restructuring how subjects are taught to infuse concepts more fluidly across other subjects	• Provide teachers more spaciousness in their schedules for collaboration and planning across subjects • Explore integration of learning across subjects so that subjects aren't taught separately in the future
Social-emotional learning • Lack of buy-in from administration and school leaders • Insufficient to incorporate SEL in math class, need to be implemented across subjects • Insufficient time to incorporate SEL	• Change mindsets and build buy in with school leaders on the importance of SEL • Professional development about SEL for teachers • Consistent incorporation across subjects

DEFINING THE MODERN MATH LEARNING CONTEXT

"All students should feel good about learning. Students do need to learn the basics but they also need to be able to know where to look for those answers. They need to be allowed to ***search for creative solutions*** *to problems.."*

-Middle School Math Teacher, Massachusetts, Public School

The Following Section Highlights:

- Practitioner perceptions of how they want **students to feel** in the modern math learning context and how this can be cultivated
- How **student identities can be embraced** in the math classroom of the future
- How a modern math learning environment can help **students be motivated, engaged, and persistent**

Key Take-Aways:

1. **More Engagement:** Many practitioners share want their students to feel engaged, inspired, having, fun and curious as well as empowered and that their voices are valued
2. **Facilitating an Intentional Classroom Culture:** Math practitioners can support student identities by encouraging students to be themselves, encouraging a growth mindset and productive struggle, and building a sense of community in the classroom of supporting one another, listening, respect, and celebrating accomplishments.

What makes these traits feel hard to feasibly implement in the math classroom? How might we overcome these barriers?

"The current curriculums that districts are using are not structured to make those concepts feasible. ***Overcoming the barriers would require a complete curricular overhaul*** *of the current pedagogy."*

-Elementary School Teacher, Iowa, Public School

*"****More exposure to schools and classrooms where these things are occurring with populations that look like ours,*** *more hands-on* ***professional development*** *designed to help us implement these things with fidelity and* ***administrative support*** *to maintain the implementation."*

-High School Math Teacher, Illinois, Public School

*"****Content that reflects diversity-*** *as teachers we are given specific curriculum to teach, and in some districts cannot veer from the curriculum at all. We would not be able to modify the lessons and content to align with students in our classrooms."*

-Elementary School Math Teacher, Nevada, Public School

"Model classes and support systems as well as ***opportunities to observe these strategies in practice*** *and debrief with others would be a huge way to overcome these barriers."*

-High School Math Teacher, Tennessee, Public School

How might you envision students feel in a math classroom of the future? What do teachers, school, curriculum, supplements, technology do to cultivate these feelings?

Desired Student Feelings in the Modern Math Classroom (n=153)

These Feelings Can be Cultivated By... (n=117)

- Emphasizing the **relevancy** of the math students are learning (33%)
- Using supplements, like digital tools and physical manipulatives, to make math more **hands on**, **interactive**, and **fun** (32%)
- Meeting students where they are by **differentiating** learning (28%)
- Implementing **standards-aligned**, **well-designed curriculum** that supports teachers and centers student experiences (24%)
- Fostering a **safe, inclusive, welcoming, culturally-friendly, supportive environment** (19%)
- Encouraging **student-led and -centered** instruction that values agency (14%)
- Using **adaptive methods** for individual, small, group and whole-group engagement (10%)
- Sharing a **love of learning** and passion for math (9%)
- Establishing a classroom environment that normalizes **making mistakes as a necessary part of learning** and growing (9%)

How might you envision students feel in a math classroom of the future? What do teachers, school, curriculum, supplements, technology do to cultivate these feelings?

*"As a math instructor, I picture students in the classroom of the future as **self-assured, inquisitive, and interested**. They would be thrilled to attend math class every day because they would **feel like they are a member of a community of learners**."*

-Elementary School Teacher, South Carolina, Public School

*"I envision a math classroom that is **engaging** and **adaptive for all math students**. One where students feel they belong and are confident in their math skills. I know Covid really put a great deal of hindrance on students and their math skill levels and I would love to see an even playing field again, where **all students feel supported and confident**. I do think we need more training with the diverse needs of our students. I want them to feel **comfortable around their peers and are open to collaboration** and working together."*

-Middle School Math Teacher, Pennsylvania, Public School

*"**Inspired** and **engaged**. This could be achieved by teachers having access to curriculum that is clear and coherent as well as differentiated so that every student has access to content and feels successful mastering basic skills which allows them to engage in creative problem solving and critical thinking that connects math to the world around them. I believe this also requires a narrowing and deepening of what content gets taught. Currently there are far too many content standards to make this kind of learning feasible. Ideally there would be about half as many standards and each one could be addressed deeply and purposefully.*

-High School Math Teacher, Washington, Charter School

How might you envision *student identities* being embraced, celebrated, supported, etc. in a math classroom of the future? n=148

Intentional classroom climate and culture: 42%	**Other common responses for embracing, celebrating, and supporting student identities:**
Classroom Culture Mechanisms: • Embracing and acknowledging student identities by encouraging students to be themselves, meeting students where they are, and celebrating their backgrounds and strengths • Facilitating growth mindset with students by making the classroom a space where they can take risks, ask questions, engage in productive struggle and be celebrated for their efforts and accomplishments, • Developing a sense of community in the classroom where students support one another, listen and share, respect and celebrate their peers, and embrace social-emotional learning competencies • Building math identities where students see that all people can be math people, everyone is welcome in the math classroom, and math can be beneficial to all	• **29%:** Present math in a **relatable context** for students by including real-life examples, aligning content with their interests, using technology and games, and integrating families and cultural values • **27%:** Ensuring **instruction is representative** through word problems and examples in the curriculum that feature diverse students (including special needs students) and cultures, presenting content in multiple languages, ensuring characters in videos look like them, sharing examples of math in different cultures, and highlighting diverse math figures and guest visitors • **12%:** Utilizing **differentiation** such as scaffolding, blended activities and engagement formats to meet different learning needs, and including specific supports for ELL and special needs students • **10%:** Building a **student-centered learning context** where students advocate, share their voices, take ownership of their learning, and share their methods and accomplishments • **9%:** Embracing **group work** for students to learn along side one another through flexible seating, **collaboration**, and supporting one another's learning

**Note: Responses do not total 100% because some fell into multiple codes and others lacked context to be categorized*

How might you envision *student identities* being embraced, celebrated, supported, etc. in a math classroom of the future? cont.

"Teachers would be aware of the different identities that students bring to the classroom, such as their race, ethnicity, gender, socioeconomic status, and learning style. They would use this knowledge to create a classroom environment where all students feel welcome and valued … Math activities would be designed to be open-ended and allow students to use their own creativity and problem-solving skills. This would help students to see that math is not just about memorizing formulas, but about using their own unique perspectives to solve problems."

-Elementary School Teacher, South Carolina, Public School

"Student "identities" can be respected, but I don't think they need to be "celebrated" in a classroom, especially math. JUST TEACH. Stop with the need to be this talon own classroom and start focusing on how kids can actually be competitive in a global marketplace and be contributing members of a global society."

-Middle School Math Teacher, New Jersey, Public School

How might you envision a learning context *motivating*, *engaging*, and *encouraging students to persist* in a math classroom of the future? n=151*

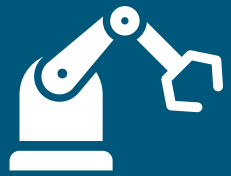
Practitioners shared reflections on how practitioners might facilitate student motivation, engagement, and persistence (MEP) in a math classroom of the future.

1. **Celebrate student success** (big and small, progress and attainment) and provide students alternative avenues to demonstrate what they've learned beyond standardized testing and typical methods of grading.
2. Build and maintain a positive and safe learning environment that incorporates **social emotional learning** and embraces a **trial-and-error** approach to learning.
3. Promote a **growth mindset** in the classroom that reinforces that every student can do math.
4. Take the time to get to know the students and leverages **assessments** to understand where students are along their math attainment journey. Differentiate lesson content accordingly to meet each student's individual learning needs (i.e., address learning loss or offer more challenge) and offer different modalities for learning so students can learn in a way that works for them.
5. Develop, choose, or customize curriculum, supplements, and classroom instruction to promote the **relevance** of mathematical concepts in a way that ties the math they're learning to real life and that promotes belonging by appealing to students' interests and learning styles.
6. Provide classroom instruction that is **student centered**, student driven, and feature elements of **student choice** to improve buy in and motivate students to engage in their learning.
7. Encourage **flexible thinking** and the belief that there are multiple paths to learning math and solving problems.
8. Infuse instructional methods and supplements to make learning more **interactive** and **interesting.**

* This question aims to relate the modernizing math body of work to existing explorations to understand and better facilitate Motivation, Engagement, and Persistence (MEP) in the Math Classroom.

The resultant framework is a draft representation of how the themes emerged from this question. The Substantial team may consider diving deeper into this framework and pressure-testing it with practitioners in upcoming workshops.

For additional supporting content of this framework, please see Appendix B.



LEVERS FOR REFINING MATH LEARNING EXPERIENCES

"We are at a critical junction in education where we will make strides to make changes in the profession that will affect our learners for decades. Math instruction in the future improves and moves the proverbial needle of achievement for learners with enhanced instructional methods, higher quality technology usage and availability, and recruiting a new generation of teachers that will help students with attaining math achievements."

-Middle School Math Coach, New Jersey, Public School

The Following Section Highlights:

- Practitioner views on where to prioritize refinements to math infrastructure
- Concrete feedback for improvements that could be made to instructional materials, assessments, and diagnostics

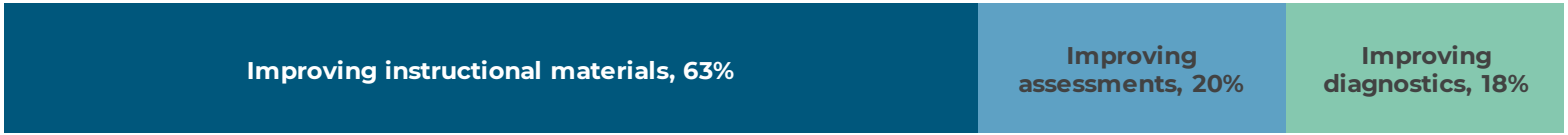
Key Take-Aways:

1. **Focus on improving instructional materials**: More than half (63%) of practitioners prioritize refining instructional materials over assessments and diagnostics to improve the modern math learning context.
2. **Ways to Improve Instructional Materials:** By ensuring instructional materials are relevant to learners, provide differentiation and scaffolding, and include manipulatives and technology integration, practitioners anticipate that higher student engagement and building a love for math will become possible.

Practitioners shared their perspectives on which topical area of development would be most a most valuable area to modernize in the math classroom.

While there was interest in all three topics, by far practitioners think improving **instructional materials** are top priority. The following slides will take a closer examination of what practitioners think it could look like to improve each of these three topics for a modern math classroom.

Which of the following topics feels the highest priority to address to modernize math effectively and efficiently? (N=153)



Practitioners were then asked to provide additional details around how either instructional materials, assessments, or diagnostics could be improved. The following slides in this section detail ideas for improvement and what will outcomes might be possible if these changes are made.

Practitioners identified that in a modern math classroom, instructional materials need to be more relevant, curriculums need to be updated, more use of hands-on instruction and manipulatives, and intentional integration of education with technology.

What kinds of updates do you think are needed to make instructional materials more modern? (N=96)

32% Relevancy: Instructional materials need updating to center on real-world situations that students can relate to, are age appropriate, and are aligned to their interests	**23% Technology Integration**: Instructional material updates require a more intentional integration of technology into the learning experience. This requires access to technology tools like computers or iPads as well as digital learning platforms that can be used across devices and browsers, and access to high quality digital products	**10% Teacher Supports**: Beyond updating curriculums and materials, teachers need training in how to differentiate instruction, use data to adjust, and have access to pacing guides and supports for modifying approach to meet the unique needs of learners.
31% Differentiation and Scaffolding: There needs to be more intentional attention to differentiation and scaffolding supports for practitioners in curriculums and instructional materials including how to address unfinished learning, building upon what students already know, and mechanisms for students to work at their own pace and in alignment with their level of mastery	**16% Standards and Assessments**: Practitioners identified a need for a reworking of standards and assessments to ensure better alignment with curriculum and materials. Here standards need to be communicated to students along with how they will support learning goals and materials must be aligned to standards and assessments, and standards should be paired back to focus on what is essential for each grade level.	**7% Understanding over Memorization**: Practitioners cited wanting to see instructional materials ground learning in project-based work to build towards understanding and comprehension and movement away from memorization
24% Use of Manipulatives: Instructional materials need to integrate manipulatives into instruction that allow students hands-on learning, fun learning in a real-world context, kinetic learning, and collaboration in peer groups	**10% Identities**: Instructional materials need to integrate student identities through attention representation in their visuals, problems, and contexts and ensuring concepts are relevant through cultural responsiveness	**4% Alignment**: Beyond instructional material updates, practitioners mentioned wanting to see more intentional alignment between instruction, digital tools, physical manipulatives, homework, and standards and reported a sense of disjointedness

Note: Themes presented in decreasing order of frequency.

With changes to instructional materials, practitioners identified that it will become possible for students stay engaged, see their own growth and success, build a love for math, and understand how content will be useful.

"Students are able to experience a real growth mindset because they know it's a marathon, not a sprint. They understand that they can accomplish any task because they can see the relevance to their own life in the work.."

-Elementary School Teacher, Michigan, Public School

"Students have gained the literacy written and with technology to seamlessly switch back and forth and be able to feel comfortable with what methods work best for them."

-Middle School Math Teacher, California, Charter School

"Teachers feel free to teach across contexts, students understand how to use math outside of the classroom, students become critical thinkers rather than regurgitating information."

-High School Math Teacher, Georgia, Public School

"True conceptual understanding and full engagement."

-Elementary School Teacher, Mississippi, Public School

"Students become more invested in their learning because they are interested in it and will have an end result to present."

-Middle School Math Teacher, Vermont, Public School

"By reducing the number of content standards, teachers can spend more time deepening learning and helping students build real-world problem-solving skills with relevant applications."

-High School Math Teacher, Washington, Charter School

Practitioners proposed changes to what assessments capture, how frequently they're conducted, and how they are structured and conducted to help support a modernized math learning context.

How do you envision math assessments being modernized or refined in the future? n=30

60% **Adjustments to the content assessments measure**: Assessments need to measure what matters most – what students truly know about concepts and problem-solving skills that students are learning. Focus should shift from solutions to examining the strategy a student used to solve the problem. Assessments should measure growth and progress rather than discrete achievement.	13% **Reevaluation of how assessments are used:** Assessments should be technology-enabled and able to provide immediate feedback so that the teacher can use this real-time data to individualize and differentiate learning.
40% **Incorporation of new, modification of existing assessment features:** Teachers suggest assessments should be made more relevant by infusing real-world problem solving and by making content more relevant to students' own lives. They also suggest that assessments be more individualized, so they set students up for success in demonstrating progress if they are behind. Assessments should be shorter, simplified, and there is opportunity to explore incorporating elements of gamification and project-based learning.	7% **Adjustments to the frequency of assessments**: Teachers proposed fewer state and standardized assessments and more frequent micro-assessments to track progress and adjust instruction as needed. If there are fewer standardized exams to teach to, some of the urgency teachers feel will be lifted and they can spend more time meeting students individual learning needs and helping students toward deeper mastery.

Note: Themes presented in decreasing order of frequency.

Practitioners identified that diagnostic tools need to provide teachers a clear path to scaffold and differentiate instruction in the modern math classroom.

How could modern diagnostics better help teachers inform their instructional practice? n=27*

Across respondents, strong themes emerged about the ways in which modern diagnostics could better inform instructional practice in a math classroom of the future by…

1. Understanding Individual Learner Needs: Providing teachers an accurate picture of what each student understands well and where they need additional attention. When a teacher understands what students understand well, they can "borrow" time from what they had been planning on teaching about that content area and reallocate that time on the student's areas of greater need. Teachers also expressed that in a future math class, optimally, these diagnostic tools should be easily incorporated into their classroom and not another thing to have to teach to or spend too much time incorporating into their already busy agenda.	**3. Building Customized Learning Plans:** Generating a suggested path for each student based off their unique data. This would create efficiency and streamline planning for instruction because the teacher could use the suggested path as a launching off point and then customize as needed from there.
2. Planning for Skills-Aligned Focus Time: Providing data to inform what classes and groups within classes students are placed into. When there is a big spread of understanding across students, it is less likely that a teacher will be able to individualize and scaffold learning. If students can be placed into skill-based classes and groups within classes, it reduces the extra time teachers would need to spend scaffolding for each student so the teacher could scaffold for groups instead and be spread less thin.	**4. Guiding Future Instruction:** Providing data to drive teachers' decisions about how they should prioritize their instructional delivery - when they should employ group work, independent work, and peer-to-peer work as well as offering a source of data to inform how well students are learning and how they may need to improve their instruction.

* Note: Themes presented in decreasing order of frequency.

If assessments are improved in a modern math classroom, practitioners suggest the effect will include positive effects on their instructional practice and improved mental health conditions for both students and teachers.

What becomes possible in the modern math classroom if these changes to assessments are made? n=30

1 More individualized instruction:

- Students will experience, and teachers will have the time and information needed facilitate individualized instruction that includes the right scaffolds and curriculum adjustments needed to support all students in a class.

2 Emphasis of process over solution:

- Students will learn that the process and strategies they learn to solve problems is more important than finding the right solution. Through this, they will develop critical thinking and problem-solving skills they can carry with them through other areas of their life.

3 Reduced stress for students:

- Students feel less test-related stress when they can focus less on tests and more on progress toward their own goals.

4 Reduced pressure for teachers:

- Teachers will feel less pressure to teach at an unreasonably fast pace to standards and can teach more deeply and scaffold instruction.

5 Increased excitement:

- Students will feel more excited about their learning.

6 Increased comfort with assessments:

- Students will feel more comfortable with assessments because they are more relevant to their life.

7 Increased comfort with taking risks:

- Students will become more comfortable with taking risks and making mistakes because they understand they are a necessary part of the learning process and are opportunities to grow.

Note: Themes presented in decreasing order of frequency.

If diagnostic tools are modernized or refined, students, teachers, and classrooms are likely to experience a range of positive psychological and academic outcomes.

What becomes possible in the modern math classroom with these changes to diagnostics? n=27

Practitioners proposed the following possible outcomes that might be possible if diagnostics are modernized and refined in the future:

Student-Level Outcomes:	• Students' learning needs are better met due to individualized instruction. • Students will experience relative competitiveness by learning in a group of students at a similar level to them.. • Students become more likely to achieve their full potential in math.
Teacher-Level Outcomes:	• Teachers will feel more confident in their instruction because they have data supporting their interventions. • Teachers would have more tools at their disposal. • Teachers would be better able to address needs and gaps in real-time. • Teachers would be better able to keep the rigor of instruction high.
Classroom-Level Outcome:	• The math classroom would become more student-centered.

"This may allow for better placement into classes. Our middle school has a pass all students policy so we have a large academic variety of students in our freshman classes currently making it difficult to address all needs when skills are all over the place."

-High School Math Teacher, Ohio, Public School

PATHWAYS FORWARD

"I think a lot of the issues in math instruction stem from district leaders and curriculum developers being so far removed from actual classroom application. They're not dealing with the students, they're not seeing it in real life. There's so many political and personal agendas as well as private sales and benefits that go into the district side that it seems like a tainted system by the time it reaches the classroom."

-Elementary School Teacher, Illinois, Public School

The Following Section Highlights:

- Barriers to modernizing the math classroom and those which practitioners feel are the most important and feasible to address
- An awareness that modernizing math requires attention to the systems that math exists within

Key Take-Aways:

1. Barriers limiting progress in the modern math learning context that practitioners feel are the most important and feasible to address include improving **access to high-quality instructional materials**, **technology infrastructure**, and modern math learning tools like **digital learning products** as well as dedicated efforts to **building math mindsets** among students
2. Math cannot be modernized unless we **acknowledge that there are systemic structures in place that limit advancement** such as the ongoing politization of education, how testing and standards drive the field, and the perceptions among teachers that their professional discretion is not trusted not adequately tapped

After reflecting on potential barriers to modernizing the math classroom, the practitioners sorted the list of barriers according to their perception of each suggestion's importance and feasibility.

IMPORATNCE

FEASIBILITY

HIGH IMPORTANCE & LOW FEASIBILITY • Shortage of quality math teachers • Retraining experienced teachers on new ways of teaching math • Practitioner fatigue with changes for reform and innovation • K-12 is a multilayered system with decision points at various levels • Teachers coming out of college or teacher prep programs underprepared	**HIGH IMPORTANCE & HIGH FEASIBILITY** • Lack of access to high-quality instructional materials or curriculum • Lack of access to technology infrastructure • Lack of access to modern math learning tool s like digital learning products • Lack of culture of positive math mindsets among teachers, students, and caregivers • Lack of resources (time, financial, etc.) for adequate professional development
LOW IMPORTANCE & LOW FEASIBILITY • Competing views on math ed approaches between traditionalists and progressives • Education implementation influenced by politics and ideology • Fear of advancement of technology (i.e., AI) • Standards/common core that frames what students should achieve without guidance on how teachers can help get them there • Teachers coming out of college or teacher prep programs underprepared	**LOW IMPORTANCE & HIGH FEASIBILITY** • Fear of advancement of technology (i.e., AI) • Standards/common core that frames what students should achieve without guidance on how teachers can help get them there • Education implementation influenced by politics and ideology • Practitioner fatigue with changes for reform and innovation • K-12 as a multilayered system with decision points at each level

According to practitioners, the key to modernized math learning contexts is having sufficient awareness of the system's complexity, the necessary inputs for modernization, systemic structures limiting advancement, and needed changes to fundamental thinking in education.

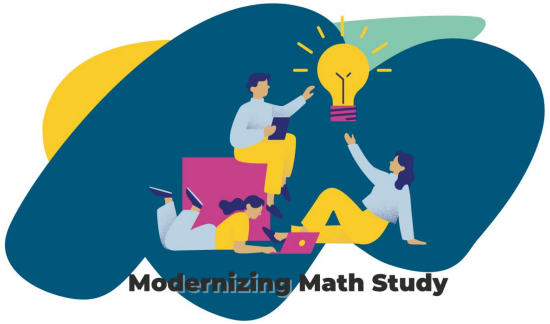
To effectively modernize math:

- **Instructional content needs to be more relevant, center each student's needs, and promote student agency**. This can look like using technology to provide students individualized support, building lessons that draw on student's interests and experiences, and students having more of a say in how they learn in the math classroom.
- **Teachers need the right supports**, such as high-quality instructional materials that center relevancy for students, sufficient time to develop rich math lessons (especially in the elementary context), professional development to feel better prepared to implement high quality and relevant instruction that leverages technology as a tool rather than a crutch, and an assurance that such supports will be offered to all classrooms and districts and not just the more affluent ones.
- **Student and teacher mindsets may need to shift** in a way that encourages having a growth mindset and productive struggle in the math classroom, where students shift from a place of fear to one of inquiry and exploration and teachers build systems of comfort and support.

Practitioners also shared thoughts about contextual factors they see as likely to limit the modernization of math. By being aware of these factors early on, there is more possibility to solve for them.

Attention will be required for the contexts below or a modernized learning context is more likely to remain out of reach:

The Politization Of Education	"I would love to see politics stay out of math instruction. This would allow teachers to teach. Do we need a structure for each grade level – yes but allow teachers to teach for their students. After all, they are the reason we are teaching. I think many forget that reason. Students and teachers need to feel successful. Then, maybe we would not have a teacher shortage." – Elementary School Teacher, Illinois, Public School
Testing And Standards Driving Education	"We need to change and update the standards to make it essential to think differently about how we learn and do mathematics and directly train teachers in how to achieve new, modernized standards." - High School Math Teacher, California, Public School
Degree Of Teacher Involvement And Trust	"I would like to see school districts have their teachers help with the decision-making with regard to which programs are being used. So many districts no longer use shared decision making and consider what teachers' thoughts are about new programs or changing programs." - Elementary School Teacher, New York, Public School



APPENDIX A | Methodology

STUDY APPROACH | Learning Questions

Phase I: Online Journal (COMPLETE)

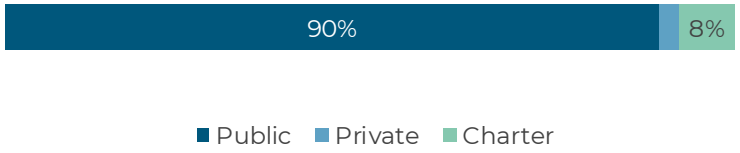
- How do practitioners define a futuristic or modernized math learning context?
  - How is it different from today's math classroom? Beyond technology, what factors contribute to modernized math?
- How are math practitioners thinking about the modernized math learning context? How do they envision it looking five years from now? 10 years from now?
  - How might a modernized math learning context motivate, engage, and encourage students to persist?
  - What content do practitioners feel is most important to cover in a modernized math learning context?
- To what extent do teacher's perceptions of day-to-day lived experiences and teaching practices shape perceptions of what a modernized math learning context might entail?
  - How might refinements to math assessments, instructional materials, and diagnostic tools help meet current math learning context challenges?

Phase II: In-Depth Interviews or Focus Group Discussions (POTENTIALLY FALL 23)

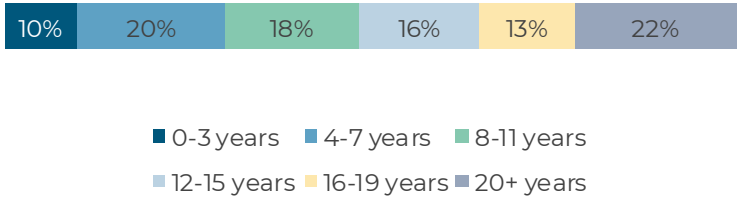
- What current factors in the math learning landscape are biggest barriers to delivering upon a modernized math learning context?
- What are the enabling conditions that have the most potential for helping to modernize the math learning context?

STUDY APPROACH | Participant Demographics

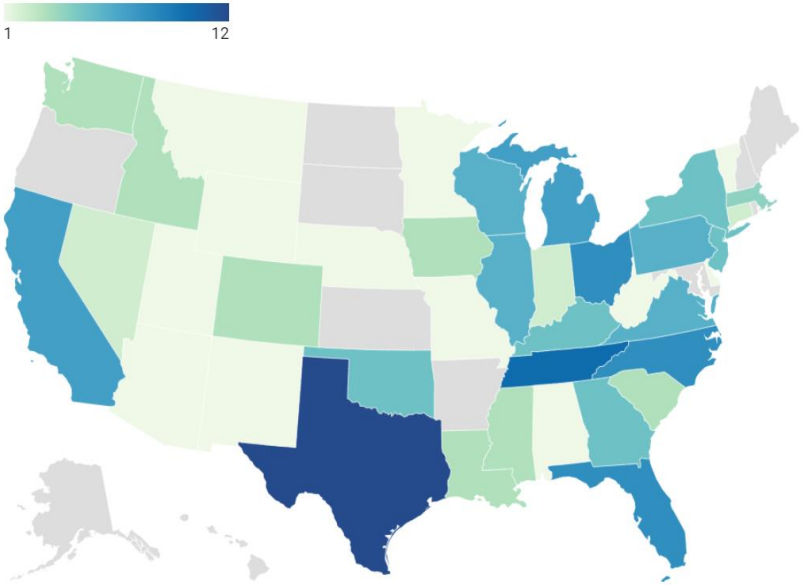
Study Participants by School Type (n=153)



Study Participants by Years in Current Role (n=153)

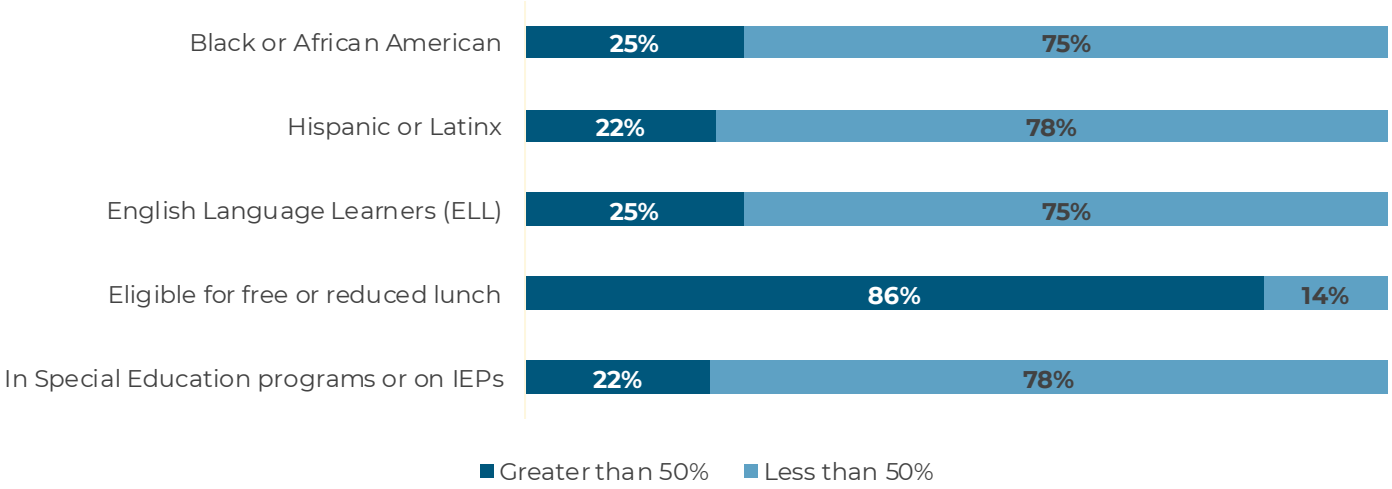


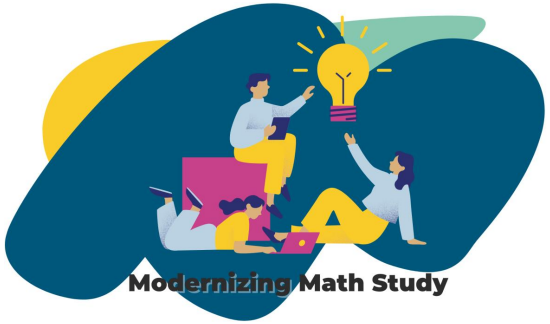
Modernizing Math Study Participants by State (n=153)



STUDY APPROACH | Participant Demographics

Study Participants Working with Student Populations at or above 50% by Demographic Group (n=153)





APPENDIX B | Modernizing Math and the Motivation, Engagement, & Persistence Framework

1 Celebrate student **success** (big and small, progress and attainment) and provide students alternative avenues to demonstrate what they've learned beyond standardized testing and typical methods of grading.

Re-thinking grading	Re-Think Assessments	Deepen in on Goal Setting
• Shift focus from working toward earning scores/grades to working toward mastery in way that emphasizes the process over the solution to improve persistence in the math classroom. • Expand the domains that teachers grade students on in a way that celebrates effort as well as ultimate success. Students are graded for their effort, their commitment to persevering through trouble spots, for their ability to explain and demonstrate their thought process, for their willingness to try again with a different method once given support.	• Rather than being the end goal students are working toward, assessments are for teachers to gauge student understanding of mathematical concepts to be able to differentiate instruction accordingly. • Consider alternative assessments like project-based or presentations to give students the opportunity to showcase their math skills and feel self-assured and believe in their abilities instead of testing. Extends the relevance of math and increases the rigor of the data used to track progress toward mastery.	• Shepard all students toward the standards but be prepared to identify individualized learning goals that drive toward those standards, underscoring what students gain by achieving them. Students will be more likely to persist when they feel like they are making progress and achieving successes, even if they are still behind where others are in the class. • Facilitate each student in exploring and attaining math skills on their own learning path that addresses their unique needs and goals. When students are engaged more closely in constructing their learning path, they will feel more bought into their learning and become more likely to persist. • Support students in accepting their learning journey and encourage them to not compare their progress to others'. By trusting their path and not comparing their path to others', they will retain confidence, motivation, and be more likely to persist. • Provide timely and actionable feedback in support of helping students make progress toward their learning goals, which leads to students feeling more motivated and willing to continue engaging with their learning. • Work closely with students' families to provide guidance on how to reinforce perseverance toward student goals in the home environment.

2 Build and maintain a positive and safe learning environment that incorporates **social emotional learning** and embraces a **trial-and-error** approach to learning.

- Incorporate social emotional learning in the math classroom and explicitly teach students how to cope with frustration and failure and encourage them to persevere. Help students feel more comfortable experiencing and coping with a full spectrum of emotions they may experience in the classroom and comfort with discomfort in learning new things. By learning these skills, students will be more likely to persist.
- Establish a culture of learning in the classroom where it is normal to make mistakes. Hold the entire class responsible for upholding an environment that feels psychologically and socially safe, where students can feel comfortable trying and, potentially, failing without fear of embarrassment. These conditions will make students more likely to engage in their learning in the math classroom.
- Leverage strong rapport with students to help build their confidence in the math classroom and encourage them to persist knowing they have someone trusted in their corner to help them.

3

Promote a **growth mindset** in the classroom that establishes and reinforces that every student can do math even if they have intrinsic or extrinsic influences otherwise (i.e., at home student hears caregiver talk about that they were bad at math when they were in school).

"Continuing to work on growth mindset and transitioning from grading to just mastery-based learning would impact students' persistence SO much. So many of my students tell me "well my mom is bad at math so so am I", I grew up hearing if you were good in ELA you probably weren't in math, and you just didn't have a math brain. This concept is so harmful to learning math and supporting growth. [...] The cultural and educational shifts we are seeing will continue and this will be the biggest impact."

- Elementary School Teacher, Illinois, Public School

4

Take the time to get to know each students, leverages assessments to understand where students are along their math attainment journey, **differentiate content and instruction delivery** accordingly.

Differentiating Content	Differentiating Instruction Delivery
• Help students become aware of and embrace their strengths and opportunities and build off them to help students progress. Assessments can be one tool to leverage to identify strengths and opportunities. • Provide students with the appropriate level of challenge - addressing learning loss for those who need it, providing additional challenge for those who need it. • Ensure that content gives students a variety of experiences, some easily attainable for them, others that involve a productive struggle. • Teacher, curriculum, activities identifies and addresses learning loss that's occurred from COVID-cases or otherwise à Students are set up for success by having a point of entry that works for their individual learning path. Students are more likely to persist.	• Teacher's role is to help students understand how they learn best (individual work, partner work, full class work, visual, auditory) à Students will feel more empowered and like they have more agency and ownership of their learning journey à Students are more likely to persist.

5 Develop, choose, or customize curriculum, supplements, and classroom instruction to promote the **relevance** of mathematical concepts in a way that ties the math they're learning to real life and that promotes belonging by appealing to students' interests and unique learning styles.

Relevance by means of integration with other subjects and application to real life scenarios	Relevance by means of appealing to student interests and lives to promote sense of belonging
• Infusing and integrating math with other subjects to increase application. • Fewer "black and white" lessons, more uncovering "they why" of the math that they're teaching . • Making lessons more meaningful and relevant for students in how they can be applied to the real world, like financial topics leads to students understand the importance of what they are learning and make them more likely to persist.	• Lessons featuring people who share characteristics that they do means students improves sense of belonging in the math classroom and makes students more likely to persist. • Framing lessons in a way that makes the math students are learning more relevant to their real lives leads to students being more interested and engaged.

"Knowing how math will impact their future careers, jobs and lifestyles will hopefully motivate students to persist in their learning. I am always being asked, "when am I ever going to use this in my life?"

- Middle School Math Teacher, New Mexico, Public School

"When students can collaborate with other students who are studying the same concept and can view lessons and simulations that feature people who look like them and perhaps struggle like they do (ie students with autism or ADHD may be featured in the simulations/videos), students will more likely feel like they belong and that they can also accomplish the task."

- Elementary School Teacher in Michigan, Public School

6 Provide classroom instruction that is **student-centered**, **student-driven**, and feature elements of **student choice** to improve buy in and motivate students to engage in their learning.

- Position oneself as a facilitator of learning where students are the ones thinking and driving the learning happening. This will increase student buy-in and motivate students in their learning.
- Offer student choices in how they engage with their learning to empower them and improve their engagement with their learning.
- Involve students in goal setting so they have a sense of where they are and where they are going and are bought into the process along the way.

"When students own their learning, then they are motivated to understand better and try harder."

- Middle School Math Teacher, South Carolina, Public School

"Guide the students to figure out how they learn best, such as partner work. Give the students choices for their learning will empower them."

- Elementary School Teacher, California, Charter School

7 Encourage **flexible thinking** and the belief that there are multiple paths to learning math and solving problems.

- Promote different entry points to solving a problem instead of prescribing one way to do math will improve student engagement.
- Allowing and encouraging students to think differently and explain their thinking is empowering, builds student buy-in, and builds their confidence in the math classroom.
- Offering opportunities for collaboration so students can see the variety of different ways their classmates may get to the same solution.

"We need to give students opportunities to work with others and collaborate on math projects and to present their ideas by sharing strategies or ways of thinking. Math is a wonderful subject that allows for a variety of ways to get to correct or viable solutions."

- Elementary School Teacher, Kentucky, Public School

8 Incorporate instructional methods and supplements to make learning more **interactive and interesting.**

- Teacher gives students opportunities to research and share their interests with the rest of the class, which can be motivating for students.
- Infuse activities that are more interactive and fun to improve motivation. Consider activities and lessons that feature:
  - Incentive-based learning
  - Instant gratification
  - Games
  - Manipulatives
  - Healthy competition
  - Technologically enabled activities

"If students are excited, engaged and having fun they will want to learn and be encouraged to learn."

- Elementary School Teacher, Indiana, Charter School

THANK YOU!