



WHAT STUDENTS HAVE TO SAY ABOUT THE BENEFITS OF MAP CLASSROOM CHALLENGES

Surveying the Student Experience

MAP Classroom Challenges (CCs) are designed as high-demand tasks that require students' mathematical engagement through drawing on their previous knowledge, applying what they know to new problems, and thinking conceptually both individually and collectively. By interacting with these problem-oriented explorations, students expand upon existing and construct new mathematical understandings. Using the Classroom Challenges enables teachers to enact what the new Common Core State Standards for Mathematics encourage: opportunities for student involvement in many of the CCSSM mathematical practices such as problem-solving, reasoning, and communicating with one another. These ambitious aims make evident that the over-arching goal of the Classroom Challenges is to transform the nature of the student's experience of learning mathematics.

QUESTIONS ABOUT THE STUDENT EXPERIENCE

The following questions guided the research effort to understand the Classroom Challenges from the perspective of the students who engaged with them.

What is the student experience of using MAP Classroom Challenges?

What do students have to say about the CC approach to teaching and learning mathematics?

Do the Classroom Challenges enable students to become more confident, more articulate, and more skillful in mathematics?

Do the Classroom Challenges indeed provide transformative experiences that affect the way students think about mathematics and do mathematics?

What does the student voice contribute to understanding the impacts of Classroom Challenges?

What is MAP?

The Mathematics Assessment Project (MAP) was a collaborative effort between teams of mathematics educators from the Shell Center for Mathematical Education at the University of Nottingham and from the University of California, Berkeley. The goal of the Mathematics Assessment Project was to design and develop well-engineered, high-quality assessment tools to support teachers and schools in implementing the Common Core State Standards for Mathematics (CCSSM).

Placing the 8 Standards for Mathematical Practice at the core, the Mathematics Assessment Project developed 100 Classroom Challenges (CCs) that are available to teachers for download, free of charge, for non-commercial usage, from the MAP website: <http://map.mathshell.org>.

The 8 Standards for Mathematical Practice

- 1. Make sense of problems and persevere in solving them.***
- 2. Reason abstractly and quantitatively.***
- 3. Construct viable arguments and critique the reasoning of others.***
- 4. Model with mathematics.***
- 5. Use appropriate tools strategically.***
- 6. Attend to precision.***
- 7. Look for and make use of structure.***
- 8. Look for and express regularity in repeated reasoning.***

THE APPROACH

To illuminate questions about the student experience, and in particular to compare and contrast the ideals and goals of the Classroom Challenges with the realities of their effects on students, Inverness Research administered a survey to 636 students in the late spring of 2014.

The sample was large, representing states across the country as well as a grade-level span from 6th grade to high school, with almost half of the survey respondents in the 8th grade. The sample also included a range of student familiarity with the Classroom Challenges. Teacher usage varied from having used at least 2, and as many as 12 CCs with the participating classes.

- Sample students came from the classrooms of either teachers who had helped pilot the Classroom Challenges as part of the MAP development process, or teachers who had participated in professional development offered by the Mathematics Design Collaborative (MDC) in which the CCs

served as the focal point. All of the teachers continued to use the CCs in their classrooms throughout the 2013-14 school year.

- **38%** of students came from classrooms where the teacher had taught **2 to 4** CCs.
- **49%** of students came from classrooms where the teacher had taught **5 to 7** CCs.
- **13%** of students came from classrooms where the teacher had taught **more than 7** CCs.
- Five states were represented in the sample: California, Colorado, Louisiana, Michigan, and Rhode Island; 85% of the students came from California, Louisiana, and Colorado.
- The student sample represented 9 districts, 10 teachers, and 31 classes.
- The grade levels of the 636 students were:
 - 6th grade – 11%
 - 7th grade – 27%
 - 8th grade – 48%
 - High School – 14%

THE OVERALL FINDINGS

At the broadest level the survey data, which includes both students' survey ratings and their extensive comments, indicates that:

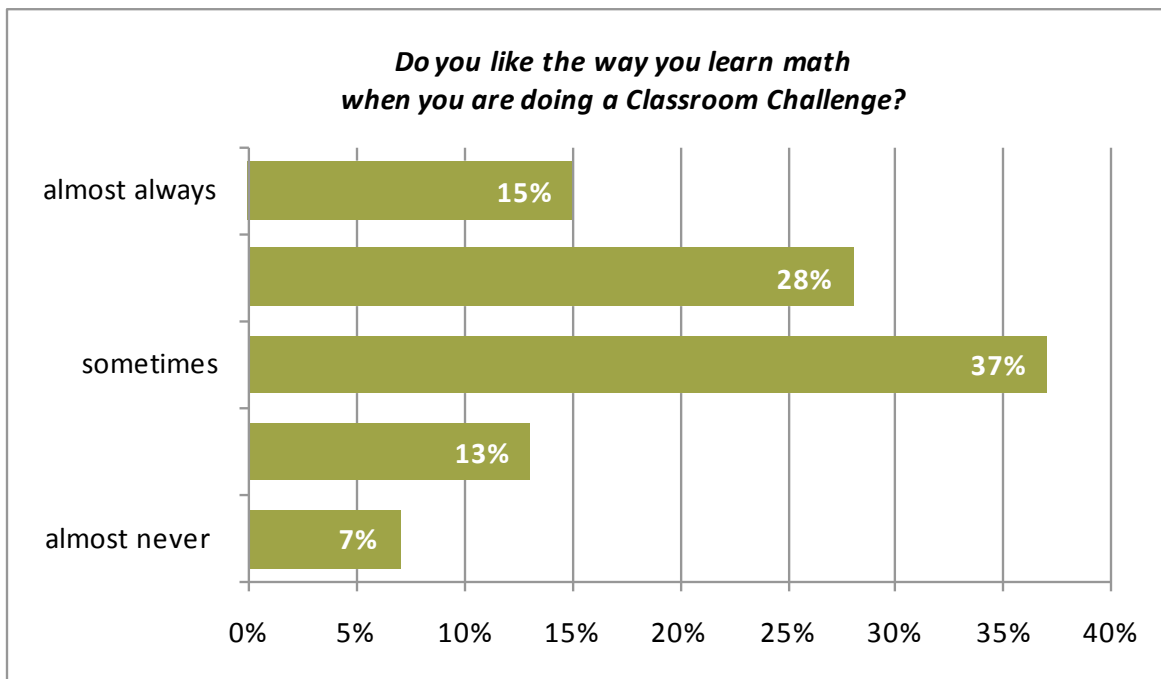
- **Students liked the way they learned math** when they were doing a MAP Classroom Challenge.
- Through using the CCs, **students acquired foundational dispositions and habits** that led to more fully developing important mathematical process skills such as communication, reasoning, and problem solving. In particular, students reported an increase in their participation in math class, in listening to others explain their mathematical thinking, and in learning new ways to show or explain their own mathematical thinking.
- **Students practiced the 8 Standards for Mathematical Practice** when they participated in MAP Classroom Challenges.
- **A minority of students—approximately 20%—remained unaffected by or disaffected** with the Classroom Challenges. Their thoughts and comments reveal some of the hurdles to changing the teaching and learning of mathematics as proposed in the CCSSM and as designed into the CCs.
- A large majority of **students reported that they understand math better** since participating in MAP Classroom Challenges.

The survey results are not dramatically affirmative. On a five-point scale from very negative to very positive, ratings on almost every question generally fell along a classic bell curve. However, and importantly, the results reflect a realistic assessment. Students reported strong but measured support of and benefit from the Classroom Challenge experience.

A CLOSER LOOK AT THE FINDINGS

Students Liked to Learn Math When They Were Doing a Classroom Challenge

The survey asked students whether or not they liked math in general, and it also posed the more specific question: *Do you like the way you learn math when you are doing a Classroom Challenge?* A very large majority, 84%, of students responded with a 3, 4, or 5 rating on a 5-point scale, where 1 = “almost never,” 3 = “sometimes,” and 5 = “almost always.”



Eighty percent of students fell in the range from “sometimes” through “almost always” liking the way they learned math while doing a Classroom Challenge, an overall high rating. Student comments help to reveal why.

Following are several of the major themes that emerged from students’ descriptions of what they liked about participating in a CC math class. Only a few of many similar quotes were selected to illustrate each theme.¹

- Students reported that because the Classroom Challenges are “**hands-on**” they learned better and more.
 - *It’s more hands-on and allows me to better understand the inter-connections.*
 - *It’s hands-on and gives (me) a chance for understanding.*
 - *It’s more hands-on and I like it that way.*
 - *It gives hands-on experience. We talk about actual math and it gives me a better understanding of what I did.*
- Many students cited how important **talking about mathematics** was to their learning. They said they benefited from discussion with their peers.
 - *I like class discussions.*
 - *I learn better when I participate.*
 - *You can talk about ideas.*

¹ Quotes are taken directly from survey comments and edited for spelling, grammatical correctness, and readability. The intent and meaning have not been altered.

- *You can discuss how to get the answer.*
- *I feel like talking about it makes it stick more.*
- *I like communicating with each other and getting better ideas of the problems and the techniques for solving them. I got the overall understanding before moving on.*
- *I like how we talked about the problems and how to solve them rather than just knowing the answer.*
- The value of **working in cooperative groups** accounted for much of the benefit of the CCs in students' reports.
 - *Something I like is that we work in groups.*
 - *I like working with new people in groups because I get to know somebody new.*
 - *I like working in groups and having multiple minds thinking about one thing in different ways.*
 - *You get to bounce ideas off of others.*
 - *When I get confused about something I can ask the people in my group for clarification.*
 - *I like working with people around the classroom and it forces me to participate and think in a different way.*
 - *Everyone gets to share ideas and work together.*
- Fewer, but still a good number of students, cited the **fun of problem-solving** as one of the things they liked about using Classroom Challenges to learn math.
 - *I like how the problems challenge you and how you can see how others do the same problem.*
 - *I like the added figuring and finding out the answers.*
 - *Sometimes I just like doing puzzles and working in groups because I have a whole new idea and I work harder.*
 - *I like the puzzle and the challenge.*
 - *Sometimes it can be nice to get a break from doing the same old things. I like more fun problems. (The CCs) can be kind of interesting.*

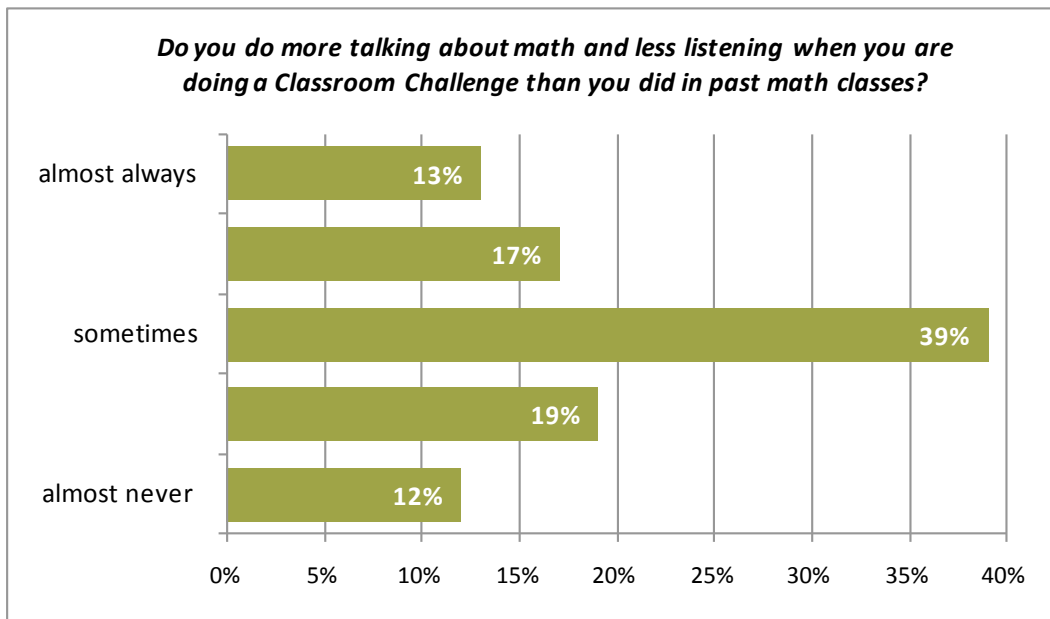
Students Developed Readiness Skills for More Sophisticated Mathematical Thinking and Learning

Before fully engaging in the 8 Standards for Mathematical Practice called for by the CCSSM, it is vital for students to cultivate attitudes and habits that serve as important readiness skills or stepping-stones toward more advanced mathematical thinking demanded by the practices. Participation in Classroom Challenges helped students develop more fully in these key foundational capacities. The development of these capacities can be attributed to the pedagogical strategies that are central to the CCs and that students identified as beneficial to them. As described in the quotes above, they say they understood math better when they engaged in hands-on activities, participated in discussions, worked in cooperative groups, and were challenged with real-world problems.

In turn, survey findings show that when these pedagogies are central, as they are in the CCs, students expressed more of their own ideas, they participated more actively through discussions and collaborative work with their peers, they learned new and multiple ways to explain their thinking effectively, and, as a result, their overall confidence in doing math increased. It appears that all of these modes of doing math differently are very likely to support students in their progress toward becoming not only mathematically proficient, but also more mathematically inclined.

- **Students did more talking and less listening.**

Almost 70% of students reported that they sometimes or almost always did more talking about math when they participated in a Classroom Challenge, while a third said they almost always did more talking. This stands in contrast to the traditional classroom where the teacher lectures and explains, students take notes, and then solve problems alone and in silence with paper and pencil.

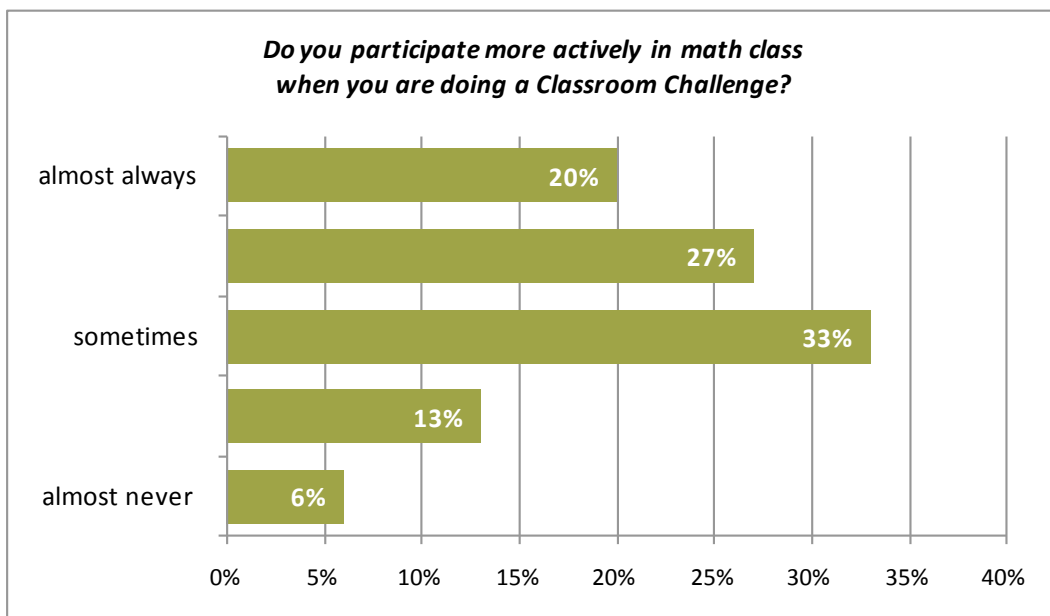


Student comments described the benefits of talking in math class.

- *Something I like is that we work in groups.*
- *When I'm doing the talking it usually helps me understand the lesson better.*
- *Math has always been an easier subject for me so I get things that my partner might not, so I can explain things.*
- *I am talking a little more because I want to get my ideas out there.*
- *Classroom Challenges had more discussions than worksheets, and (I got) a new view on math.*

• **Students participated more actively.**

Also in high contrast to typical traditional math classrooms, students reported that they participated more actively when their teacher used a Classroom Challenge. Rather than just two or three students who are “good in math” raising their hands to respond with the right answer, 80% of students said they sometimes or almost always participated more actively in their CC math class.

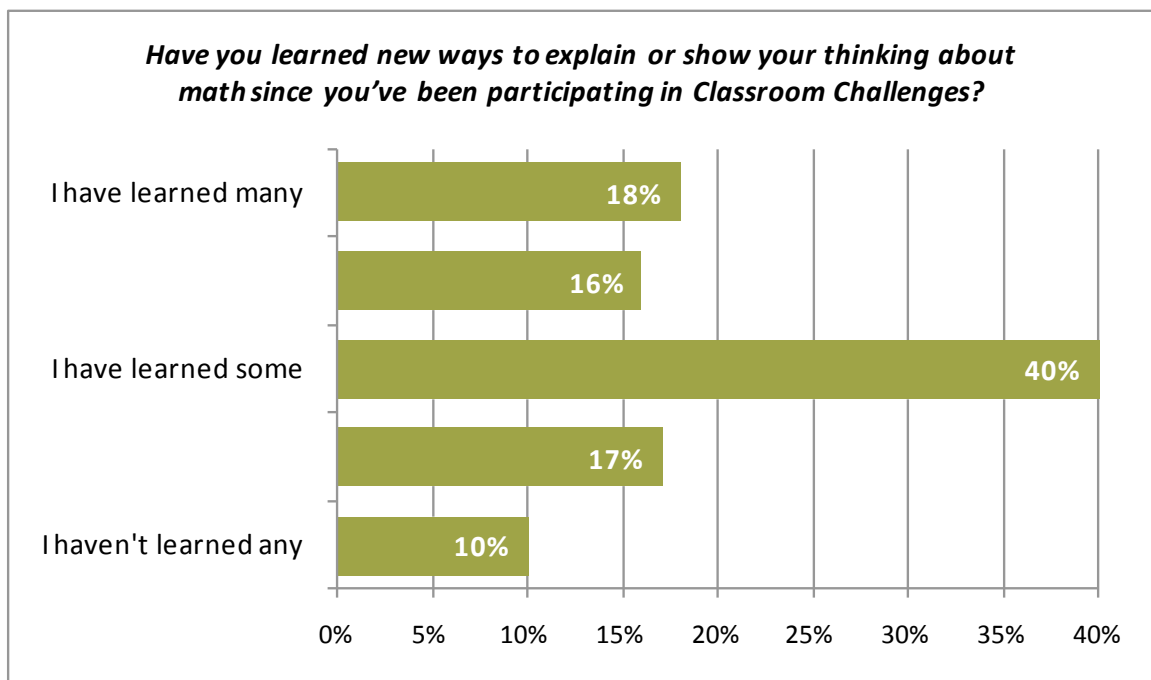


Students also grasped that their more active participation was key to better understanding of math concepts.

- *When we do Classroom Challenges we do them as a class. Asking questions more openly is now an option (for me.)*
- *I feel more active in the class discussions ... I feel like I can relate, and it is cool to learn new things.*
- *I have more chances to share.*
- *With different students to work with, I am more engaged.*
- *Classroom Challenges have gotten me more used to sharing my answers.*
- *I sometimes participate more because I understand more with more people working together on the problem.*

• **Students learned new ways to explain or show their mathematical thinking.**

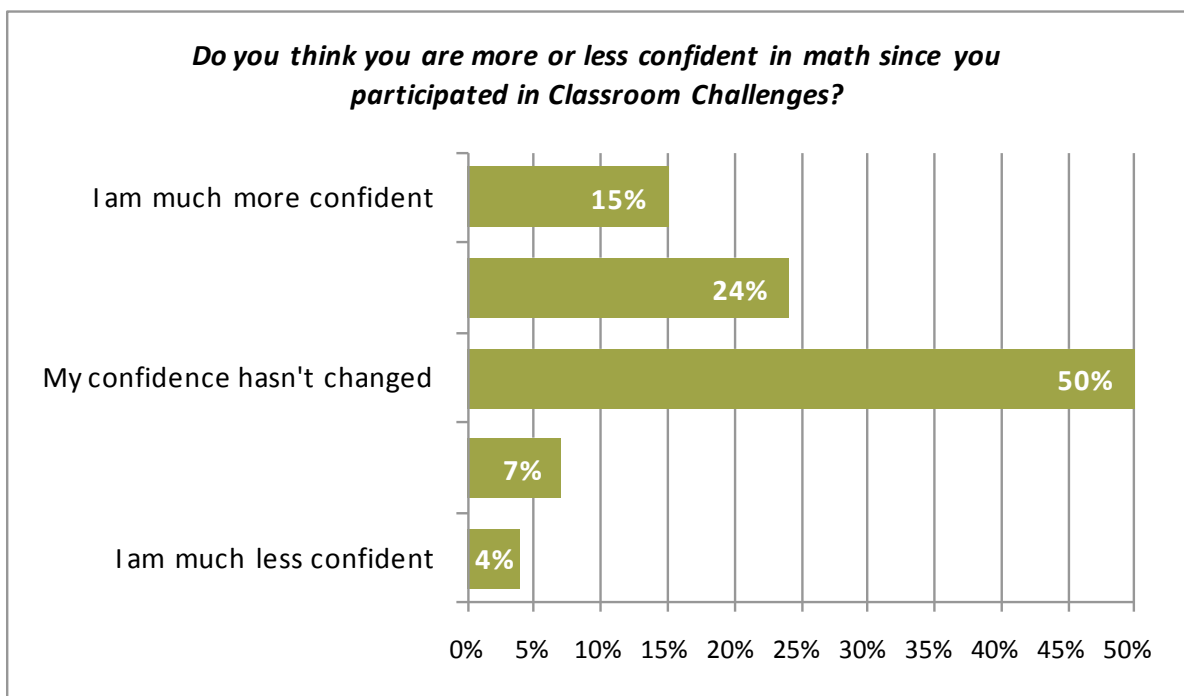
Seventy-four percent of the student survey respondents reported that they learned new ways to show their thinking, thereby expanding their view of the nature of mathematics.



- *I have learned that for a lot of problems there is more than one way of thinking.*
- *We learn new ways almost every day.*
- *I've learned how to say things so that everyone understands.*
- *I learned to use more math words when I'm writing.*
- *I learned to use graphs to show my thinking.*
- *I have learned a new way of thinking – it's investigation work.*

• **Students gained confidence in math.**

Even though exactly half of the survey respondents said that their confidence level hadn't changed as a result of participating in Classroom Challenges, almost 40% of students said their confidence had increased. Confidence begets confidence to take on new and different learning risks. In a subject matter like math where many, especially female and minority students, do not see themselves as competent, increasing the confidence to learn of 40% of students is an accomplishment.



The survey asked, “If you think you are more confident in math since you participated in Classroom Challenges, please give an example.” The following are a few offered from just one 6th grade class:

- *I know the way to get the answers and I know the tricks to math ... I want to learn more.*
- *I know now that certain methods work, which make me more confident.*
- *I think I'm more confident because at first I was not very good with variables, and now I get good grades on quizzes about them.*
- *I understand more about what it is when real-world situations are mentioned.*
- *It made me more confident because now I'm excited to do math.*
- *I'm more confident because I spend more time on math.*
- *I've learned a lot and so I feel more confident.*

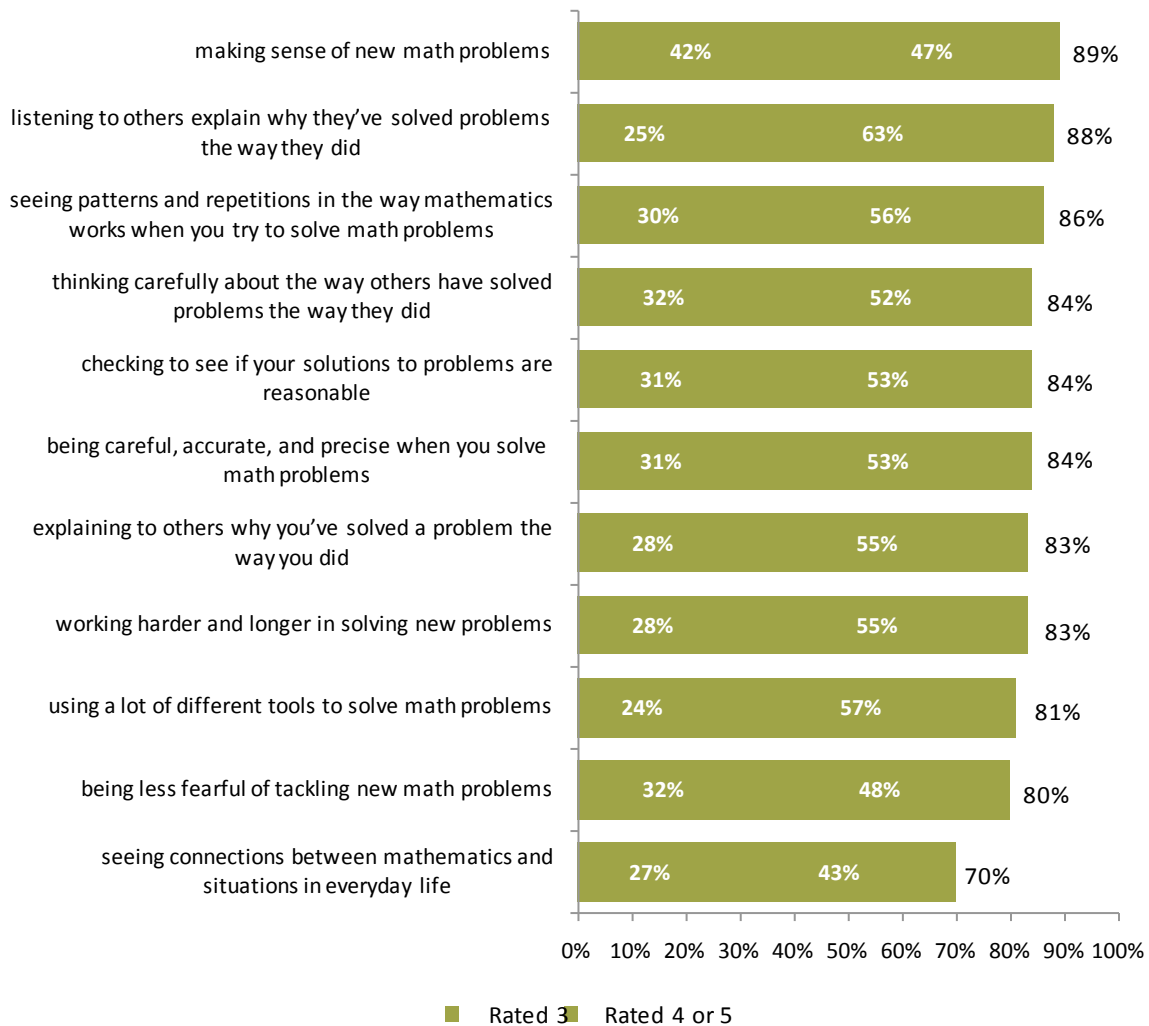
Students Gained Practice with the 8 Standards for Mathematical Practice

The survey asked students to rate their improvement in 11 processes linked to the 8 Standards for Mathematical Practice that MAP designers aimed to place at the center of the Classroom Challenges. The CCs were intended to assist teachers and students in enacting those practices. The graph on the following page shows that for the most part students felt that participating in Classroom Challenges did, in fact, contribute to their improvement in Mathematical Practices.

MAP Classroom Challenges were especially effective in promoting:

- Practice #1: Making sense of problems and persevering in solving them.
- Practice #2: Reasoning abstractly and quantitatively.
- Practice #3: Constructing viable arguments and critiquing the reasoning of others.

Percentage of students who, after participating in Classroom Challenges, say they have gotten better at certain tasks



Data includes student ratings on a scale of 1 – 5, where 1 = “I’m not better at this at all,” 3 = “I’m somewhat better at this,” and 5 = “I’m much better at this.”

A Minority Remained Unaffected by or Disaffected with Classroom Challenges

Throughout the survey roughly 20% of students gave low ratings (1s or 2s) in response to questions. Student responses to the survey question “What are some things you do not like about participating in Classroom Challenges?” shed light on reasons why a consistent minority were left unmotivated by their CC experiences. They fall into three rough categories:

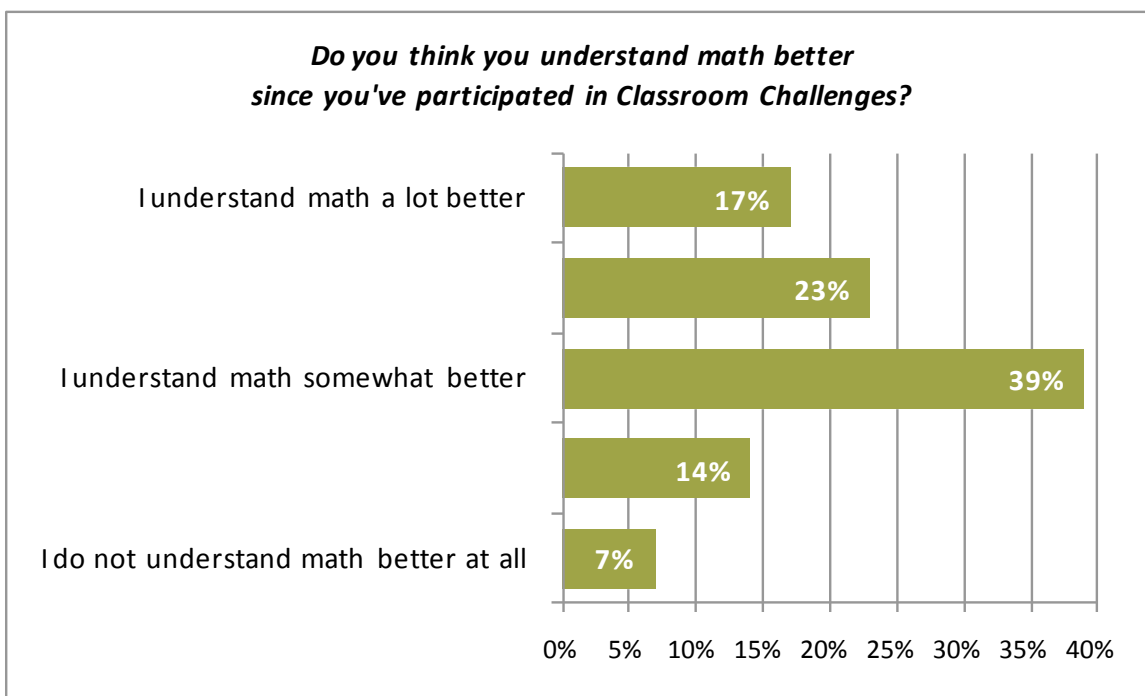
- Nearly one-third of students didn’t like participating in the CCs because they **didn’t like working in groups**. Many student comments reflected similar sentiments to “I don’t like group,” or “It’s easier for me to learn on my own than in a group.” They also objected to dysfunctional groups, when other students clowned around or didn’t participate fully.
- Many students **objected to the investigative approach** embedded in the Classroom Challenges. They chafed under the non-traditional pedagogy: “We are expected to figure it out ourselves,” or “I

like being taught by being told outright, 'Here's this and you do it like this' ... I don't really like the roundabout way of doing things," or "I am forced to struggle and am not being given the help I desire... I need to have lessons taught as a lecture instead of being sent out on my own."

- A large number of objections to the CCs referred to how **difficult or confusing** they were, and **how much time they took**. "You do lots of work, it's not a small task," said one student. Another said, "Problems are time-consuming," and another reflected many similar opinions, "The problems are difficult."

Students Understand Math Better Since Participating in Classroom Challenges

In response to the "bottom line" question, "Do you think you understand math better since you participated in Classroom Challenges?" almost 80% of students said they did.



Their comments, many of which attribute understanding multiple ways of solving problems as key to doing better in math, explain why.

- *I now know how to find the answers a lot more easily, and (I know) different methods. I feel more confident in math and I do better.*
- *I learned new ways to figure things out, so math is easier to do.*
- *We get to make our own methods and prove that they work, while looking at other methods. This allows me to look and see different ways of doing things until I understand.*
- *Before I didn't know much about things like negatives and percents. Now I know a lot more and it helps me in school ... I like to work together, because I personally find it easier to learn. You can see the ways other people solve things and share yours.*
- *The lessons include graphs and pictures instead of just numbers, so I get a better understanding of what is happening.*
- *I am able to work with and get help from my peers. We are able to solve problems on our own but with help if needed.*
- *Since we see many methods to solve a problem, I am able to understand concepts much better because I can choose the one I am most comfortable using.*

IN CONCLUSION

Students' reports affirm the efficacy of the design logic and purpose of the MAP Classroom Challenges. Their ratings and comments show not only how the design succeeds but also explain why it does.

Students reported that they liked learning math through CCs

First and foremost, a large percentage (80%) of students reported that they liked learning math with CCs. Especially against the backdrop of what is more common—high numbers of middle and high school students who do not like math or suffer from math anxiety—this large majority speaks well of the influence of the Classroom Challenge experience. A shift from not liking to learn math to liking to learn it is an important affective change, one that indicates how the CCs can make the average student more open and inclined to study mathematics.

Students identified key pedagogical elements as benefits

While testifying that they liked learning math through the CCs, students' accompanying explanations gave credibility and authority to their stance. They spontaneously identified key pedagogical elements deliberately embedded in the CCs that they said helped them learn and understand math better. They explained that the CCs are hands-on, encourage talking not just listening, rely on cooperative group work, and offer students the pleasure and fun of solving challenging real-world problems.

Students developed foundational capacities

In turn, students reported on the effectiveness of non-traditional modes of learning math that the designers aimed to have enacted through the pedagogies embedded in the CCs. They said that 1) they expressed more of their own ideas, 2) they participated more actively through discussions and collaborative work with their peers, and 3) they learned new and multiple ways to explain their thinking effectively. And most importantly, as a result of this kind of engagement, students' overall confidence in doing math increased.

Students practiced the 8 Standards for Mathematical Practice

Comfort and fluency with these new learning modes appeared not only to lead to greater confidence, but also to serve as sound preparation for engaging in the CCSSM 8 Standards for Mathematical Practice. The survey provided strong evidence that the Classroom Challenge experience helped groom and coach students to “practice the practices.” MAP CCs were especially effective in promoting Practice #1 - Making sense of problems and persevering in solving them; Practice #2 - Reasoning abstractly and quantitatively; and Practice #3 - Constructing viable arguments and critiquing the reasoning of others.

Students said they understood math better

The net result is that almost 80% of the students surveyed reported that they understood math better through their participation in the Classroom Challenges. CCs are designed to give average students experiences that will make mathematics more accessible, more enjoyable, and more comprehensible, and the students' perspectives gleaned from the survey affirm that the CCs succeeded. For many individuals the MAP Classroom Challenge experience served as an open door to mathematics, one that had been previously closed. And for students at large, the design of the Classroom Challenges appears to have widened the pipeline, offering a broader spectrum of students opportunities to see mathematics differently, to learn mathematics differently, and to acquire a new sense of confidence and self-efficacy in the study of mathematics.

Inverness Research, a national education evaluation and consulting group headquartered in Northern California, has over 25 years of experience studying local, state, and national investments in the improvement of education.

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