

Making Sense of Learning Math

Insights from the Student Experience

Mathematics is an integral part of students' daily lives, from marking the first 100 days of elementary school to the pivotal moment of crossing the threshold into Algebra 1. Math not only serves as the key that unlocks the doors to the sciences and technology but also empowers individuals personally. At the same time, math literacy stands as an undisputed public good, providing society with the indispensable tools needed to propel innovation and grapple with intricate societal challenges. For all these reasons math is a subject that sparks seemingly endless and contentious debates in universities and think tanks, among leaders of industry, and in government that are popularly referred to as the “[math wars](#).” But how do students themselves experience mathematics in today’s classrooms? In this report we explore students’ perceptions of their everyday experience in math. How do high school students perceive the math learning experience? How do they see themselves as math learners? And what insights do they have for creating a more engaging math education for all students?

The Math Learning and Identity Project

The insights presented in this report are derived from the YouthTruth Math Learning and Identity Project, which collected three sets of data over the course of the 2022-2023 school year. First, we integrated five questions related to math learning and identity into YouthTruth's comprehensive student experience survey during the 2022-2023 school year, yielding responses from almost 90,000 high school students. Second, as part of this survey, we also collected open-ended responses from over 66,000 students concerning their school experiences. Lastly, we engaged in collaborative student voice workshops with students from two different school districts. These workshops aimed to illuminate how students interpreted the math data from their own schools and to gather their insights and recommendations for improving math education. (For more details about the sample and our methodology see the appendix of this report).

This work is licensed under the Creative Commons BY-NC-ND License. To view a copy of the license, visit creativecommons.org/licenses/by-nc-nd/4.0

© 2023. The Center for Effective Philanthropy, Inc. All rights reserved.

FINDINGS

SCHOOL MATH VERSUS REAL MATH

Many high school students perceive “school math” or “education math” as lacking inherent value and as disconnected from their practical needs. Students express a strong desire to acquire “real” math skills that will empower them to pursue the future they envision for themselves.

1

DETERMINED MATH LEARNERS

Students who have strong math identities and positive math learning experiences describe their relationships with their teachers as an important source of their determination to learn math.

2

(UN) INTERESTING MATH PROBLEMS

Students explain that their desire to learn math is inhibited by uninteresting work that dampens their intrinsic motivation to acquire math skills.

3

Students' overall responses to the five math learning and identity survey questions set the stage for this report. While over 70 percent of students agree that they can learn math through hard work, only 61 percent report that they keep trying when math gets hard. Just over half of students, 57 percent, agree that it is important for everyone to learn math. Less than half, 47 percent of high school students, report that they tend to work on interesting problems in their math classes – and nearly a quarter of students, 23 percent, say they never or rarely work on interesting problems in math. Finally, less than half of students, just 46 percent, are comfortable asking questions in their math class when they need help, and a full quarter, 26 percent, report that they are rarely or never comfortable speaking up in math.

MATH IDENTITY AND LEARNING SURVEY ITEMS OVERALL RESPONSE DISTRIBUTIONS

I can be good at math if I work hard at it.



I keep trying in math when the work gets hard.



It is important for everyone to learn math.



In my math class we work on interesting problems.



I feel comfortable asking questions in math class when I do not understand.



Values may not add up to 100% due to rounding.



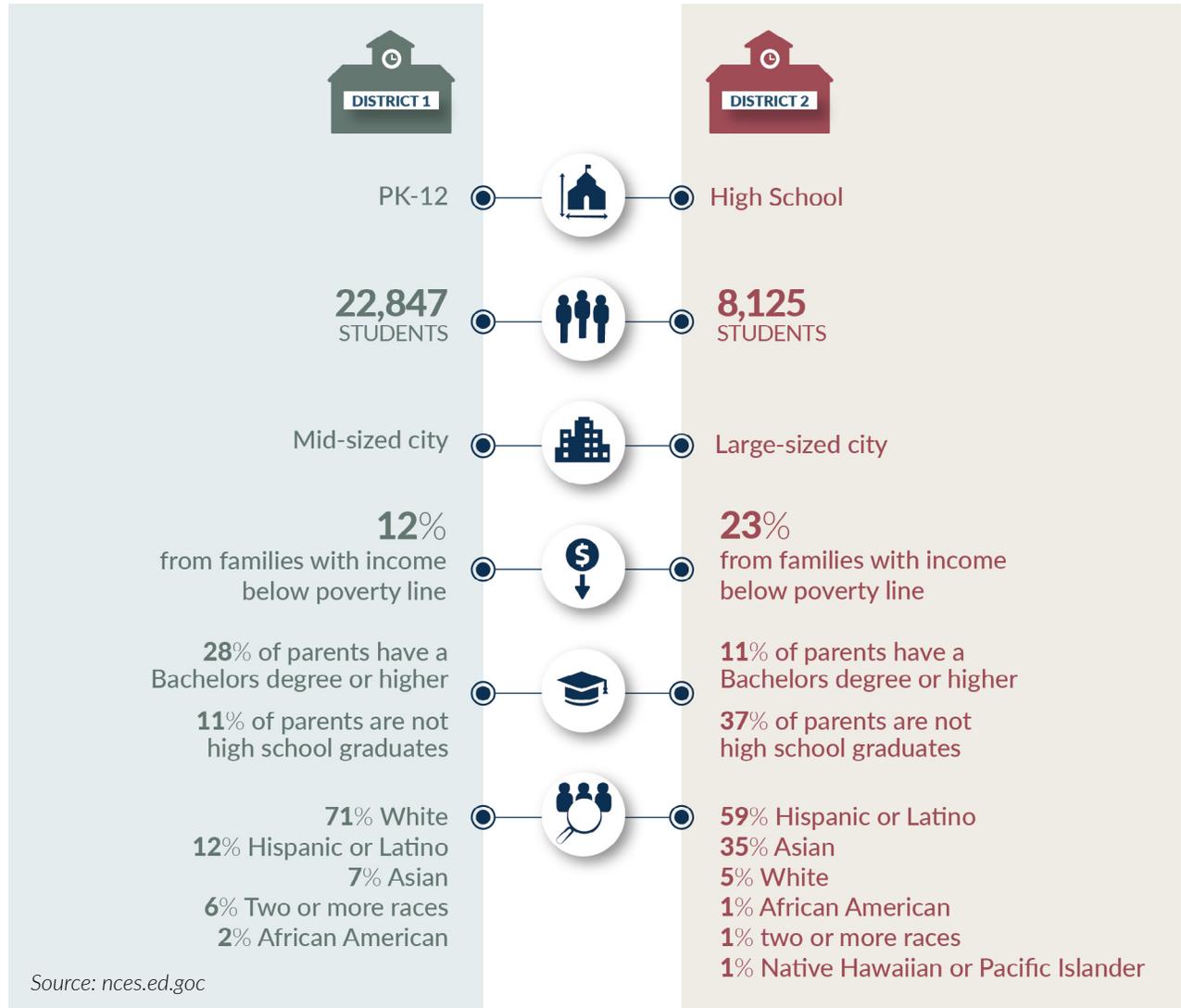
1

SCHOOL MATH VERSUS REAL MATH

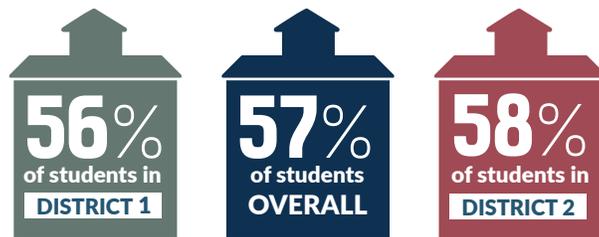
Many high school students perceive “school math” or “education math” as lacking inherent value and as disconnected from their practical needs. Students express a strong desire to acquire “real” math skills that will empower them to pursue the future they envision for themselves.

Only 57 percent of students agree that it is important to learn math. Moreover, this lack of enthusiasm for the importance of learning math cuts across demographic characteristics, including students' grade level, gender, and race. Even students on the accelerated math path, who completed Algebra I in 7th or 8th grade, and might be expected to exhibit higher enthusiasm for math, do not express a significantly greater level of agreement than their peers regarding the importance of learning math.

To gain a deeper understanding of the survey data and the factors influencing students' perceptions of the importance of learning math, we engaged in collaborative workshops with students from two diverse districts. These workshops provided additional insights as students shared their own interpretations of their responses to the math learning and identity survey questions.



Despite the differing demographic profiles of the two districts, students in both areas joined the prevailing consensus, aligning with the 57 percent of students nationwide who agreed it is important for everyone to learn math. In District One, 56 percent of students concurred with the notion that everyone should learn math, and in District Two, this sentiment was echoed by 58 percent of students.



AGREE THAT IT IS IMPORTANT FOR EVERYONE TO LEARN MATH

During the workshops, students outlined a valuable distinction in how they interpret math's importance. They differentiated between what they called "school math," which they recognized as having extrinsic value for graduation and college admissions, and "real math" – inherently valuable mathematics. A minority mentioned school math as significant for assisting in other subjects or as a "brain teaser." However, echoing the open-ended survey responses from high school students nationwide, those in both districts underscored the importance of "real" math, the kind with everyday relevance that can help them achieve their life goals. One student succinctly summarized the dichotomy, stating, "Math is important but we're being taught the wrong kind of math."

**“
Math is important but
we’re being taught the
wrong kind of math.
”**

District 2 student in workshop

In the workshops, many students adamantly described that "real math" is important as it provides access to wealth, power, and adult independence, explaining that it translates to financial success. Correspondingly, students list a range of skills they wish to acquire, including managing bank accounts, investments, bill payment, insurance understanding, navigating car loans and mortgages, practicing effective saving, and filing taxes.

Students' frustration with not being taught about taxes is particularly notable and was shared by students in the workshop as well as in national open-ended survey responses. Students' comments suggest that they view understanding taxes as a crucial aspect of adulthood and an integral part of comprehending the financial system, which they find frustratingly opaque. One workshop student humorously expressed, "Not knowing how to do taxes is frustrating, but at least I know algebra."

**“
Not knowing how to do taxes is frustrating,
but at least I know algebra.
”**

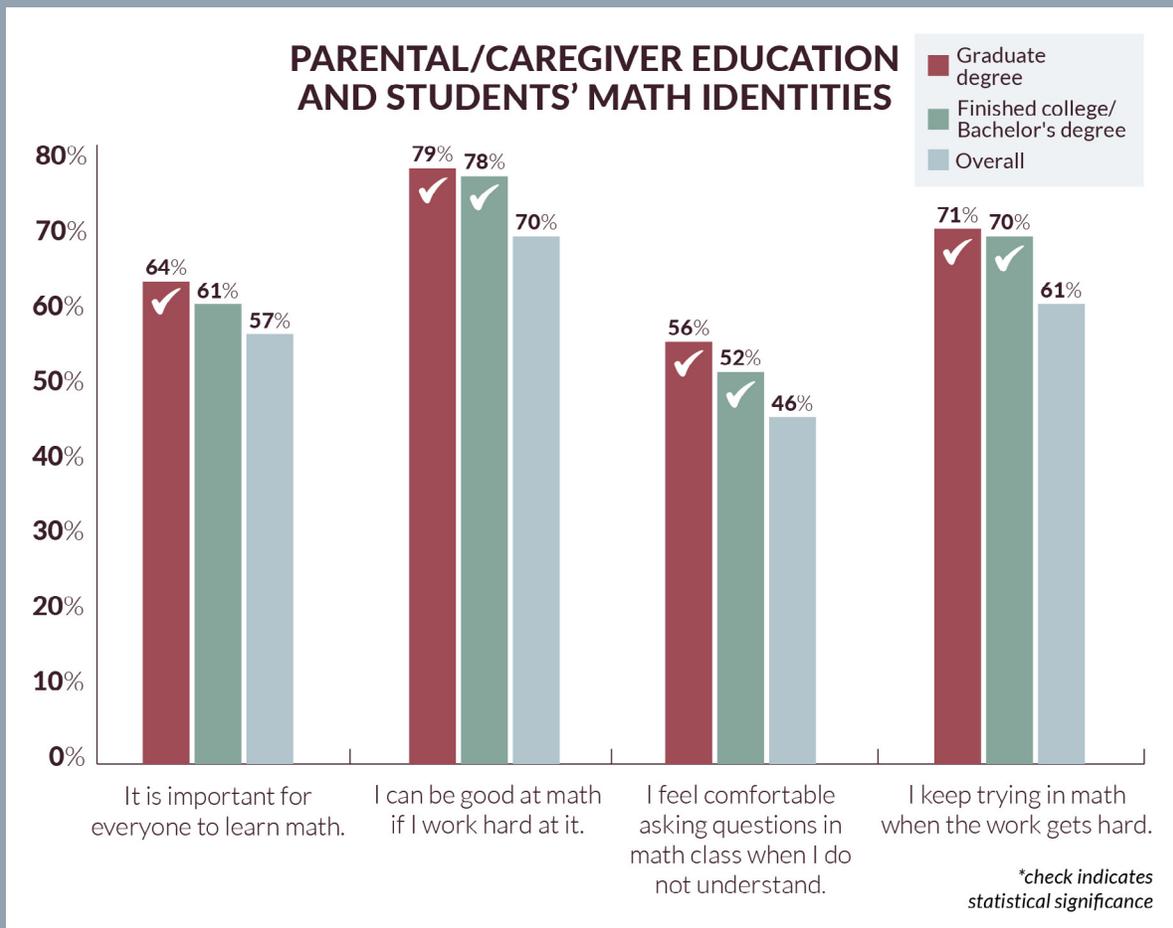
District 1 student in workshop

MATH IDENTITY AND PARENTAL OR CAREGIVER EDUCATION

Students' survey responses show that their perspectives about math are strongly related to their parents' education levels. Students with parents or caregivers holding advanced degrees express a more favorable math identity than their peers.

While high school students overall express lukewarm enthusiasm about the importance of math, one group stands out with a notably more positive view: students whose parents or caregivers have graduate degrees. In contrast to the 57 percent of students overall who agree it is important for everyone to learn math, 64 percent of students with parents or caregivers holding graduate degrees endorse the significance of math education.

[Parental or caregiver education](#) serves as a well-recognized indicator of socioeconomic status, and it is reasonable to infer that the importance of math is being reinforced at home for these students. This is evident as students with parents holding advanced degrees or bachelor's degrees also more commonly express confidence in their ability to excel in math through hard work, persist when faced with challenges, and feel comfortable seeking help when needed.



The compounding impact of parental education is a crucial factor in students' math education. Our findings show that students' belief in the importance of math education is also positively associated with their sense of preparedness for college and career. In other words, students who appreciate the value of math also report being more well-prepared for their future educational and professional pursuits.

2

DETERMINED MATH LEARNERS

Students who have strong math identities and positive math learning experiences describe their relationships with their teachers as an important source of their determination to learn math.

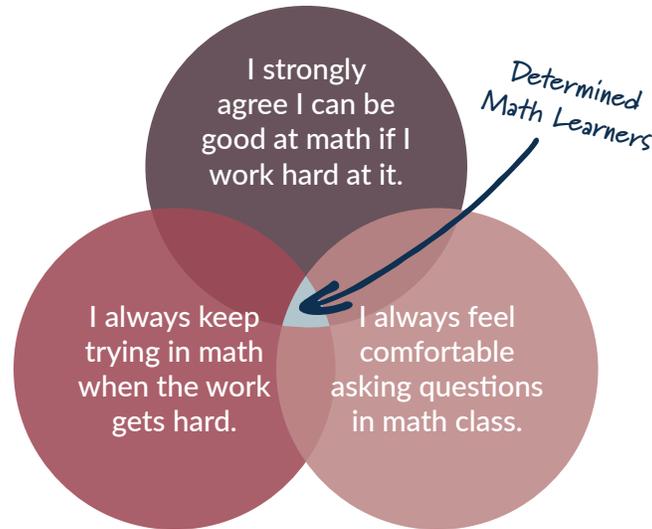
Students' belief that they can be good at math if they work hard at it has the potential to jumpstart the acquisition of new skills, especially when accompanied by resilience and a readiness to seek assistance. A full 70 percent of students agree that they can be good at math if they work hard at it, underscoring a robust collective sense of math self-efficacy that holds promise for both learners and educators. Nonetheless, only 61 percent of students indicate they often or always keep trying in math when the work gets hard, and less than half, 46 percent, state they often or always feel comfortable asking questions in math class when they need help.

STUDENTS' OVERALL, SELF-EFFICACY, RESILIENCE, HELP-SEEKING



To further understand how these three attributes play out in the student math learning experience, we sought the insights of students in their own words by delving into the open-ended survey responses of a subset of respondents we deemed "determined math learners" – those students who rated themselves highest on all three of the above questions. This group of "determined math learners" represented 12 percent (8,015) of the 66,000 students who provided open-ended responses about their school experiences.

SELF-PERCEPTIONS OF DETERMINED MATH LEARNERS



In their open-ended comments about what they like most about their experience in school, determined math learners went out of their way to describe, in striking detail, the ways that their teachers help to make them more successful math learners. According to these students, their teachers foster math determination by presenting challenging assignments, establishing a classroom environment where asking questions is encouraged, and displaying genuine care for both their academic achievements and overall well-being.

One determined math learner stated, “Especially in my math class, my teachers helped place me in a class that challenges me more, and they helped me

“
My math teacher has us complete a survey at the end of every week, it makes me feel comfortable knowing that she cares.

9th grade Asian/Asian-American girl

“
My teachers give us time to ask questions. In math class, we do discussion prompts after learning parts of the unit in order to de-stress.

12th grade white boy

to challenge myself.” Another mentioned, “No matter what, my teachers are always respectful to me, and I know that they only want to see me succeed.”

Many determined math learners also emphasized the ways their teachers personally connected with them in their math class, with one writing: “My math teacher has us complete a survey at the end of every week, it makes me feel comfortable knowing that she cares.” Furthermore, determined math learners highlighted the profound impact of teachers who recognize the social aspects of learning math: “My teachers give us time to ask questions. In math class, we do discussion prompts after learning parts of the unit in order to de-stress.”

ASKING QUESTIONS IN MATH CLASS

Students' survey responses show that there are significant disparities among student groups in terms of their comfort with regularly asking questions in math class.

[Inquiry and asking questions is an instrumental part of the learning process.](#) However, of the five math learning and identity questions, feeling comfortable when asking questions received the weakest overall rating from students. Less than half (46 percent) reported that they always or often ask questions in math, while slightly more than a quarter (26 percent) of students indicated that they rarely or never feel comfortable asking questions in math.

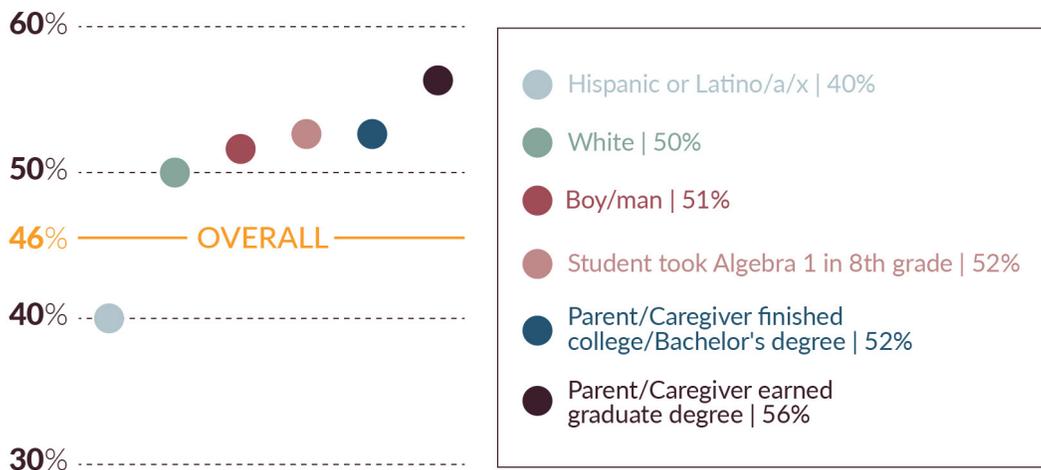
Moreover, there are significant disparities in students' responses to this question that suggest some groups of students feel a greater sense of empowerment than others in their math classes.

In addition to students with parents or caregivers holding bachelor's (52 percent) or advanced degrees (56 percent), boys (51 percent), white students (50 percent), and those who took Algebra I in eighth grade (52 percent) agreed at a significantly higher rate than students overall (46 percent) that they are always or often comfortable raising questions in math class. Conversely, a significantly lower percentage of Hispanic/Latinx students (40 percent) expressed comfort in asking questions in math compared to high school students overall.

STUDENTS WHO FEEL COMFORTABLE ASKING QUESTIONS IN MATH CLASS

46% | **26%**
OFTEN/ALWAYS | NEVER/RARELY

PERCENTAGE OF STUDENTS WHO OFTEN/ALWAYS FEEL COMFORTABLE ASKING QUESTIONS IN MATH CLASS



These disparities and students' weak responses overall suggest an important and actionable area for enhancing the math learning experience for all students by creating classrooms that invite all students' questions.

3

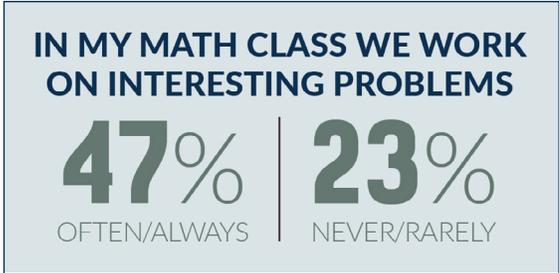
(UN) INTERESTING MATH PROBLEMS

Students explain that their desire to learn math is inhibited by uninteresting work that dampens their intrinsic motivation to acquire math skills.

While research and common-sense wisdom suggest that [engaging high school students in interesting math problems](#) is fundamental to a high-quality math program, the reality, according to students themselves, falls short. Student survey responses show that less than half of students, 47 percent, report that they often or always have the opportunity to work on interesting math problems, while a full 23 percent state that they seldom or never engage with such problems.

In contrast to the demographic disparities in students' responses to other math questions, this particular question reveals a unanimous sentiment. Students across various demographics, including gender, race, the year they took Algebra I, and even parental or caregiver education, are in agreement: there is a dearth of engaging and thought-provoking math problems in their classes.

To further investigate the potential consequences of the lack of engaging problems in the high school math learning experience, we turned again to firsthand insights from students derived from the workshop with students in District 1, where 45 percent of students reported encountering interesting math problems on a regular basis.



During the workshop, District 1 students underscored the importance of interesting math problems as key to any learning experience and which they often found lacking in their math classes. At the same time they also expressed a deep understanding of how to tackle complex subjects, describing their own learning strategies in a way that aligns with what researchers refer to as "[effortful struggle](#)." Their descriptions of learning complex skills included phrases like "I practiced often," "I motivated myself. I kept pushing and pushing," "I work through my mistakes, going through the steps slowly," and "I got help and advice from others."

District 1 students also readily recognized the applicability of these strategies to math learning, acknowledging that making mistakes and taking measured steps are crucial elements of the learning process. However, when we inquired whether they would employ these strategies in their math learning, their responses unveiled the challenges stemming from uninspiring math problems in their classes. As one student, who had earlier extolled the virtues of diligent effort, candidly stated, "While logically these strategies would work, I simply don't find enjoyment in math."

“
I simply don't find enjoyment in math.

District 1 student in workshop

CONCLUSION



$$\Delta U = \frac{m}{2} R \Delta T$$

$$\Delta U = \frac{3}{2} pV = \Delta U = \frac{3}{2} \Delta pV$$

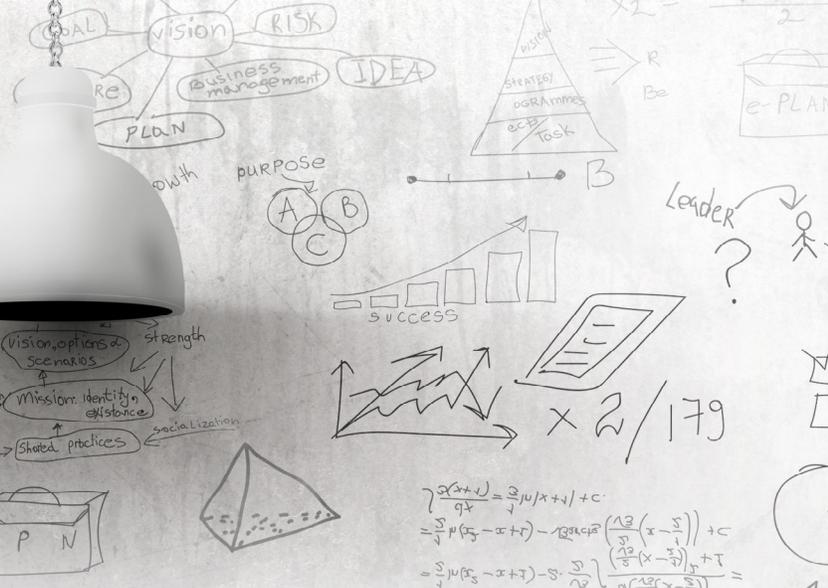
$$A = p \Delta V = Q = \Delta U + W$$

$$Q = C_p \Delta T = \Delta Q$$

$$n = \frac{A - Q_1 - Q_2}{\Delta_1} = \frac{Q_1}{Q_2}$$

$$n = \frac{F_1 F_2}{F_1} = 1 - \frac{F_1}{F_2}$$

$$Q = Am = Q$$

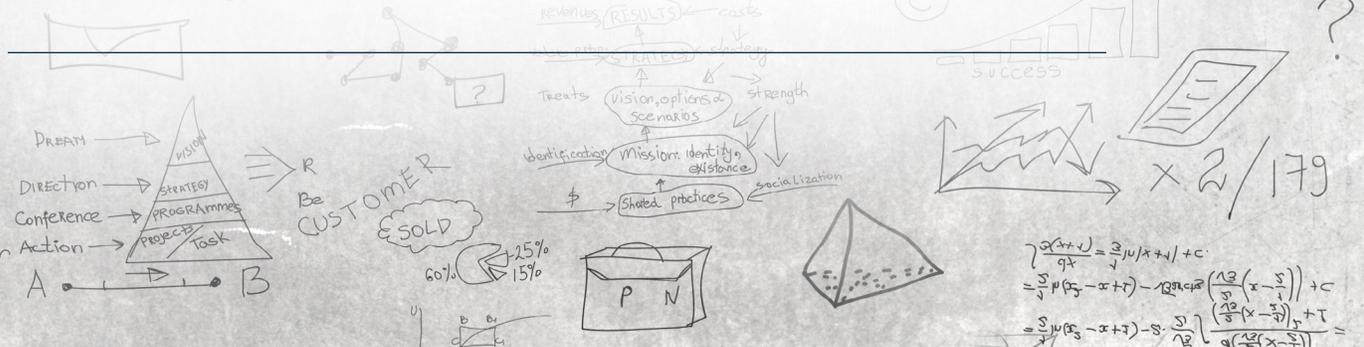
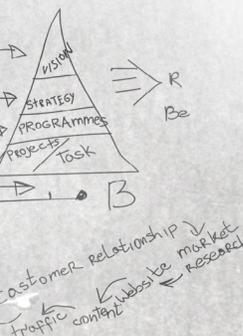


Students' Advice

There is widespread concern about mathematics performance in the US, but a lack of understanding of students' own experiences. And we can't improve math performance without first understanding the student experience. We hope this report gives a window into the perspectives of students who are the recipients of and participants in math education.

At the end of each student voice workshop for this project, we extended an invitation to students to have the final word in this report. We asked them to write an "exit ticket" - a note saying whatever they wanted to the adults with the power to shape math education in the United States. Selected exit tickets are shared below, preceded by summaries of advice from the thousands of students who also offered their advice for improving math in their open-ended survey comments. We hope their reflections inspire those with the power to shape math education to create a more meaningful, engaging, and relevant math education that empowers all students to succeed.

- A. 213,550.00
- B. 376,271.09
- C. 769,533.22
- D. 421,945.15
- F. 652,542.20



$$\sum_{n=2}^{\infty} \frac{(-1)^n}{n^2 + n - 2} = \frac{1}{3} \sum_{n=2}^{\infty} \frac{(-1)^n}{n-1} - \frac{1}{3} \sum_{n=2}^{\infty} \frac{(-1)^n}{n+2}$$

$$= \frac{1}{3} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} + \frac{1}{3} \sum_{n=2}^{\infty} \frac{(-1)^{n+3}}{n+2} = \frac{1}{3} \ln 2 + \frac{1}{3} \sum_{n=4}^{\infty} \frac{(-1)^{n+1}}{n}$$

$$= \frac{1}{3} \ln 2 + \frac{1}{3} \left(\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} - 1 + \frac{1}{2} - \frac{1}{3} \right) = \frac{2}{3} \ln 2 - \frac{5}{18}$$

$$2\sqrt{81} + \sqrt[3]{-125} + \sqrt[6]{1}$$

$$\sqrt[3]{8,0027}$$

$$\frac{\sqrt[4]{48}}{\sqrt[3]{3}}$$

$$(-1)^{n+1} = \sqrt[3]{8,0027}$$

TO TEACHERS

Students ask for more interactive classes that break the traditional pattern of note-taking and testing. They ask for hands-on activities and tactile physical engagement with mathematics to help them connect and engage with math. They also emphasize the importance of empathy, understanding, and compassion in the learning process.

Please work to improve the interactivensess of classes.

(District 2 student)

I think one way to improve is by doing more hands-on work. I feel like all we do is take notes and do tests.

(District 1 Student)

Math and high school are difficult. Empathy, understanding, and compassion are what we need to learn.

(District 1 Student)

TO CURRICULUM DESIGNERS

Students call for a more relevant, engaging, and enticing math education that serves their needs and aspirations. They emphasize the importance of more activities that relate to potential career paths. Their plea is for math to be consistently connected to the real world throughout all levels of education, ensuring that the purpose and meaning of math endure beyond Algebra I.

Improve math education so that it is relevant and enticing to students in the future of math!

(District 2 student)

Make math more connected to the real world. Do this with ALL levels of math.

(District 1 Student)

Make class assignments and activities based on career paths.

(District 2 Student)

TO POLICYMAKERS

Students propose practical solutions to enhance their education. They suggest the inclusion of financial literacy classes as an easily implementable improvement for future students. Students also ask for revised math requirements to endorse more applied math courses so that coursework better supports students' interests and future career goals.

Consider adding a business class as a requirement. I feel like this is something that can be easily fixed for future students.

(District 2 student)

Either apply math to life more or lower the math requirement to Algebra I so students are more invested in school.

(District 1 Student)

In high school students should have the choice of extending their math career as it relates to their interested future field.

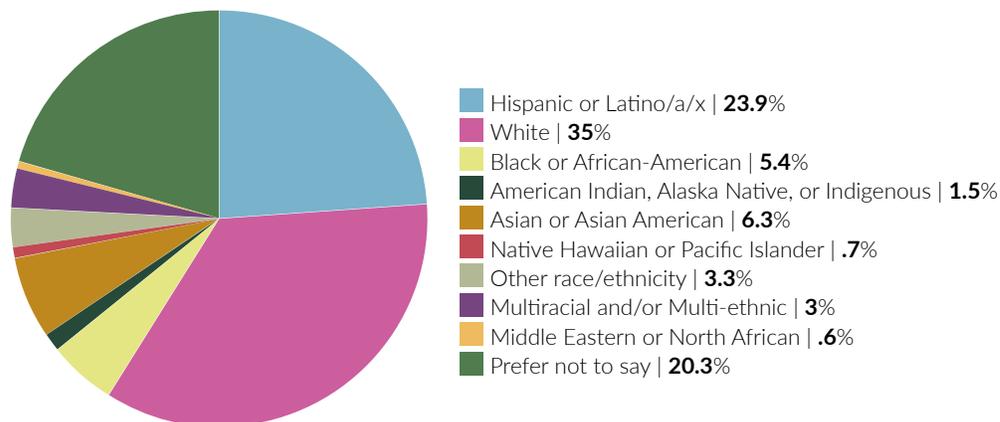
(District 1 Student)

APPENDIX

SAMPLE CHARACTERISTICS

The insights shared in this report are based on data collected from October 2022 through June 2023 from 89,598 high school students from 148 schools in 62 districts across 14 states: California, Florida, Louisiana, Massachusetts, Maine, Michigan, New Jersey, New York, Ohio, Oregon, Pennsylvania, Texas, Vermont, Washington.

RACE/ETHNICITY



QUANTITATIVE ANALYSES

The quantitative survey data were examined using descriptive statistics and a combination of independent chi-square tests, phi effect size, and weighted ordinal regression.

For comparisons among subgroups, chi-squared tests were conducted. An alpha level of .05 was used to determine statistical significance, and effect sizes were examined for all analyses. Only analyses with at least a small effect size are reported. To examine relationships across survey items, a weighted ordinal regression was performed with race, gender, and caregiver education level included as covariates. 89,598 students' responses were included in this analysis.

Regressions were post-stratified to be representative by race/ethnicity. Post-stratification weights were assigned based on NCES data. Non-responses and two YouthTruth demographic variables that are not present in NCES data (other race/ethnicity, and Middle Eastern or North African) were dropped from the regression analyses. Only results with a p-value less than .05 were considered statistically significant. 67,659 students' responses were included in this analysis.

QUALITATIVE ANALYSES

Survey responses: Before inputting students' open-ended responses into the research tool used for this project (CANVS AI) the data were cleaned using a script to remove empty, very short (less than five words), and nonsensical responses. Students' open-ended responses were initially coded automatically using a broad codebook related to education. Codes were then refined through a process of removing, merging, and adding new codes. Analytic questions aimed at uncovering insights into students' experiences regarding math-related topics were employed to focus our investigation. Using the natural language processing tool in CANVS AI, we generated summaries highlighting trends within the students' experiences. We also uploaded students' responses to quantitative questions about math learning and identity into CANVS AI, enabling a targeted examination of their open-ended responses based on their answers to the quantitative questions. Two open-ended survey responses from 66,484 students each were included in this analysis.

Student voice workshops: We partnered with two distinct school districts (for more details, refer to the district overviews on page 4) to organize and conduct two student workshops. The goal of these workshops was to understand how students interpret the math learning and identity survey items and how they perceive the patterns in the quantitative data. To achieve this, our research team developed protocols to guide these workshops, focusing on prompting students to provide written responses. These responses were transcribed and analyzed to yield student-informed insights. 100 students (roughly 50 in each) participated in the student voice workshops.

We are very appreciative of the support from the Bill & Melinda Gates Foundation, which provided funding for this project. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the foundations. We are also grateful to Andy Sokatch of the Bill & Melinda Gates Foundation and Elisha Smith Arillaga of the Center for Effective Philanthropy for their invaluable feedback on an early draft of this report.

A special appreciation goes to the leaders of District 1 and District 2 for their instrumental role in orchestrating the student voice workshops. And, of course, heartfelt gratitude to the students of District 1 and District 2, who gave of their time to help us gain a deeper understanding into the student experience with math. Finally, we would also like to extend a thank you to all of our school partners and their students without whom this work would not be possible.

YouthTruth

— LISTEN. LEARN. IMPROVE. —

Contact us for more information:

131 Steuart Street, Suite 501, San Francisco, CA 94105
675 Massachusetts Avenue, 11th Floor, Cambridge, MA 02139



YouthTruthSurvey.org
hello@youthtruthsurvey.org
844.987.8847

Media inquiries
media@youthtruthsurvey.org
415.683.7958