Target Scores: How is Connecticut doing on the Math Standards and what can we learn?

Performance Matters
October 17, 2019
Analysis
Background

• Connecticut has been administering the Smarter Balanced Assessment since 2015
• Claim and target level data is only reported as “+”, “=“ or “-”
• Claim 1 targets are based on the grade level content standards
• Claims 2, 3 & 4 targets are based on the Standards for Mathematical Practice
• Targets have depth of knowledge (DOK) ranges identified in the blueprint
Purpose

• Determine strengths and areas in need of improvement

• Identify trends in math achievement based on assessment targets

• Inform curricular and instructional decisions

• Drive professional learning
Technical Information
Student Target Scores

- Student target score: The distance from proficient as a proportion of score points

Example 1: Amelia took one item, worth one point and got it correct

<table>
<thead>
<tr>
<th>Points Available</th>
<th>Expected score for proficiency</th>
<th>Amelia’s Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.6</td>
<td>1</td>
</tr>
</tbody>
</table>

Target Score: $1 - 0.6 = 0.4$

Example 2: Cai took one item, worth two points and scored 1 out of 2 points

<table>
<thead>
<tr>
<th>Points Available</th>
<th>Expected score for proficiency</th>
<th>Cai’s Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.4</td>
<td>1</td>
</tr>
</tbody>
</table>

Target Score: $\frac{1 - 1.4}{2} = -0.2$

Example 3: Mani took two items, both worth one point, and the easier one correct but the harder one incorrect

<table>
<thead>
<tr>
<th>Points Available</th>
<th>Expected score for proficiency</th>
<th>Mani’s Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.7</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Total: 2

Target Score: $\frac{1 - 1.2}{2} = -0.1$

"Proficiency" changes with each grade – we expect students to know and do more each year.
Effect size = mean target score / Standard deviation

Both groups have a target effect size of 0.2
Comparison to what districts already see

• Districts already see “Above proficient” “Near Proficient” or “Below Proficient” for the targets.

• Effect sizes near .2 roughly correspond to “above proficient” and below -.2 roughly correspond to “below proficient”. We thus set .2 as a “meaningful” difference

• A more nuanced approach – how far above proficient?

• Year to year view without clicking between windows
Target Performance
Target Data Considerations

Target performance was evaluated in two ways at the state and district level:

• Grade level target performance over time
• Domain performance across grades and over time
  • Rough and matched cohorts

Additional evaluation of target data at the state level included:

• Math certifications vs. elementary certifications
• Demographic performance
Domain Data

- We wanted to connect the performance of the same students year over year. We aggregated the items into domains.

<table>
<thead>
<tr>
<th>Elementary domains (3-5)</th>
<th>Middle Grades domains (6-8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Algebraic Thinking</td>
<td>Ratios and Proportional Relationships (6th and 7th grades only)</td>
</tr>
<tr>
<td>Numbers and Operations Base 10</td>
<td>The number system</td>
</tr>
<tr>
<td>Numbers and Operations: Fractions</td>
<td>Expressions and Equations</td>
</tr>
<tr>
<td>Measurement and Data</td>
<td>Functions (8th grade only)</td>
</tr>
<tr>
<td>Geometry</td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td>Statistics and Probability</td>
</tr>
</tbody>
</table>

- And looked at cohorts of students

<table>
<thead>
<tr>
<th></th>
<th>Graduation Year</th>
<th>Grade 3 Test Year</th>
<th>Grade 4 Test Year</th>
<th>Grade 5 Test Year</th>
<th>Grade 6 Test Year</th>
<th>Grade 7 Test Year</th>
<th>Grade 8 Test Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary Cohorts</td>
<td>2026</td>
<td>2017</td>
<td>2018</td>
<td>2019</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2025</td>
<td>2016</td>
<td>2017</td>
<td>2018</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Cohorts</td>
<td>2023</td>
<td></td>
<td></td>
<td></td>
<td>2017</td>
<td>2018</td>
<td>2019</td>
</tr>
<tr>
<td></td>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td>2016</td>
<td>2017</td>
<td>2018</td>
</tr>
</tbody>
</table>

Matched cohort; those students who stayed in district for grades 3-5 or grades 6-8.
Rough cohort – all students in a district.
State Results
Grade 3

3rd Grade Target Performance

Target
- Develop understanding of fractions as numbers.
- Multiply and divide within 100.
- Reason with shapes and their attributes.
- Recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.
- Represent and interpret data.
- Represent and solve problems involving multiplication and division.
- Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.
- Solve problems involving the four operations, and identify and explain patterns in arithmetic.
- Understand concepts of area and relate area to multiplication and to addition.
- Understand properties of multiplication and the relationship between multiplication and division.
- Use place value understanding and properties of arithmetic to perform multi-digit arithmetic.

solid = Major, dashed = Additional, dotted = Supporting
Grade 4

4th Grade Target Performance

Target
- Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.
- Draw and identify lines and angles, and classify shapes by properties of their lines and angles.
- Extend understanding of fraction equivalence and ordering.
- Gain familiarity with factors and multiples.
- Generalize place value understanding for multi-digit whole numbers.
- Generate and analyze patterns.
- Represent and interpret data.
- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
- Understand concepts of angle and measure angles.
- Understand decimal notation for fractions, and compare decimal fractions.
- Use place value understanding and properties of operations to perform multi-digit arithmetic.
- Use the four operations with whole numbers to solve problems.

Year

solid = Major, dashed = Additional, dotted = Supporting
Grade 5

5th Grade Target Performance

Target
- Analyze patterns and relationships.
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions.
- Classify two-dimensional figures into categories based on their properties.
- Convert like measurement units within a given measurement system.
- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Perform operations with multi-digit whole numbers and with decimals to hundredths.
- Represent and interpret data.
- Understand concepts of volume and relate volume to multiplication and to addition.
- Understand the place value system.
- Use equivalent fractions as a strategy to add and subtract fractions.
- Write and interpret numerical expressions.

Year
2016 2017 2018 2019

Effect
solid = Major, dashed = Additional, dotted = Supporting
Grade 6

6th Grade Target Performance

Target
- Apply and extend previous understandings of arithmetic to algebraic expressions.
- Apply and extend previous understandings of multiplication and division to divide fractions by fractions.
- Apply and extend previous understandings of numbers to the system of rational numbers.
- Compute fluently with multi-digit numbers and find common factors and multiples.
- Develop understanding of statistical variability.
- Reason about and solve one-variable equations and inequalities.
- Represent and analyze quantitative relationships between dependent and independent variables.
- Solve real-world and mathematical problems involving area, surface area, and volume.
- Summarize and describe distributions.
- Understand ratio concepts and use ratio reasoning to solve problems.

solid = Major, dashed = Additional, dotted = Supporting
Grade 7

7th Grade Target Performance

Target

- Analyze proportional relationships and use them to solve real-world and mathematical problems.
- Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.
- Draw informal comparative inferences about two populations.
- Draw, construct and describe geometrical figures and describe the relationships between them.
- Investigate chance processes and develop, use, and evaluate probability models.
- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.
- Use properties of operations to generate equivalent expressions.
- Use random sampling to draw inferences about a population.

Year

2016 2017 2018 2019

Effect

solid = Major, dashed = Additional, dotted = Supporting

CONNECTICUT STATE DEPARTMENT OF EDUCATION
Grade 8

8th Grade Target Performance

Target
- Analyze and solve linear equations and pairs of simultaneous linear equations.
- Functions: Define, evaluate, and compare functions.
- Investigate patterns of association in bivariate data.
- Know that there are numbers that are not rational, and approximate them by rational numbers.
- Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.
- Understand and apply the Pythagorean theorem.
- Understand congruence and similarity using physical models, transparencies, or geometry software.
- Understand the connections between proportional relationships, lines, and linear equations.
- Use functions to model relationships between quantities.
- Work with radicals and integer exponents.
# Major work of the Grade

<table>
<thead>
<tr>
<th>Grade</th>
<th>Above Proficient</th>
<th>Near Proficient (Above)</th>
<th>Near Proficient (Below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Fractions as Numbers</td>
<td>Solve problems with time, volume, mass</td>
<td>Solve problems with multiplication and division</td>
</tr>
<tr>
<td></td>
<td>Solve problems with time, volume, mass</td>
<td>Area related to multiplication and division</td>
<td>Multiply and divide whole numbers</td>
</tr>
<tr>
<td></td>
<td>Solve problems with multiplication and division</td>
<td>Properties of multiplication and division</td>
<td>Multiply and divide within 100</td>
</tr>
<tr>
<td></td>
<td>Solve problems with the four operations</td>
<td>Solve problems with the four operations</td>
<td>Solve problems with multiplication and division</td>
</tr>
<tr>
<td>4</td>
<td>Fractions from unit fractions</td>
<td>Decimal notation for fractions</td>
<td>Fraction equivalence and ordering</td>
</tr>
<tr>
<td></td>
<td>Decimal notation for fractions</td>
<td>Place value and multi-digit arithmetic</td>
<td>Operations with decimals to hundredths</td>
</tr>
<tr>
<td></td>
<td>Place value and multi-digit arithmetic</td>
<td>Understanding the place value system</td>
<td>Ratio reasoning to solve problems</td>
</tr>
<tr>
<td></td>
<td>Understanding the place value system</td>
<td>Use equivalent fractions to add and subtract</td>
<td>Independent and dependent variables</td>
</tr>
<tr>
<td>5</td>
<td>Volume with multiplication and addition</td>
<td>Multiply and divide fractions</td>
<td>Solve problems with expressions and equations</td>
</tr>
<tr>
<td></td>
<td>Multiply and divide fractions</td>
<td>Understand the place value system</td>
<td>Solve problems with expressions and equations</td>
</tr>
<tr>
<td></td>
<td>Understand the place value system</td>
<td>Use equivalent fractions to add and subtract</td>
<td>Solve problems with expressions and equations</td>
</tr>
<tr>
<td>6</td>
<td>Divide fractions</td>
<td>Algebraic expressions</td>
<td>One variable equations</td>
</tr>
<tr>
<td></td>
<td>Algebraic expressions</td>
<td>One variable equations</td>
<td>One variable equations</td>
</tr>
<tr>
<td></td>
<td>One variable equations</td>
<td>Rational number system</td>
<td>Four operations with rational numbers</td>
</tr>
<tr>
<td>7</td>
<td>Generate Equivalent Expressions</td>
<td>Proportional relationships</td>
<td>Solve (pairs of) linear equations</td>
</tr>
<tr>
<td></td>
<td>Proportional relationships</td>
<td>Radicals and exponents</td>
<td>Define, evaluate and compare functions</td>
</tr>
<tr>
<td>8</td>
<td>Pythagorean Theorem</td>
<td>Functions to model relationships</td>
<td>Congruence and similarity</td>
</tr>
</tbody>
</table>
Target Connections

- Coherence within and across grades
- Logical pre-requisites needed for student success of mathematical content
- Content standard clusters are the same as the targets
- Mapping clusters to targets to understand connections between targets
## Impact of Connections

<table>
<thead>
<tr>
<th>M + 3D</th>
<th>Solve problems involving the four operations, and identify and explain patterns in arithmetic.</th>
<th>4A</th>
<th>4C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A + 3E</td>
<td>Use place value understanding and properties of operations to perform multi-digit arithmetic.</td>
<td>4D</td>
<td>4E</td>
</tr>
<tr>
<td>M = 3F</td>
<td>Develop understanding of fractions as numbers.</td>
<td>3K</td>
<td>5F</td>
</tr>
<tr>
<td>M + 3G</td>
<td>Solve problems involving measurement and estimation of intervals of time, liquid volumes, and</td>
<td>4I</td>
<td></td>
</tr>
<tr>
<td>S - 3H</td>
<td>Represent and interpret data.</td>
<td>4J</td>
<td></td>
</tr>
<tr>
<td>M - 3I</td>
<td>Geometric measurement: understand concepts of area and relate area to multiplication and to</td>
<td>3J</td>
<td>5I</td>
</tr>
<tr>
<td>A - 3I</td>
<td>Geometric measurement: recognize perimeter as an attribute of plane figures and 3-4 distinguish</td>
<td>4I</td>
<td></td>
</tr>
<tr>
<td>S + 3K</td>
<td>Reason with shapes and their attributes</td>
<td>4L</td>
<td>5K</td>
</tr>
<tr>
<td>M - 4A</td>
<td>Use The Four Operations With Whole Numbers To</td>
<td>5F</td>
<td>5A</td>
</tr>
<tr>
<td>A + 4C</td>
<td>Generate And Analyze Patterns</td>
<td>5B</td>
<td></td>
</tr>
<tr>
<td>S + 4B</td>
<td>Gain Familiarity With Factors And Multiples</td>
<td>6E</td>
<td>6C</td>
</tr>
<tr>
<td>M + 4D</td>
<td>Generalize Place Value Understanding For Multi-Digit Whole Numbers</td>
<td>4E</td>
<td>5C</td>
</tr>
<tr>
<td>M + 4E</td>
<td>Use Place Value Understanding And Properties Of Operations To Perform Multi-Digit Arithmetic</td>
<td>5D</td>
<td>4A</td>
</tr>
<tr>
<td>M + 4F</td>
<td>Extend Understanding Of Fraction Equivalence And Build Fractions From Unit Fractions By Applying And Extending Previous Understandings Of</td>
<td>4H</td>
<td>5E</td>
</tr>
<tr>
<td>M + 4G</td>
<td>Understand Decimal Notation For Fractions, And Compare Decimal Fractions</td>
<td>4I</td>
<td>5C</td>
</tr>
<tr>
<td>M + 4H</td>
<td>Solve Problems Involving Measurement And Conversion Of Measurements From A Larger Unit</td>
<td>6H</td>
<td>5I</td>
</tr>
<tr>
<td>S + 4I</td>
<td>Represent And Interpret Data.</td>
<td>5H</td>
<td></td>
</tr>
<tr>
<td>S + 4J</td>
<td>Geometric Measurement: Understand Concepts Of Angle And Measure Angles.</td>
<td>7F.5</td>
<td>HS.G-CO.A</td>
</tr>
<tr>
<td>A + 4K</td>
<td>Draw And Identify Lines And Angles, And Classify Shapes By Properties Of Their Lines And Angles.</td>
<td>5K</td>
<td></td>
</tr>
<tr>
<td>A + 5A</td>
<td>Write and interpret numerical expressions.</td>
<td>6E</td>
<td>6C</td>
</tr>
<tr>
<td>A - 5B</td>
<td>Analyze patterns and relationships.</td>
<td>6E</td>
<td>6G</td>
</tr>
</tbody>
</table>
Teacher Content Knowledge

• Drop in performance at 5\textsuperscript{th} and 6\textsuperscript{th} grade

• Queried the teacher certifications for all teachers in the state. All teachers must hold some certification, but some hold (either primarily, or in addition), Math Elementary, Math Middle School, Bilingual Math Elementary or Bilingual Math Middle School.

• Calculated the percent of full time equivalent teachers at a grade level in a given school who held a math certification. Ultimately categorizing students as belonging to a grade/school where some teachers held math certification verses no teachers held math certification

• Unable to directly match students to teachers.

• All 7\textsuperscript{th} and 8\textsuperscript{th} grade teachers must hold a math specific endorsement.

• The plots do not control for SES or other demographic information.
Certification Impact Grades 3-4

Some = 5.6% of students

Some = 9.1% of students
Certification Impact Grades 5-6

Some = 18.2% of students

Some = 63.3% of students
Domain Rough Cohort 3-5
Domain Rough Cohort 6-8

Statewide Rough Cohorts
Common Domains for Grades 6-8

Proficiency Effect Size

Proficient

Domain
- Expressions and Equations
- Geometry
- Ratios and Proportional Relationships
- Statistics and Probability
- The Number System

Graduation Year
- • 2022
- - 2023

Grade

6 7 8
Sample Race/Ethnicity

3rd Grade Target Performance
By Race/Ethnicity

Target
- Develop understanding of fractions as numbers.
- Multiply and divide within 100.
- Represent and solve problems involving multiplication and division.
- Solve problems involving the four operations, and identify and explain patterns in arithmetic.
- Understand concepts of area and relate area to multiplication and to addition.
- Understand properties of multiplication and the relationship between multiplication and division.

Race/Ethnicity
- Asian
- Black Or African American
- Hispanic
- White

8th Grade Target Performance
By Race/Ethnicity

Target
- Analyze and solve linear equations and pairs of simultaneous linear equations.
- Functions/Define, evaluate, and compare functions.
- Understand and apply the Pythagorean theorem.
- Understand congruence and similarity using physical models, transparencies, or geometry software.
- Understand the connections between proportional relationships, lines, and linear equations.
- Use functions to model relationships between quantities.
- Work with radicals and integer exponents.
Sample Gender
Sample Economic Disadvantage Status

3rd Grade Target Performance
By Economic Disadvantaged Status

Target
- Develop understanding of fractions as numbers.
- Multiply and divide within 100.
- Represent and solve problems involving multiplication and division.
- Solve problems involving measurement and estimation of intervals of time, liquid volume, and masses of objects.
- Solve problems involving the four operations, and identify and explain patterns in arithmetic.
- Understand concepts of area and relate area to multiplication and to addition.
- Understand properties of multiplication and the relationship between multiplication and division.

Economic Status
- =
- Economic Disadvantage Status

8th Grade Target Performance
By Economic Disadvantaged Status

Target
- Analyze and solve linear equations and pairs of simultaneous linear equations.
- Functions: Define, evaluate, and compare functions.
- Understand and apply the Pythagorean theorem.
- Understand congruence and similarity using physical models, transparencies, or geometry software.
- Understand the connections between proportional relationships, lines, and linear equations.
- Use functions to model relationships between quantities.
- Work with radicals and integer exponents.

Economic Status
- =
- Economic Disadvantage Status
A Look at District Data
District Graphs

• Individual districts data for grade level and cohort performance was plotted
• Plots are intended to assist in identifying school needs such as:
  • Professional development
  • Curricula modifications
  • Resources
Elementary Sample

District A
Common Domains for Grades 3-5

District B
Common Domains for Grades 3-5
Middle School Sample

District C
Common Domains for Grades 6-8

District D
Common Domains for Grades 6-8
Beyond Claim 1
Claim 2 is most closely linked to math practice 1, 5, 7, and 8
• Make sense of problems and persevere in solving them
• Use appropriate tools strategically
• Look for and make use of structure
• Look for and express regularity in repeated reasoning

Claim 3 is most closely linked to math practice 3 and 6
• Construct viable arguments and critique the reasoning of others
• Attend to precision

Claim 4 is most closely lined to math practice 2, 4, and 5
• Reason abstractly and quantitatively
• Model with mathematics
• Use appropriate tools strategically
Claim 2

All Connecticut students

Target
- Apply mathematics to solve well-posed problems arising in everyday life, society, and the workplace.
- Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flow charts, or formulas).
- Interpret results in the context of a situation.
- Select and use appropriate tools strategically.
Claim 3

All Connecticut students

Target
- Base arguments on concrete referents such as objects, drawings, diagrams, and actions.
- Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures.
- Distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in the argument—explain what it is.
- State logical assumptions being used.
- Test propositions or conjectures with specific examples.
- Use the technique of breaking an argument into cases.
Claim 4

Claim 4
All Connecticut students

Target
- Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.
- Apply mathematics to solve problems arising in everyday life, society, and the workplace.
- Construct, autonomously, chains of reasoning to justify mathematical models used, interpretations made, and solutions proposed for a complex problem.
- Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flow charts, or formulas).
- Identify, analyze, and synthesize relevant external resources to pose or solve problems.
- Interpret results in the context of a situation.
- State logical assumptions being used.
Summary
Broad Conclusions

• By 2019 all grade three targets near proficiency
• Targets related to problem solving have the greatest need
• Fractions domain has steepest decline in cohort data
• Younger students consistently higher performing than older peers
• Depressed performance 6-8
• Large differences between racial and ethnic groups and these differences grow over time
• Large disparity between students who are economically disadvantaged and those that are not
• Starkest difference between students identified as limited English proficiency
• Targets with higher DOK expectations have lower performance
Moving Forward

• Feedback on using the analysis to improve mathematics education
  – Professional learning
  – Curriculum development/revision
  – Instructional practice

• Additional analysis and similar plots by:
  – Performance band
  – SPED identification
  – Schools

• Suggestions on additional enhancements
Next Steps

• Look at the plots for your own district by accessing the report.
  – Remember that this is a comparison to expectations – and our expectations change for each grade
  – Individual students for interventions are not identified based on this analysis

• What do the plots of the data tell you about math target performance in your district?
  – Strengths and areas in need of improvement

• What conclusions can be made about mathematics education in your district?
  – Think about root cause

• What can your district do to address the areas in need of improvement?
  – Action plan
Thank You

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References


• Sparks, S. D. (2018). A primer on continuous school improvement. Education Week. 37(19) 15.