Math Performance Report

Math Madness: Where students are struggling and how to get them back on track!

www.prodigygame.com
Fall 2022
Executive Summary

At Prodigy Education, our mission is to help every student in the world love learning. Our adaptive learning games, Prodigy Math and Prodigy English, have been designed to do just that by putting Motivation First!

In this report, we present the results from an anonymized analysis of a subset of the nearly 5 billion math questions that students answered on Prodigy Math in the last school year. By sharing these insights, we aim to support teachers in identifying where students may be falling short - and how to get them back on track.

Key Findings

In reviewing math questions answered by 38 million students in 1st- to 6th-grade on Prodigy Math last school year, some clear patterns of struggle emerged:

1st to 3rd grade:
- Word Problems (1st to 3rd grade)
- Number Lines (1st to 3rd grade)
- Fractions (3rd grade)

4th to 6th grade:
- Line Plots (4th grade)
- Unit Conversions (5th grade)
- Multiplying and Dividing Fractions (6th grade)

In this Math Performance Report, we dive deeper into each of these topics to provide further context and sample questions. Plus, you'll find some teacher-to-teacher tips that'll help you put these findings into practice right away.
Math Scores Have Dropped Post-COVID

Student achievement in both math (and reading) in the United States is in a worrying state following the global COVID-19 pandemic. As a report from the National Center for Education Statistics (NCES, 2022) outlining the results of the ‘National Assessment of Educational Progress: Long-term Trend—Reading and Mathematics’ assessments states, “This is the largest average score decline in reading since 1990, and the first ever score decline in mathematics.”

In 2022, the United States Department of Education (USDOE) released its 2022–2026 Strategic Plan. It included a focus on “addressing digital fluency through instruction that leverages technology as a creative and playful medium that enhances student learning” (2022, p.18).

When we consider the findings from the National Center for Education Statistics (NCES) and the Strategic Plan from the USDOE, two key takeaways are:

- Action is needed to support students’ long-term success in math
- The integration of playful, technology-based learning tools is recommended

Prodigy Education is Here to Help

Prodigy Math is used by millions of students in classrooms and in homes across North America. It was named the most-used supplemental resource in the United States during the 2021–2022 school year (LearnPlatform, 2022). Using Prodigy Math, American students collectively answered nearly 5 billion standards-aligned math questions and spent over 3,500 years of cumulative time answering them. As a result, Prodigy Education is uniquely positioned to support parents, teachers, and learners during a time when that support is needed most.

Images: (Left) In Prodigy Math, students can engage in competitive gameplay with friends and foes. (Right) The question interface in Prodigy Math includes access to video lessons, hints, and digital manipulatives.
A Closer Look: 1\textsuperscript{st} to 3\textsuperscript{rd} Grade

According to the Common Core Standards Initiative (n.d.), educators working with 1\textsuperscript{st}- to 3\textsuperscript{rd}-grade students should focus their instructional time on the following areas:

<table>
<thead>
<tr>
<th>1\textsuperscript{st} Grade</th>
<th>2\textsuperscript{nd} Grade</th>
<th>3\textsuperscript{rd} Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition and subtraction up to 20.</td>
<td>Numbers in base-ten notation</td>
<td>Understand how to multiply and divide inducing strategies for doing so up to 100.</td>
</tr>
<tr>
<td>Whole numbers and place value (including grouping in ones and tens)</td>
<td>Build stronger fluency in addition and subtraction.</td>
<td>Learn how to use fractions, specifically unit fractions.</td>
</tr>
<tr>
<td>Linear measurement in various units.</td>
<td>Use standard units of measurement.</td>
<td>Build knowledge of area and rectangular arrays.</td>
</tr>
<tr>
<td>Reason with the elements of geometric shapes including building them and breaking them down.</td>
<td>Outline and analyze key features of geometric shapes.</td>
<td>Outline key features of two-dimensional shapes and analyze them.</td>
</tr>
</tbody>
</table>

According to the Common Core Standards Initiative (n.d.), educators working with 1\textsuperscript{st}- to 3\textsuperscript{rd}-grade students should focus their instructional time on the following areas:

- **685M** Math questions answered during the 2021–2022 school year by 1\textsuperscript{st}- to 3\textsuperscript{rd}-grade students in Common Core State Standards math content on Prodigy Math.
- **2700** Years equivalent of combined time answering math questions from August 1, 2021, and June 30, 2022, in all US-based curricula, 1\textsuperscript{st} to 3\textsuperscript{rd} grade.
- **24.5M** Number of unique students who logged into a Prodigy Math account at least once between August 1, 2021, and June 30, 2022, 1\textsuperscript{st} to 3\textsuperscript{rd} grade.
1st to 3rd grade

Area of Struggle: Word Problems

Helpful Context:

While word problems with lots of text can cause young students to become overwhelmed, questions with minimal text can also be misunderstood by students even when they are able to perform math calculations well. In the example shown here, the most common incorrect answer chosen by students was “11” which tells us that it’s likely students are incorrectly interpreting the word “more” as a sign that they should be doing addition.

Sample problem: 1st grade

This table shows the results of a class survey:

<table>
<thead>
<tr>
<th></th>
<th>Pizza</th>
<th>Spaghetti</th>
<th>Lasagna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>1</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

How many more people picked ‘Lasagna’ than ‘Pizza’?

Teacher-to-Teacher Tip:

“I recommend teaching math vocabulary within context rather than in isolation. While methods such as teaching keywords or using the ‘CUBES method’ may be a tempting way to simplify and proceduralize word problems, it requires more logic-based thinking from students.

One powerful practice is to have students pair up and read problems to one another. While one student is reading, they can ask their partner what they think each sentence or piece of information means. By having conversations about the math together, the words and scenarios become more meaningful rather than something to quickly filter through.”

Joshua Prieur
Director, Educational Efficacy
1st to 3rd grade

Area of Struggle: Number Lines

Helpful Context:

Students are often pros when it comes to answering addition and subtraction questions. Things can get trickier when they’re asked to write/read addition or subtraction sentences—especially when interpreting from number lines. The most common incorrect answer to this sample question was “A” which signals that students may have difficulty comprehending how the information shown on a number line translates into a number-based sentence. It might also be worth considering whether students understand why the commutative property applies for addition but not for subtraction.

Sample problem: 1st grade

Teacher-to-Teacher Tip:

“I recommend exposing students to more natural opportunities to use number lines. For example, you can easily create small laminated number lines to stick to students’ desks or add a large number line on the classroom carpet for students to move across. In addition, you could look to relate number line operations to tangible objects such as counters.

By incorporating these highly-visual elements into regular math conversations, students will move from seeing number lines as an overwhelming challenge to seeing them as a tool that can help them think.”

Krystin Champagne
Education Specialist, Lead
3rd grade
Area of Struggle: Fractions

Helpful Context:
Fractions themselves can be tricky and troublesome for students, and Prodigy Math results show that they were especially difficult for students when they were represented on a number line.

In this sample question, students should click where “⁴⁄₆” is on this number line to answer the question correctly. The most common incorrect answer we saw chosen was “²⁄₆”. This likely points to students misunderstanding the value of fractions—they may often think only of the numerator as representing the number of ticks they need to count on the number line, rather than looking at both the numerator and the denominator.

Sample problem: 3rd grade

Teacher-to-Teacher Tip:
“I recommend using tangible manipulatives that students can work flexibly with. These can help them grasp the concept of fractions as quantities. Fractions are often related to real-world objects such as pizzas or candy bars with the intention to help make them relatable; however, if a student learns once that a whole pizza has eight slices, then they might always think that the denominator and numerator both need to be eight in order to have something that is “whole” (equal to one).

By having students work with manipulatives such as snap-cubes, fraction rods/strips (try them unlabelled!) and, even graph paper, students can visualize pieces/parts of a whole without being distracted or confused by unnatural real-world scenarios (such as how to divide ⁷⁄₆” of a candy bar among five friends).”
A Closer Look: 4th to 6th Grade

According to the Common Core Standards Initiative (n.d.), educators working with 4th- to 6th-grade students should focus their instructional time on the following areas:

<table>
<thead>
<tr>
<th>4th Grade</th>
<th>5th Grade</th>
<th>6th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-digit multiplication and division.</td>
<td>Adding, subtracting, dividing, and multiplying fractions.</td>
<td>Ratio and rate to whole number multiplication and division, and using ratio and rate to solve problems.</td>
</tr>
<tr>
<td>Fractions, including equivalence, addition and subtraction of fractions with like denominators, and multiplication of fractions by whole numbers.</td>
<td>Dividing with two-digit divisors, integrating decimal fractions into the place value system, operations with decimals (to hundredths), and operations using whole numbers and decimals.</td>
<td>Division of fractions, extending the notion of number to the system of rational numbers, including negative numbers.</td>
</tr>
<tr>
<td>Classifications and properties of geometric shapes that allow them to be analyzed.</td>
<td>The concept of volume.</td>
<td>Write, interpret, and use equations and expressions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Statistical thinking.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>147M</strong></th>
<th><strong>80%</strong></th>
<th><strong>815</strong></th>
<th><strong>13.5M</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Math questions answered during the 2021–2022 school year by 4th- to 6th-grade students in Common Core State Standards math content on Prodigy Math.</td>
<td>In a 2021 survey by Prodigy Education, 8 out of 10 students in 5th to 8th grade said that Prodigy was their favorite way to do math.</td>
<td>Years equivalent of combined time answering math questions from August 1, 2021, and June 30, 2022, in all US-based curricula, 4th to 6th grade.</td>
<td>Number of unique students who logged into a Prodigy Math account at least once between August 1, 2021, and June 30, 2022, 4th to 6th grade.</td>
</tr>
</tbody>
</table>
4th grade

Area of Struggle: Word Problems – Line Plots

Helpful Context:

Students often misunderstand word scenarios which can lead to incorrect calculations. In this sample question, students are asked to read the line (or dot) plot and find the total time of the five shortest flights. Nearly 40% of student responses are “20 $\frac{5}{8}$ h” which means that many students are looking at the shortest flight (4 $\frac{1}{8}$ h) and multiplying it by five while there are only two flights of that length. Students are not realizing that they need to then look to the next three shortest flights (4 $\frac{3}{8}$ h) and add those to the two shorter flights. Thus, while students understand what a line plot is and how to read fractions on a number line, they don’t always understand how to use it when thinking about it in mathematical situations.

Sample problem: 4th grade

A group of 4th grade students measured the time of some flights to the closest $\frac{1}{4}$ hours. Measurement of the Time of Flights

What is the total time of the 5 shortest flights?

Teacher-to-Teacher Tip:

“I recommend starting with line plot data points as values when discussing them in class. You might say, “Each dot represents one pig.” As you move on to more complicated graphs, continue having students refer to them by what they’re worth. For example, you could say: “Each dot represents two centimeters, so four dots represent what?”

Another tactic you can implement is to have students extract the data from the line plot. For this sample question, we might ask students what the lengths of each of the different flights were (and write them out in a table). After the data gets extracted, students could then identify the shortest by length of time and how many of each there are before adding them together.”

Joshua Prieur
Director, Educational Efficacy
5th grade

Area of Struggle: Unit Conversions

Helpful Context:

Unit conversions can be something that trips up even the savviest of students. Based on our observations, it seems like the biggest challenge is that students haven’t fully developed the natural instincts that might logically tell them whether a unit conversion just doesn’t seem quite right. For example, in this sample question, the most common incorrect response was that 356 lbs = 22.25 oz. So, rather than multiplying the number of pounds by 16, students are dividing, erroneously leading them to a smaller number.

Sample problem: 5th grade

Teacher-to-Teacher Tip:

“I recommend having students frequently relate units to real-world items to make them less abstract. Students should be able to automatically catch that 356 lbs couldn’t possibly be 22 oz. just as naturally as they would know that 10 + 12 couldn’t possibly be two.

When doing word problems and real-world problems, use measurements that are as realistic as possible so that scenarios like backpacks that can only carry a maximum of 135 mg of weight don’t fly over their heads as something normal. Engage in lots of estimation exercises in various units. Whenever possible, have students work hands-on with (or look at) visuals of real-world objects to make connections between units and what we would commonly measure them with.”

Krystin Champagne
Education Specialist, Lead
6th grade

Area of Struggle: Multiplying and Dividing

Helpful Context:
Fraction operations are easy prey for tips and tricks like “just multiply across” that can rob students of important conceptual learning opportunities. Unfortunately, students can easily misremember these tricks. If there isn’t a deep conceptual understanding, students won’t have the instinct to detect when their trick has given them the correct answer or one that is way off. In this sample question, over 13% of students incorrectly answered “1/12.”

Sample problem: 6th grade

Teacher-to-Teacher Tip:
“I recommend using the term “of” in place of “multiplied by” when discussing how to multiply fractions. You can build on this by using manipulatives so that students can begin considering how they would sort out “one-fourth of eight counters.”

When dividing fractions, have students create their own abstract drawings (of objects or fraction strips) as they work through visualizing the division of the same fractions (e.g., 3/4 ÷ 3/4) to then divide fractions with like-denominators (e.g., 3/4 ÷ 1/4). As you move into dividing simpler fractions with unlike denominators, such as 3/5 ÷ 1/2, have students draw and converse through “How many ‘½s’ can we make out of ‘3/5’?” just as they would for dividing whole numbers (e.g., “How many 3s could we get out of ½?”). Once students are comfortable making sense of this concept, you can begin drawing connections between how “multiplying by the reciprocal” is similar to strategies they may have been using in their illustrations (e.g., finding common denominators).”

Stephanie McEwan
Education Specialist
Methodology

The Math Performance Report was developed using anonymized achievement data derived from 1st to 6th grade students’ use of Prodigy Math during the 2021–2022 school year. This included only students who were assigned Common Core State Standards for Mathematics content by their parent/guardian or teacher.

All data were aggregated into a peer-reviewed dashboard that was sorted by grade level. It is important to note that the aggregated data was dependent on the amount of grade-level curriculum students collectively completed. The data were then broken down by domain, cluster, standard, and skill¹, as depicted in the image below.

How domains, standards, clusters, and skills layer into one another.

Student performance on math content covering depth of knowledge level 1–3 questions (Guido, 2022) was evaluated both grade-by-grade and in two distinct categories: 1st to 3rd grade and 4th to 6th grade. Emphasis was placed on the questions that were most often answered incorrectly (as well as the most commonly submitted incorrect answers) within each skill. This information provided clues as to which content was the most troublesome and made it possible to identify probable reasons why students were struggling.

¹ Skills are defined by Prodigy Education as the areas of content that students must understand in order to master a specific standard. Some standards have many skills while others have only one.
Conclusion

It is our hope that these insights and teacher-to-teacher tips will be useful to teachers as they consider how to support their students during the 2022–2023 school year and beyond.

Creating this report would not have been possible without students’ and teachers’ use of Prodigy Math, a digital game-based learning tool offered by Prodigy Education. Prodigy Education’s mission is to help every student in the world love learning. As part of this mission, we ensure all of our in-game educational content and core gameplay features are completely free to access for everyone.

You can easily join the growing community of more than 3 million teachers who already rely on Prodigy’s games as free and effective classroom support tools. In addition to the no-cost educational content, teachers also benefit from features designed specifically for them, including:

• Assessment tools that allow teachers to align the math content that students see in Prodigy Math to the content being taught in class.

• Insightful reports that include real-time data designed to help surface insights about individual students’ learning progress.

For more information on how Prodigy Education can help support your class, or to create your free Teacher account, please [click here](#) to visit our website.
References


