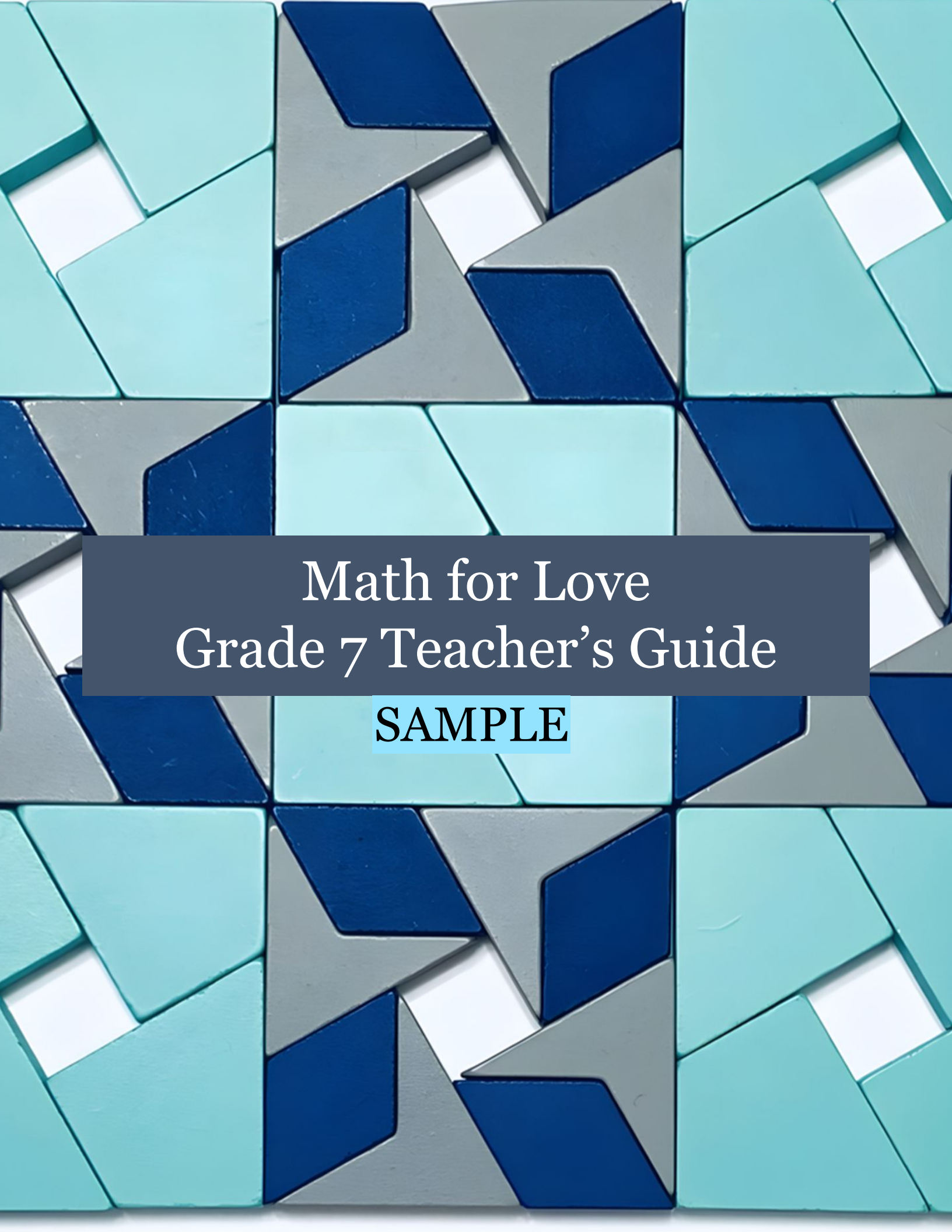


Math for Love
Grade 7 Teacher's Guide

SAMPLE

Introduction

Welcome to the Math For Love Supplemental Curriculum! We are thrilled that you will be using this curriculum with your students. Like the lesson plans, we'll make this introduction quick, easy to read, and useful.

We are Math For Love, an organization dedicated to transforming how math is taught and learned. Our passion is connecting students and teachers with opportunities to experience excellent mathematics, deepening everyone's skill and enjoyment in the process.

The Math For Love Supplemental Curriculum is built on our belief that *play* and *rigor* go hand in hand, and that the best of mathematics is accessible to students and teachers who are ready to work hard and have fun. You and your students will learn a lot of math over the next 80 lessons, and by the end we hope you'll see why we think math is one of the best parts of the day.

The Big Picture

We built this curriculum with a few key principles in mind.

Principle 1.
Every student can participate in rigorous mathematical thinking.
Rigorous mathematical thinkers want to understand *why*, not just get the answer. They make connections and seek underlying structure and coherence. They develop powerful tools to solve problems, including fact fluency and procedural efficiency. Rigorous mathematical thinkers ask questions, make conjectures and predictions, test out their ideas relentlessly, and expect to be surprised.

Principle 2.
Play is the engine of learning.
Mathematicians engage in play constantly: exploring, wondering, noticing, and being led by curiosity. Play can transform math class from tedious to joyful, from shallow to deep, from mundane into fascinating. Students at play are more likely to persist, to build tenacity, to remember, and to learn. Play is the secret sauce that helps students come to love and succeed in mathematics.

Principle 3.
Without rigor, mathematical play is formless.
Without play, mathematical rigor is unsustainable.
We need both, together, to get the most out of mathematics.

In this introduction, we'll discuss some specific teacher moves that can help encourage rigorous mathematical play.

But first, some details.

The Details

The Math For Love Supplemental Curriculum is built to provide eighty days of 1-hour (or longer) classes, intended to complement a standard curriculum. It can be used for small groups, enrichment, remediation, after school programs, and summer programs. Every lesson is written to accommodate a wide range of student skill level, making it easy and enjoyable to differentiate and support each individual's learning. Our belief is that beautiful and interesting math problems — when designed to be appropriately accessible — should be offered to everyone, no matter where they are in their math journey.

Materials included with curriculum:

- Teacher Guide
- Student Workbooks
- Manipulative Kit
- Math Games

The Lessons

Each lesson follows a standard format with four sections:

- Opener
- Main Activity
- Closer
- Choice Time

We sometimes provide a sketch of how a lesson might unfold, with prompts and questions to help you respond organically to what your students bring to the conversation. Any sample dialog is never meant to be a script, and precisely how the lesson goes will depend on you and your students.

We include guidelines for how long we expect each part of the day will take; however, times will vary depending on student engagement and your decisions.

When preparing for a lesson, review all sections of the lesson in advance. This will help you make decisions on how to group students, how to arrange materials, and what images to project. Even a little bit of preparation will help you be ready to emphasize what's important in the lesson and respond naturally to your students' ideas.

Choice Time Days

Occasionally a full lesson - after the Opener - is devoted to Choice Time. These Choice Time Days are intended to give students a chance to dig deeper into any lessons, or relax with some extra time to play the games they already know. As with normal Choice Time, you can use the suggestions we provide, or substitute in other options.

See the sample lesson templates on the next pages for more details about the lesson plans.

SAMPLE DAY	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

This is where we highlight the main standards we're focusing on for the day, particularly in the main activity. We usually highlight one practice standard and one content standard.

Materials: This section will mention everything you need for the day. The main activity will also include a materials list.

Opener	**We'll say what the opener is here**	10 – 15 minutes
Main Activity	**We'll say what the main activity is here**	20 – 40 minutes
Closer	**We'll summarize what's happening in the Closer here**	5 – 10 minutes
Choice Time	• We'll provide a short list of good options for Choice Time here. • You're always welcome to choose different options!	5 – 25 minutes

Standards Connections

These are additional standards that are connected (or could connect) to today's lesson.

Opener

The lessons cycle through a short collection of our favorite opening routines. The first time you see a particular Opener, there will typically be more detail included. Later, these writeups will become shorter and more succinct. Don't be surprised to see the Opener instructions look almost identical on different days - once you're confident with a given opener, it should take very little time to prep for using it with class.

Here are the main Openers we use in this grade.

➔ Would You Rather

Give students a choice between two options. They debate which one is better, using math to convince each other.

➔ Fraction Talks

Project an image that includes several colors.
Prompt: "What fraction of the image is each color?"

➔ Counterexamples

Make a false claim or conjecture.
Invite students to find an example that proves you wrong.

➔ Broken Calculator

Project a calculator with some broken keys, and a target number.
Prompt: how many ways can you hit the target number using the broken calculator?

➔ Teacher-led Games

For example, Bullseyes and Close Calls, Don't Break the Bank, Penny Nickel Dime.

➔ Challenge Problems or Mini-Lessons

A warmup problem, small exploration or lesson.

Tips for the Classroom

1. Look here for some specific ideas for increasing student interaction, adjusting challenge, and more.

2. If there's an image to project for an opener, it's typically on the next page.

Prompts and Questions

- Look here for useful things to say to students to help them get started or push deeper in their thinking.

Main Activity

Materials and Prep

Here's where we describe what students will need for the main activity (doesn't include choice time materials). You'll need to read the lesson to make some decisions about how to arrange the materials for the day. In general, keep this simple – offer containers of manipulatives rather than exact amounts.

Motivating Question (OR How to Play)

To begin working or playing on their own, students should either have a question that frames the day's exploration— along with the knowledge and skill to begin thinking about it — or know the rules of the game they're about to play. We essentialize that question (or summarize those rules) here.

Launch

This is how to introduce the motivating question and get students excited and curious to think about it, or to teach the game in a way students will understand and find irresistible. In the case of games, demonstrating with a student volunteer is almost always the most powerful way to communicate how the game is played.

In general, the Launch should be as thorough as necessary *and* as short as possible. The goal should always be to have the students spending as much time as possible doing the thinking during math class. Whenever you are speaking to the whole class, pose questions and look for opportunities to ask for student ideas, questions, and contributions.

Work

As soon as they're ready, students go to work on their own or in pairs or small groups. This section will have some ideas of what to look for, the lesson flow, extensions, good hints, and (occasionally) solutions.

While students work, circulate in the room, offering help, prompts, hints, asking questions, making connections between ideas, and getting a sense of your students' strengths and where they could benefit from greater support.

Tips for the Classroom

1. Look here for additional ideas on how to implement this activity.
2. We'll often include extensions or simplifications to help with differentiation.
3. Student workbook pages will typically be included on the page right after the Tips for the Classroom.

Launch Key Points

- We try to include some key points for how to help the launch succeed in getting students excited to work.
- Points about the essential knowledge or skills might be here too.

Prompts and Questions

- This section gives ideas for what you might say to students during the "Work" section of the lesson, when they're working on their own or in small groups.
- Sometimes a prompt, hint, or nudge to talk to someone else is all students need.

Closer

Gather the students together for a whole-class discussion when the Main Activity is done. This is where students reflect, consolidate their learning, and potentially try an extension or variation of the Main Activity. To make sure the engaged thinking continues during this part of the day, rather than just summing up what everyone should have learned, take the opportunity to pose questions, invite student comments, and use partner sharing to give everyone a chance to participate.

Prompts and Questions

- These prompts are for the Closer.
- They might be useful things to say to the class as a whole.
- They also might be helpful replies to anticipated student contributions to a closing discussion.

Choice Time

Choice Time is when students get a chance to revisit games, puzzles, and other material they want to spend more time with. Getting to choose their activity helps with buy-in and self-regulation, and is a chance for students to reflect on what they want to think about more.

Choice Time works like this:

1. Present students with a short list of suggested activities.
2. Students choose the game, worksheet, challenge problem, block set, or other activity they'd like to pursue and commit to sticking with it for at least 5 - 10 minutes.
3. If time permits, students can try more than one activity.

The suggestions for Choice Time are only suggestions. If there is another activity from the curriculum that you think would be a better fit here, or if a student has a strong preference for something not on the suggested list, feel free to make a swap.

You may need to print some materials in advance to prepare for Choice Time. Since the final Choice options are up to you, we don't give a list of materials you'll need for them.

Here are some options that can be freely offered any Choice Time:

- Challenge Problems
- Free Block Play
- Multiplication by Heart (once students know how to play it)
- Prime Climb (once students know how to play it)
- Work on problems from an earlier lesson

Teacher Moves

Here are some useful ways to support your students during these lessons.

- **Model enthusiasm and curiosity.** Ask questions. Statements like "I wonder if…" and "I notice that…" go a long way. If students see you enjoying the work, they'll be much more likely to enjoy it too.

- **Keep instructions and launches as brief as possible** (but as long as necessary) and look for places to invite student questions or ideas. As much and as often as possible, we want students to be spending classroom time doing mathematics and thinking mathematically.

- When launching games, **play a demo game with a volunteer** to help students learn the rules. When students play games against each other during work time, try these ways of grouping students:
    - Students play one against one and switch opponents often.
    - Students play in groups of three. Two play while one watches as a referee. When the game is over, the referee position rotates.
    - Students play two against two, and have to agree on moves with their teammate.
    - Students play collaboratively with a partner, and try to get the highest score they can, rather than beat an opponent.

- **Resist solving students' problems for them.** While working on hard problems, it's natural to feel stuck, or unsure of what to do next. Sometimes a key insight requires a lot of exploration first. Give students the time they need.

- **On the other hand, support students when they need it.** There's no use in leaving students feeling dispirited or unsuccessful, and the goal is for students to be productive, even if stuck. We provide ideas for questions, prompts, and hints to keep students motivated and engaged. Even when students are playing or exploring, understand your job as looking for opportunities to help students develop greater efficiency, organization, and power in their methods.

- **Have a plan for how to respond to wrong ideas and answers**. One of the strongest ways to handle these moments is to turn them back to the students by treating the idea seriously and asking for counterexamples or supporting arguments. A very good phrase to keep in your back pocket is: "Convince me."

- **Be willing to be the slowest person in the room**. This means asking for elaboration and clarification if you think there is even one student in the room who doesn't understand an argument yet.

- **Care and respect**. Show students you care about them, respect their thoughts, and that it matters to you that they learn, and enjoy, mathematics.

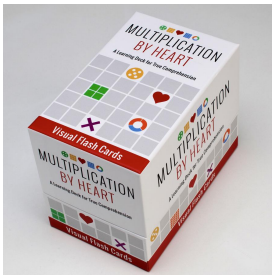
Materials

We provide just about everything you need to use this curriculum with a classroom of 25 (or more) students. The only extras you'll need are scratch paper, pencils, and crayons or colored pencils. You may occasionally need to make some additional photocopies for Choice Time, though students can often turn to earlier pages in their Student Workbook and find what they need. In addition to this Teacher's Guide and the student workbooks, manipulatives and games include:

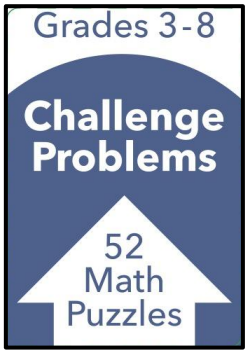
21st Century Pattern Blocks. These blocks include 8 shapes, with enormous possibilities for exploring multiplication, division, fractions, ratios, geometry, and more. These are also great for students to explore with during Choice Time.

Number Rods. Another excellent tool for understanding arithmetic operations, fractions, measurement, and more. Rods go from 1 cm to 10 cm long, in the colors named to the left.

Prime Climb. One of the world's most popular mathematical board games. Includes a unique visual for prime factorizations of numbers that acts as a guide for multiplication and division. Always a good Choice Time option once students learn how to play. Video instructions available at mathforlove.com/prime.



Multiplication by Heart. A visual flash card deck with three subdecks. Great in the classroom for small group fact practice and for simple fluency games. Ideas included in the lessons, and at mathforlove.com/multiply.



Challenge Problems Deck. These extra puzzles and problems are great options for Choice Time. These generally get harder the higher the number.

Also included: **Square Tiles**, **6-sided and 10-sided Dice**, and **Polyominoes** (which include dominoes, triominoes, and tetrominoes).

Other Stuff

- Email errata@mathforlove.com if you notice an error that should be fixed.
- **Additional Material:** We'll gather corrections and additional material at mathforlove.com/curriculum/grade7.
  Password: M4LCurriculum
- Problem with access? Email info@mathforlove.com.

Thanks and Acknowledgements

These lesson plans were built from the lessons we developed over our years working with teachers and students of all ages. However, putting together this more ambitious curriculum required a team, and we were lucky to have an amazing one.

Our curriculum writers were Karen Gallagher, Mark Goldstein, Tara Hofmann, Becky Holden, and Chase Orton. Our editors were Hana Murray and Jen Moffett. We had help with images from Bella Christianne and Hana Murray. Hana Murray also created the cover using photos of 21st Century Pattern Blocks.

This team of writers and editors worked with incredible focus and skill to build the teacher's edition you're holding now — big thanks to all of them for their dedication and contributions to this project.

Some images for this book were made, with permission, using Mathigon Polypad (polypad.amplify.com) - thanks to the good folks there for building such a fantastic tool. Mathigon also partnered with us to create digital versions of the Multiplication by Heart and Addition by Heart cards included in the curriculum kits. If you'd like to use the digital versions, they are free to use at fluency.amplify.com.

Finally, thanks to all the teachers, coaches, students, and staff who have used versions of our materials over the years, and welcomed us into their classrooms.

Daniel Finkel | Founder | Math for Love

Katherine Cook | Creative Director | Math for Love

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DAY 1	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

MP2 Reason abstractly and quantitatively.

4.OA.2 Multiply or divide to solve problems.

Materials: 6-sided and 10-sided dice, Odd Pig Out game sheets, paper, pencil

Opener	**Bullseyes and Close Calls**	10 – 15 minutes
Main Activity	**Odd Pig Out**	20 – 40 minutes
Closer	**Are You More Likely to Roll Even or Odd Products in Odd Pig Out?**	5 – 10 minutes
Choice Time	• Odd Pig Out • Bullseyes and Close Calls • Pattern Block Free Play • Challenge Problems	5 – 25 minutes

Standards Connections

MP1 | MP5 | MP6 | MP7 | 7.SP.6

Bullseyes and Close Calls

Secretly choose a three digit number with no repeated digits and write it down where no one can see it.

Students attempt to guess the number. After each guess, respond using the following options.

Outcome of Guess	Feedback
Correct digit in the wrong place	"Close Call"
Correct digit in the correct place	"Bullseye"
No correct digits	"Nothing"

Note: you might need to say "2 Close Calls," or "1 Bullseye and 2 Close Calls," or some other combination. DON'T say "first digit Close Call, second digit Bullseye." Your responses apply to the entire number, not individual digits.

Play 1 - 3 games. Vary the difficulty depending on student comfort.

Mild: 3-digit numbers
Medium: 3-digit numbers with repeated digits allowed
Spicy: 4-digit numbers
Super spicy: 5-digit numbers!

Prompts and Questions

- What numbers can I cross off after that guess?
- Is there anything you know after that guess? Any number that is or isn't in our mystery number?
- Why are you so sure the number doesn't have a 5?

Tips for the Classroom

1. Note that students DON'T get a Bullseye or Close Call for each digit. The clue applies to the entire number.
2. Write the guesses and the responses somewhere that everyone can see it.
3. Keep track of digits. The skill in the game is about using the feedback from the guesses to make educated future guesses. For example, after guessing 139 and finding that none of those digits are in the number, cross off the 1, 3, and 9 from the list of possible digits.
4. Pause the game occasionally to ask students what they know for sure. Are there any digits that they are sure are not in the number? Any digits they know are in the number? How do they know?

Example Game
Your secret number is 487

Guess	Feedback
139	Nothing
820	Close Call
468	1 Close Call, 1 Bullseye
568	Close Call
482	2 Bullseyes

Odd Pig Out

Materials and Prep
10-sided and 6-sided dice, Odd Pig Out worksheets, pencil.

How to Play
Players take turns rolling two 10-sided dice as many times as they like. After each roll, they multiply the numbers shown on the dice.

- If the product is even, they add that number to their current points for the turn.
- If the product is odd, players lose all their points *from that turn* and their turn is over.

A player may choose to end their turn at any time and "bank" their points. The first player with 500 points in their bank wins.

Launch
Choose a volunteer and play a demonstration game using the 10-sided dice. Start by quickly explaining the rules, then clarify as you play during the demonstration game. Play for at least 3 or 4 turns, until students seem to understand the rules.

As you play your turns, solicit advice from students. You can ask them to give a thumbs up if they think you should keep going and a thumbs down if they think you should bank your points.

Work
Students play Odd Pig Out. Try grouping students in pairs to play against each other, one on one, to start. Once they've played a few games, have students play in teams of two on two. Team play will force them to talk to their partner about whether they should roll more or stop.

While students play, walk around the room and check in on how students are thinking about their strategy. This will be a good opportunity for you to get a feel for how comfortable your students are with multiplication facts.

Tips for the classroom
1. Remind students that they will lose games and win games, and each loss can be a chance to re-examine how they are playing. Help them be good winners and losers.

2. If students need more support, they can play with two 6-sided dice instead of the 10-sided dice. A worksheet and table for this modification is included below. For a game with 6-sided dice, the winner is the first to claim 300 points.

3. Students can play to 1000 for a longer game.

Launch Key Points

- Keep the Launch brief so that students can start playing the game on their own as soon as possible.
- Make sure the process for banking points, or losing them, is clear.
- Take risks during your demonstration game, both to generate excitement and to show what happens when you roll an odd product.

Prompts and Questions

- How many points do you have for this turn, so far?
- Who is ahead?
- Are you sure that's the product for those two numbers?
- Do you find yourself using a strategy? For example, do you roll 3 times, and then bank? Or are you riskier than that?

Day 1

Odd Pig Out

How to Play

Players alternate turns rolling two dice and finding the product as many times as they would like.

a. If the product is **even**, they add that number to their current points. They may choose to roll again or end their turn.
b. If the product is **odd**, they lose all their points from that turn and their turn is over.

The player who reaches 300 points or more in their bank first is the winner!

	1	**2**	**3**	**4**	**5**	**6**
1	1	2	3	4	5	6
2	2	4	6	8	10	12
3	3	6	9	12	15	18
4	4	8	12	16	20	24
5	5	10	15	20	25	30
6	6	12	18	24	30	36

Day 1

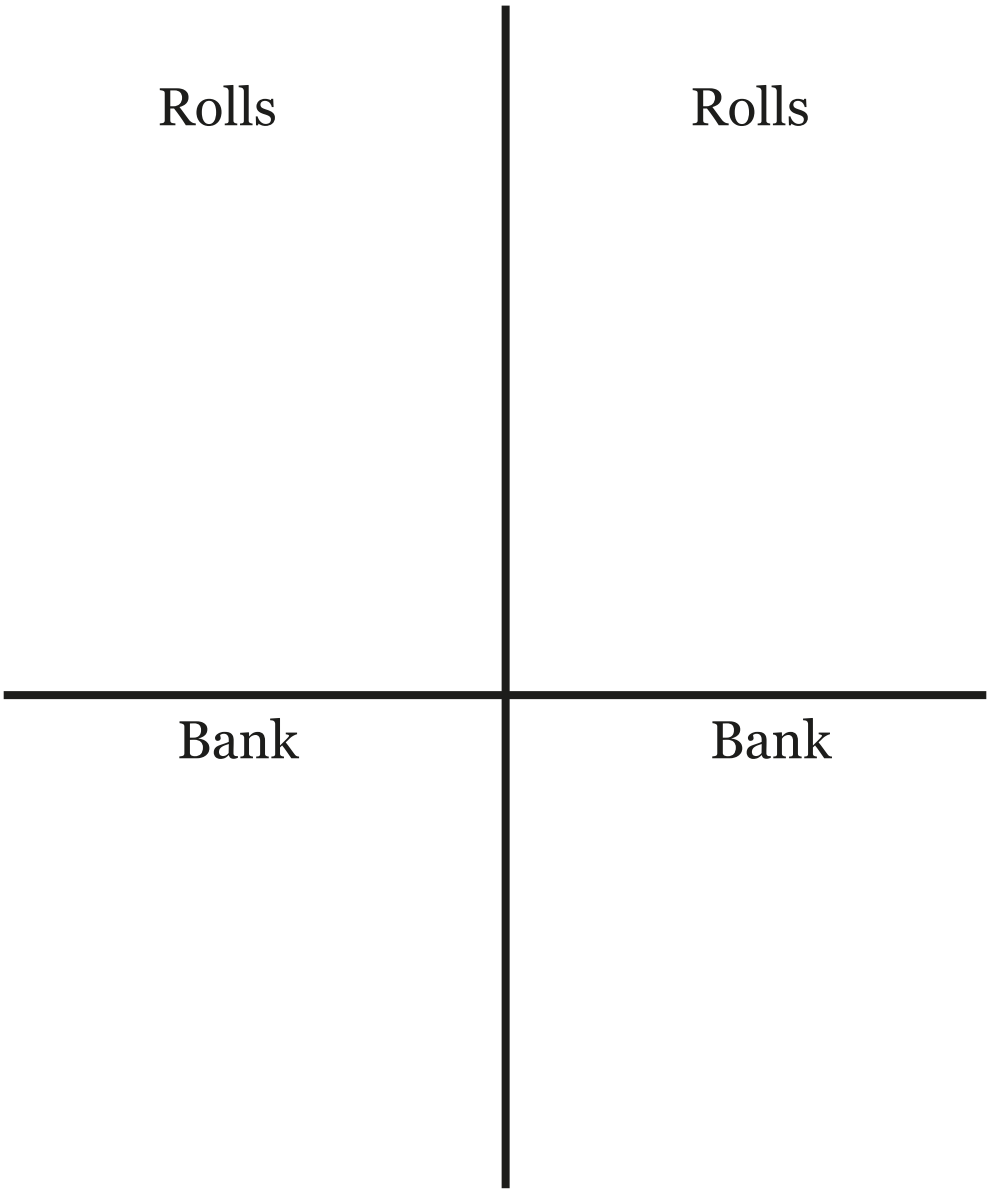
Odd Pig Out

How to Play

Players alternate turns rolling two dice and finding the product as many times as they would like.

a. If the product is **even**, they add that number to their current points. They may choose to roll again or end their turn.
b. If the product is **odd**, they lose all their points from that turn and their turn is over.

The player who reaches 300 points or more in their bank first is the winner!



Closer

Discuss Odd Pig Out. Ask students whether they developed strategies as they played. If so, did they find themselves playing a riskier or more conservative strategy?

Follow this up by ask students whether they think they are more likely to roll odd products or even products, or whether they think they are equally likely.

To help explore this, pose the following series of questions, and ask students if they can figure out how likely they are to roll even or odd numbers.

- How many odd numbers are there on the multiplication table (up to 6 by 6)?
- How many even numbers?
- How are they distributed?
- Do students see any patterns?

Depending on how the conversation goes, students may start to articulate a conjecture about the products of even and odd numbers.

Even times even = even
Even times odd = even
Odd times even = even
Odd times odd = odd

This gives an argument that the odds of rolling an even product are three times the odds of rolling an odd product.

Alternatively, students might circle the even or odd numbers on a multiplication table and find the same thing!

Prompts and Questions

- Do you prefer to be more risky or more cautious? Which seems like it works better in the long run?
- What's your favorite winning strategy so far?
- Do you have a rule for when you stop rolling and bank your points?

Choice Time

Today's Choice Time Options

- Odd Pig Out
- Bullseyes and Close Calls
- Pattern Block Free Play
- Challenge Problems

Prepare students for Choice Time by explaining that they will choose from some pre-selected options. Once they choose an activity, they should spend at least 10 minutes on it before trying something else.

Show the Challenge Problem Deck and explain that it will always be among the Choice Time options. Students can simply take a challenge problem card and try to solve it, on their own or with a partner. Be sure to provide scratch paper and pencils.

Pattern Block Free Play is also an option, and helpful for students to explore the possibilities of the 21st Century blocks.

Overview

Focus Standards

MP6 Attend to precision.

6.NS.2 Compute fluently with multi-digit numbers and find common factors and multiples.

Materials: 6-sided dice, scratch paper, pencil.

Opener	**Counterexamples**	10 – 15 minutes
Main Activity	**Damult Dice Division**	20 – 40 minutes
Closer	**Damult Dice Division Strategies**	5 – 10 minutes
Choice Time	• Challenge Problems • Odd Pig Out • Pattern Block Free Play • Damult Dice Division	5 – 25 minutes

Standards Connections

MP3 | MP6 | MP7 | 5.NBT.6

Counterexamples

Counterexamples is a fun, quick way to highlight how to disprove conjectures by finding a counterexample. The leader (usually the teacher) makes a false statement that can be proven false with a counterexample. The group tries to think of a counterexample that proves it false.

The best statements usually have the form "All _____s are _____" or "No _____s are _____."

For the first day you play Counterexamples, get the students used to the game with the statement **"All birds can fly."**

Tell students their job is to come up with an example that proves your statement false. In this case, they are likely to suggest penguins as a counterexample. If they do, modify your statement: **"All birds can fly except penguins."** Counterexamples here could include baby birds, injured birds, ostriches, etc.

Next, use the following motivating examples and an "I notice" or "I wonder" statement. This allows students to see you model the process of making a conjecture.

Step 1. Share motivating examples
Write these down where everyone can see them.

- 19 ÷ 5 leaves 4 left over (i.e. 19 = 5 × 3 + 4)
- 19 ÷ 6 leaves 1 left over (i.e., 19 = 6 × 3 + 1)
- 26 ÷ 5 leaves 1 leftover
- 26 ÷ 6 leaves 2 leftover

Share the following observation: "I notice that when I divide the same number by 5 or 6, I don't get the same remainder."

Step 2. Pose a conjecture
State this as an 'obvious' conclusion from the motivating examples. You might say, "I bet it's true that *every* time I divide a number by 5 and 6, I get different remainders." Then write:

Conjecture: No number has the same remainder when you divide it by 5 and by 6.

Step 3. Invite students to try to find counterexamples - that is, examples that prove your conjecture false.
They may need some time. Every time a counterexample is offered, ask the class to consider it fully and see whether it satisfies the goal. Sometimes counterexamples can be deceiving!

Prompts and Questions

- I think I see a pattern here. I'm going to make a conjecture...
- You think my conjecture is wrong. But how can you *show* me it's wrong?

Counterexamples (continued)

Potential Student Counterexamples:
0, 31, 32, 33

These numbers have the same remainder when you divide by 5 or 6. These (and other) examples show that our conjecture is not actually true.

Step 4. At this point, extend the game by offering a revised conjecture that accounts for the counterexamples the students came up with.
Some examples of possible revised conjectures include the following:

Potential Revised Conjectures

- *No number has the same remainder when divided by 4, 5, and 6. (This is false.)*
- *The smallest number that has the same remainder when divided by any collection of numbers will be the product of them plus one (This is also false.)*

How you frame the revised conjecture will depend on what counterexamples the students found.

Once you have a revised conjecture, students can continue searching for new counterexamples. As long as students are engaged, feel free to continue cycling between refining the conjecture and seeking counterexamples, though in general one or two iterations will be sufficient.

In this case, we might have the following counterexamples and refinements:

Counterexamples to the first revised conjecture: 61, 62, 63

Revised Conjecture: no 3-digit numbers have the same remainder when divided by 4, 5, and 6.

Counterexamples: 121, 122, etc.

Damult Dice Division

Materials and Prep

6-sided dice, scratch paper, pencil; 10-sided dice (optional)

How to Play

Basic version (for 2-3 players):
On your turn, roll 3 dice. Choose 2 of the dice you rolled to make a 2-digit number, and divide it by the number on the remaining die. Your score is the quotient, rounded down to the nearest whole number. You get a +10 point bonus if the quotient is a whole number (i.e., if there's no remainder when you perform the division). The winner is the first person to reach 200 points.

Example Turn:
You roll 2, 5, 6. You have the following options for moves:
- 25 ÷ 6 = 4R1: 4 points
- 26 ÷ 5 = 5R1: 5 points
- 52 ÷ 6 = 8R4: 8 points
- 56÷2 = 28. Plus the 10 point bonus is 38 points!
- 62÷5 = 12R2: 12 points.
- 65÷2 = 32R1: 32 points.

All-Play (for 3 or more players): This version gets every student writing equations, and also gives everyone something to do on every turn.

Take turns as the roller. Roll three dice. Everyone writes down a division equation formed by creating a 2-digit number and dividing by the third, and the quotient (either in decimal, fraction, or remainder form). The roller gets to score their move as per the original game (scores are rounded down to the nearest whole number). After the roller has scored, all other players reveal their equations. If a player was the only one to write down a certain equation, they get to keep the score. If two or more players wrote down the same equation, they don't score any points. If a player wrote the same equation as the scorer, they don't score any points.

Example turn: Player 1 rolls 2, 5, 6. Everyone writes down an equation using those numbers.

Player 1 reveals their equation:
56 ÷ 2 = 28.
This comes out to a whole number for a 10 point bonus, so they get 38 points.

Next the other players reveal their equations.
- Player 2: 65 ÷ 2 = 32.5 (0 points)
- Player 3: 65 ÷ 2 = 32.5 (0 points)
- Player 4: 56 ÷ 2 = 28 (0 points)
- Player 5: 26 ÷ 5 = 5.2 (5 points)

Launch

Invite a student volunteer to demonstrate the game. Play a few turns each, making sure the scoring structure is clear. Find an arrangement on one of your turns that lands exactly on a whole number so that you can collect the 10 bonus points.

Once you've demonstrated how to play, students can play the game for themselves in pairs or small groups.

Work

The basic version is good for 2 - 3 player games. For more than that, use the all-play variation.

After students have had about ten minutes to play, bring the group together and introduce the All-Play variation, if you haven't already. Students can play All-Play in groups of 3 - 6.

Closer

Ask students whether they developed any strategies to help them win.

Break into six teams and play a full-class team game of Damult Dice All-Play. Students will need to convince their team of the best move every round, so there should be plenty of conversation. Play for as long as time allows.

Tips for the classroom

1. The All-Play variation is great for classroom play, since everyone engages on every roll. Jumping right into to this variation is a great idea. Demonstrate the game for at least 3-4 turns with the whole class.

2. If students crave an additional challenge, try these variations:
   - Play with 10-sided dice instead of 6-sided dice.
   - Roll 4 dice. Your quotient will be a 3-digit number divided by a 1-digit number.

Choice Time

Damult Dice Division All-Play, especially with 10-sided dice, is an excellent option for this and future Choice Times.

- Challenge Problems
- Odd Pig Out
- Pattern Block Free Play
- Damult Dice Division

Launch Key Points

- Damult Dice Division requires students to be able to divide. Make sure this is something students have at least some way of doing before you start. The opener for this lesson is a good way to check for understanding and review the basics of division if necessary.
- Allow multiplication charts if students struggle with the division.
- Get students playing the game quickly. You only need to play a few turns in the demo, not a whole game.
- Make sure that over the course of your turns, you demonstrate every rule and way to score.

Prompts and Questions

- I see you wrote 26÷5. What would happen if you did 56÷2? Would that give you a greater score?
- Could you arrange the digits another way to get a greater quotient?
- Is there another way to arrange these digits to get a whole number?
- How did you do that division?

DAY 3	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

MP8 Look for and express regularity in repeated reasoning.

6.NS.4 Compute fluently with multi-digit numbers and find common factors and multiples.

Materials: Prime Climb worksheets, scratch paper, pencil, colored pencils.

Opener	**Would You Rather**	10 – 15 minutes
Main Activity	**Prime Climb Color Chart**	20 – 40 minutes
Closer	**What Patterns Can You Find in the Hundred Chart?**	5 – 10 minutes
Choice Time	• Challenge Problems • Odd Pig Out • Damult Dice Division • Prime Climb Coloring	5 – 25 minutes

Standards Connections

MP1 | MP3 | MP7 | 4.OA.4

Would You Rather

Would You Rather questions offer a choice between two options. The job of the students is to decide which of the two options they would rather have, and convince their classmates of the wisdom of their choice.

The choice is usually real-world in nature, and may require students to make reasonable guesses to fill in missing information. As a result, Would You Rather provides a protocol that is quick and easy to use as an opener, and gets students to model with mathematics (Math Practice 4) and have mathematical conversations (Math Practice 3).

To begin, project the Would-You-Rather question on the next page, and encourage students to:

1. **Come up with their own answer**
2. **Convince their peers using mathematics**.

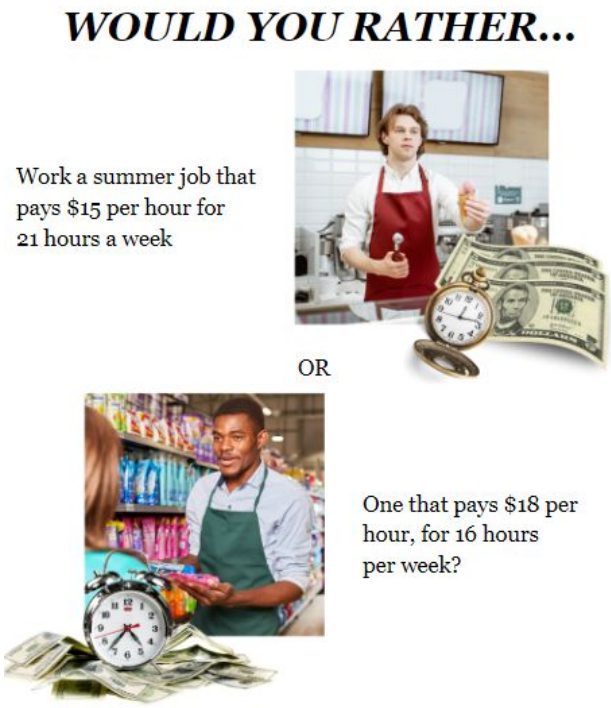
Groups of 3 are generally ideal for small group discussion.

Transition to a full class discussion after groups have talked for 3-5 minutes, and see if a consensus emerges. Students may have questions and requests for more information.

Consensus is not necessary! Students may disagree with the group for any reason. What's important is they defend their reasoning, ideally with mathematics.

Possible student observations and questions.

- $15 per hour for 21 hours is more money.
- $18 per hour for 16 hours is less work for the money.
- The first option is only $27 more for 5 more hours. I'd rather have my 5 hours than 27 more dollars - that's just $5.40 per hour for those last five hours when you think about it like that!
- Is it the same job?
- Do I know anyone working there?



Prompts and Questions

- What additional piece(s) of information would help you make a decision?
- What types of jobs would make one option more appealing for you than the other?

WOULD YOU RATHER...

Work a summer job that pays $15 per hour for 21 hours a week

OR

One that pays $18 per hour, for 16 hours per week?

Prime Climb Color Chart

Materials and Prep
Prime Climb worksheets, pencil, colored pencils.

Motivating Question
What patterns can you find in the hundred chart?

Launch
Show students the chart with the coloring to 20, and ask them what they notice and wonder.

Give students some time in pairs to discuss or write down their ideas, then discuss as a class. In particular, what are student ideas to explain how the numbers are colored?

Possible student observations might include:

- Every even number has orange in it.
- If there is green in a number you can reach it if you skip count by 3.
- The numbers with blue end in 5 or 0.
- The numbers with red are prime.

Wonderings might include:

- Why does 4 have two orange parts?
- Why does 8 have three orange parts?
- If prime numbers are red, why isn't 7 red?

Once they've discussed what they see and how to understand it, pose a question for them to tackle: how should the numbers from 21 to 30 be colored?

Launch Key Points

- Don't answer questions during the launch - focus on generating them. Plan to come back to unresolved questions and conjectures in the Closer.
- Students should have enough sense of the patterns at play in the numbers from 1 - 20 to work forward. Be ready to gather them again to discuss 21 and 22 if they don't make forward progress.

Work

Students work in pairs or trios to color in the numbers so that it extends the pattern(s).

If the majority of students are stuck after five minutes or so, you can gather the class together and discuss how to color 21. A rationale for the coloring: 3 is green, 7 is purple, and $3 \times 7 = 21$, so 21 should be green and purple.

Repeat for 22. This is a good chance to highlight that for composite numbers divisible by primes larger than 10, the number will have a red segment in its coloration which can be distinguished by writing in the prime it represents on the segment.

Once students have the hang of how the coloring works, let them work on their own again. They can color in as much of the chart as they can, but getting to 50 is a good initial goal. In general, multiplying and dividing is the key to understanding how the coloring works.

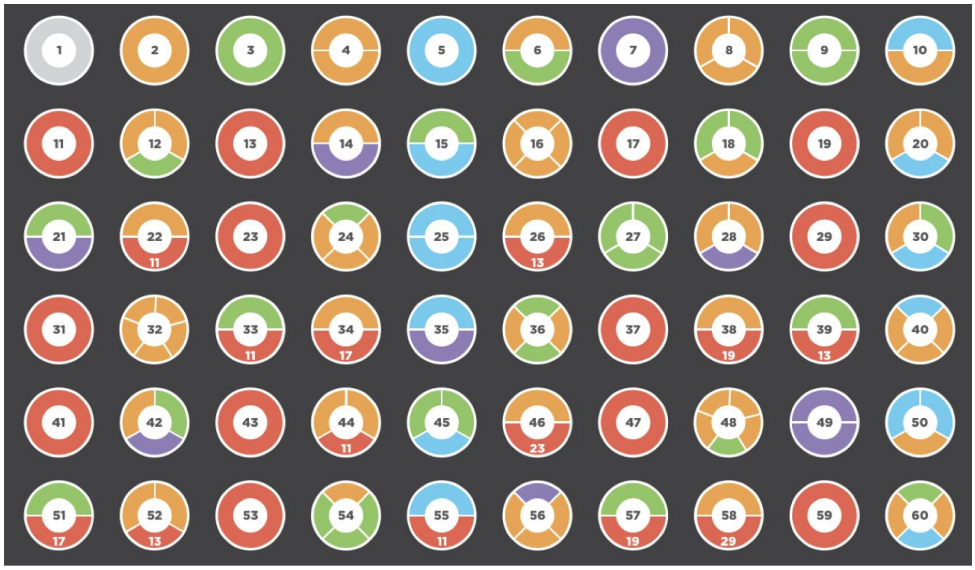
Prompts and Questions

- Look at just one color at a time. What's happening with orange? What's happening with blue?
- What numbers have blue? (5, 10, 15, 20.) What do you think comes next in that pattern? So probably 25 and 30 will have a blue part colored in, right?
- Which numbers have two or more orange parts colored in (4, 8, 12, 16, 20)? What pattern do you see in those numbers?

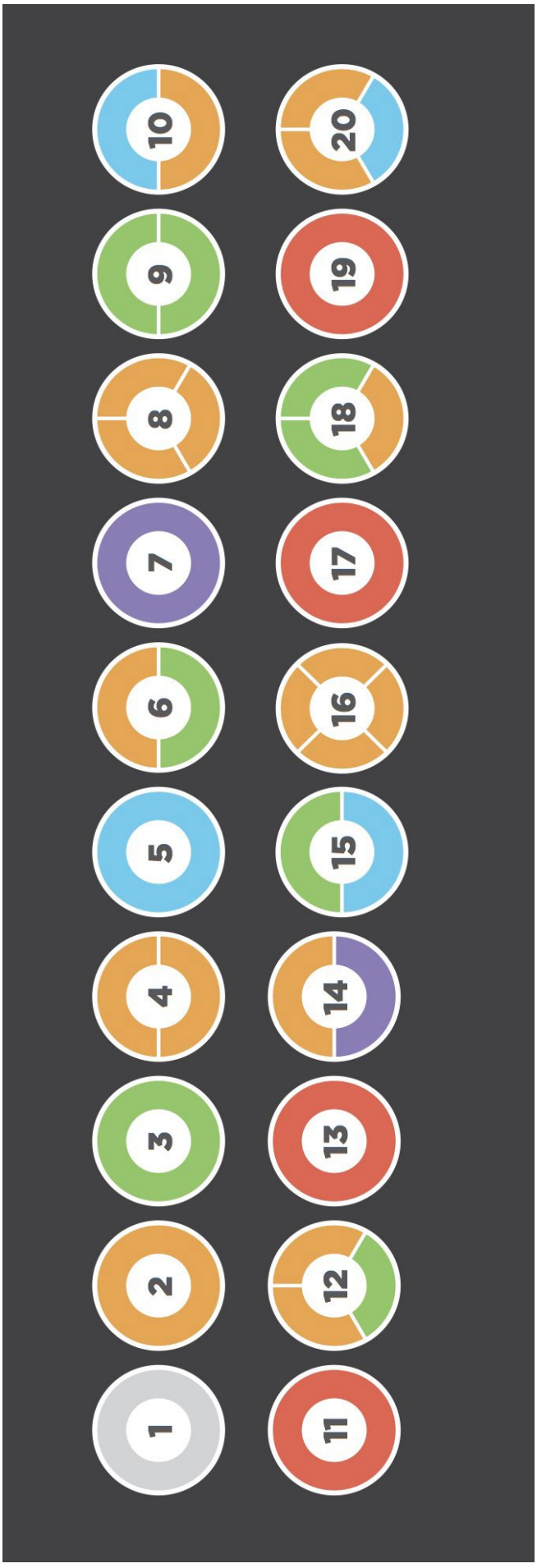
Tips for Classroom

1. Don't expect students to finish the entire chart in one lesson. They can come back to it in the future, including at Choice Time whenever they'd like.

2. As much as possible, have students explain their reasoning, question the reasoning of others, and determine the truthfulness of their conjectures about how the patterns in the coloring works.

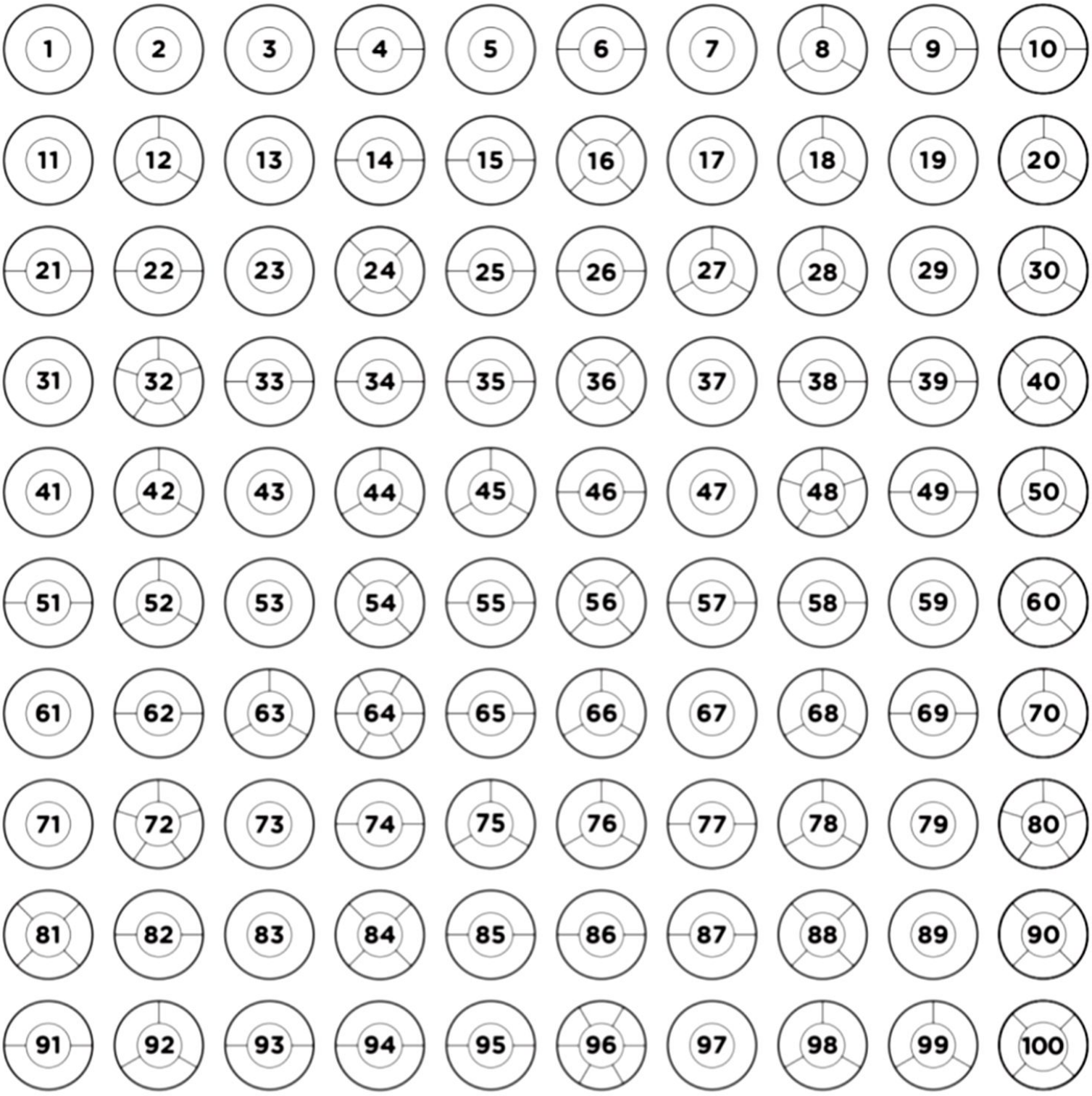


Day 3



Day 3

Prime Climb Coloring Chart



Closer

Pick a few numbers that everyone has at least thought about: 28, 29, 30, for example. Let students defend their choices for coloring. Prompt them with questions, such as the ones below (modify them for the numbers your class chooses to discuss).

- Why should 29 be red?
- Why does 30 have orange, green, and blue?
- Based on what we know, what colors will 72 have?

You can use the chart colored up to 60 as a reference, but it's best if students can argue why a given coloration works, and convince other students based on multiplication arguments.

Prompts and Questions

- What patterns do we see in the Prime Climb Color Chart?
- How can you defend your coloring based on the patterns we know about?
- If I wrote out some multiplication problems like $2 \times 5 = 10$, $3 \times 5 = 15$, $4 \times 5 = 20$, what do you notice about the colors of all the numbers in the equations?

Choice Time

- Challenge Problems
- Odd Pig Out
- Damult Dice Division
- Prime Climb Coloring

DAY 4	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

MP7 Look for and make use of structure.

6.NS.B Compute fluently with multi-digit numbers and find common factors and multiples.

Materials: Prime Climb, scratch paper, pencil.

Opener	**Broken Calculator**	10 – 15 minutes
Main Activity	**Prime Climb**	20 – 40 minutes
Closer	**Prime Climb Strategies**	5 – 10 minutes
Choice Time	• Challenge Problems • Prime Climb • Odd Pig Out • Damult Dice Division	5 – 25 minutes

Standards Connections

MP6 | MP8 | 5.OA.B

Broken Calculator

This creative exercise in arithmetic is surprisingly dynamic, with a simple constraint that provides interest and rigor.

Display the image on the next page. Tell the students that you have a calculator with some broken buttons. The challenge for students is to **make a target number on the calculator in as many ways as they can**, despite not being able to use the broken keys.

Students work in pairs or trios to write down a list of solutions. Circulate and help students to talk to each other, extend their thinking, or get unstuck. If students are starting to slow down after 5 minutes or so, pause to highlight some interesting approach from a student, or let students share solutions they found notable.

If students seem to have exhausted their interest in the original question, offer additional challenges.

Example Challenges (optional)

- Solve the problem using the division key.
- Solve the problem starting with a 3-digit number.

Tips for the Classroom

1. Avoid writing faulty "equations" that treat the equals sign as the "compute" button on a calculator, i.e.,

   $3 \times 7 = 21 \div (3 + 7) = 2.1$ is false and strange.

   Write a single equation using parentheses if necessary, or rewrite what you've done so far on a new line.

   $(3 \times 7) \div (3 + 7) = 2.1$ is clear.

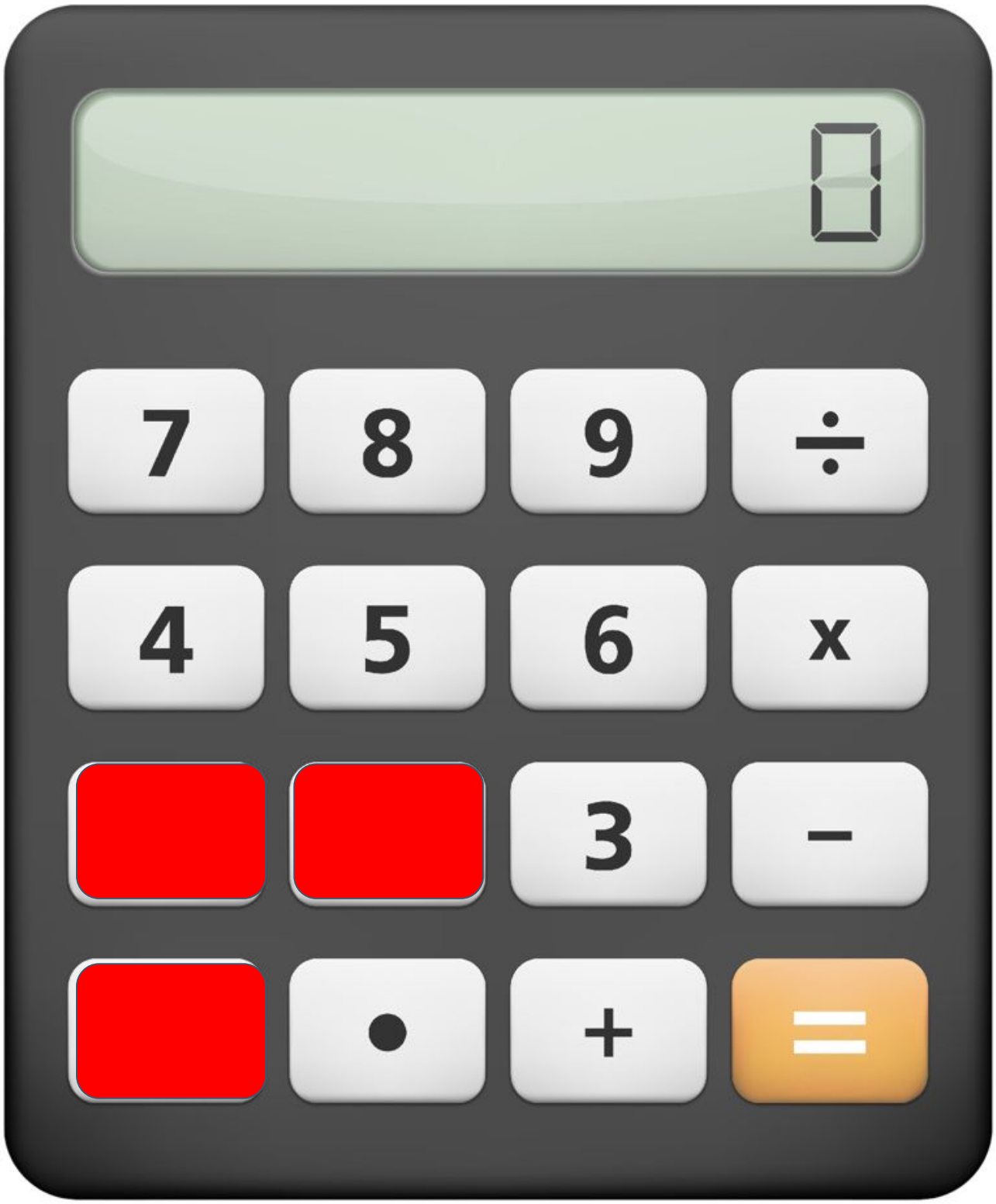
2. As a convention, it's okay to include parentheses to clarify order if necessary, even though the calculator doesn't have buttons with parentheses.

3. Have a representative from each student group come up at some point while they're working to write one or two of their favorite solutions on the board. This helps other students to get inspired, and also makes the transition to share solutions quicker.

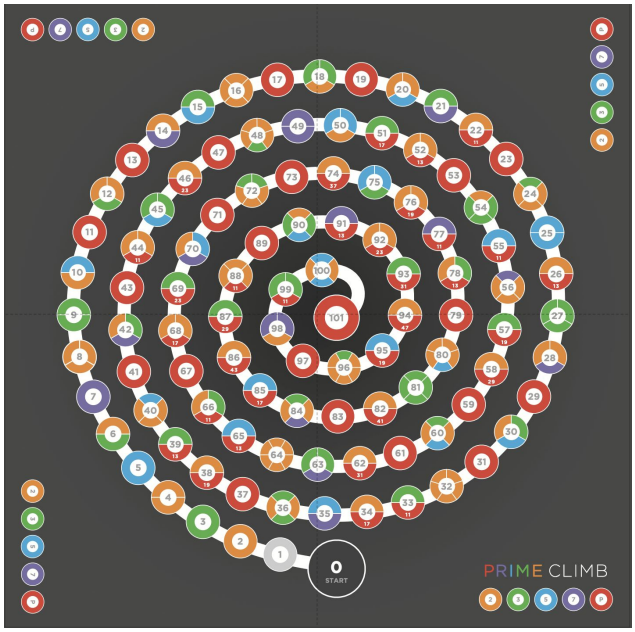
Prompts and Questions

- Good idea, but you used the "1."
- Can you use that same approach to get another solution?
- How many different ways have you come up with so far?
- Do you think it's possible to solve using division?

Target: 2.1



Prime Climb



Materials and Prep

Prime Climb, scratch paper, and pencil.

How to Play

Video instructions available at:
mathforlove.com/games/prime-climb/how-to-play.

Here are the "Quick Start" version of the rules:

During a turn, there are four phases.

1. **Roll.** Roll the dice. You get two numbers from 1 to 10 to use for moving. If you roll doubles, you get that number four times instead of two.
2. **Move.** Move your pawn(s). Apply your dice rolls one at a time to the number your pawn(s) is on, using your choice of +, -, ×, or ÷. You can also use Keeper cards if you have them.
3. **Bump.** If you end your Move phase on the same space as another pawn, send it back to start. This applies to your own pawn as well.
4. **Draw.** If you end your Move Phase on an entirely red space (i.e., a prime number greater than 10), draw a Prime card. If it is a Keeper card, save it for a future turn. Otherwise, apply the card now.

After someone lands both pawns exactly on 101, they win the game. (In the quick version of the game, you win after you get just one pawn to 101.)

Example Turn:

With pawns on 4 and 26, you roll a 3 and a 9. You could:

- Add 3 to 4 to move your pawn to 7, then multiply by 9 to move your pawn to 63.
- Multiply 26 by 3 to move your pawn to 78, then add 9 to move it to 87.
- Add 9 to 4 to move one pawn to 13, and multiply 26 by 3 to add the other to 78. Since 13 is completely red, you would them draw a Prime card.

You're never allowed to move to numbers off the board. You CANNOT add the 3 and 9 first and use a 12 to multiply or divide. You have to apply the numbers on the dice one by one.

DAY 4 | Opener | Main Activity | Closer | Choice Time

Launch

Set up the game and explain the rules. Take a student volunteer and demonstrate 3 or 4 turns each, showing, in particular, how Prime cards get drawn when you land on red circles. Also emphasize that dice must be applied to pawn(s) one at a time–they cannot be added (or subtracted) together and then used to multiply (or divide). Once students seem ready, have them play in groups of 4 with two players per team.

Work

Students may have questions that come up during the course of play. You can consult the full rules of the game, or just have students respond by deciding on what seems like the best way to settle the question and keep play going.

Tips for the Classroom

1. Have students roll in the box lid to prevent them from knocking over pawns during the game.

2. Students can use the multiplication table or scratch paper to help themselves with hard multiplication problems. The board's color scheme can help too.

3. Students may dislike getting knocked back to start. However, they'll quickly learn that they can make fast progress if they get a good roll, especially when they roll doubles.

4. You can shorten a game with two pawns by making the objective to get only 1 pawn to "101" instead of both.

Closer

Invite students to reflect on their experience, in pairs or trios first, and then as a whole class.

- What strategies did we learn playing this game?
- It can be discouraging being bounced back, but were there ways to catch up quickly? What kind of rolls helped you get near 101 quickly?
- How did you use the Keeper cards? Did you ever use one before you used the numbers you rolled?
- How did the colors help you with the math?

Choice Time

- Challenge Problems
- Prime Climb
- Odd Pig Out
- Damult Dice Division

Launch Key Points

- Make sure the process for drawing and using Keeper Cards is clear.
- Make sure students understand dice must be applied to pawns one at a time.

Prompts and Questions

- Where do you land if you add each number to the same piece? Where could you land if you added each number to separate pieces?
- Can you get either pawn to a red circle with that roll?
- Can you bump anyone with that roll?
- You rolled a 3 and a 5. What if you added the 3 to your pawn first, then multiplied by 5?
- If you subtract, you could land on a red circle and draw a Prime card.
- Can you divide down and then multiply up?
- What would happen if you used one of your keeper cards first, and then used the numbers you rolled?

DAY 5	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

MP6 Attend to precision.

7.NS.1 Apply and extend previous understandings of operations with fractions.

Materials: Box the Numbers worksheets, scratch paper, pencil, colored pencils.

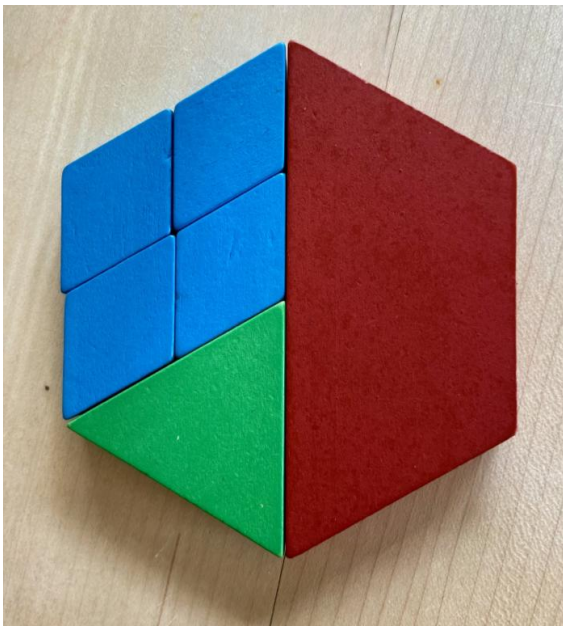
Opener	**Fraction Talks**	10 – 15 minutes
Main Activity	**Box the Numbers**	20 – 40 minutes
Closer	**How Can You Box the Biggest Score?**	5 – 10 minutes
Choice Time	• Challenge Problems • Prime Climb • Odd Pig Out • Damult Dice Division	5 – 25 minutes

Standards Connections

MP7 | MP8 | 6.NS.C

Fraction Talks

Display a picture that represents a fractional relationship or relationships.



Ask: **what fraction of this image is each color?**

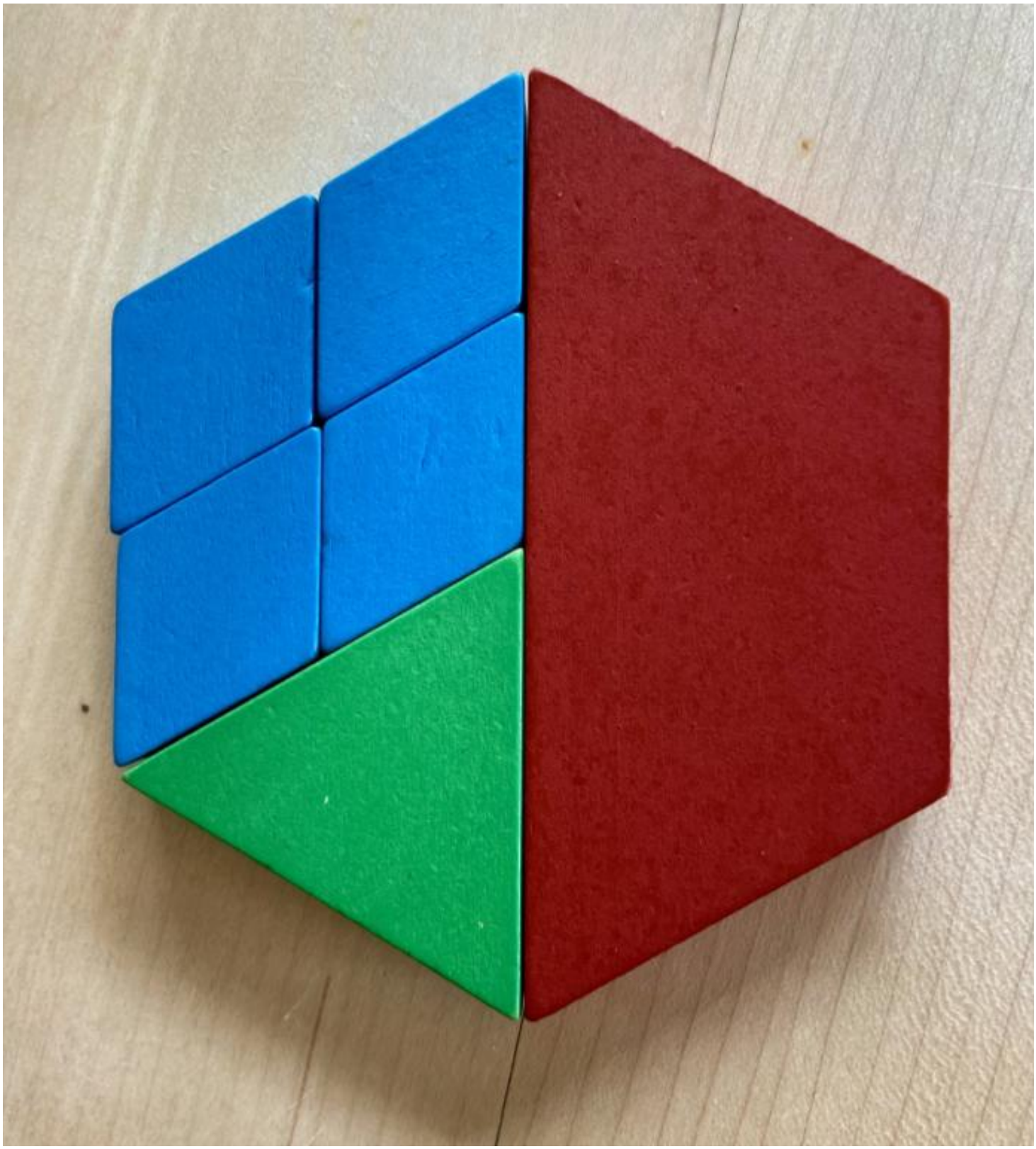
Give students a small amount of think time and then a little discussion time - as long as it's productive talk. Then facilitate a discussion that brings out important ideas, including multiple ways to think about it, with as much input coming from students as possible.

Tips for the Classroom

1. Give students constructive language to use in the discussion, like, "I respectfully disagree, because..." and "I agree with _____, because..."
2. Don't worry if you don't reach total consensus on every problem. Sometimes a student will need more time to process. You can move on when it feels like it is time.
3. As an extension, you can ask students to find what fraction is represented by two colors added together.

Prompts and Questions

- Who would like to defend this answer?
- I don't quite follow. Could you draw what you are seeing?
- How did you do that/know that?
- Does anyone else think they can explain what Shawn is saying?
- Turn to the person next to you and explain how you figure out the fraction.



Box the Numbers

Materials and Prep
Box the Numbers worksheets, pencil, and colored pencils.

How to Play
Each player takes turns drawing a horizontal or vertical line connecting two dots. When a player completes a square, they add those points to their score **and they get to go again**. The game is over when all the dots are connected by horizontal or vertical lines. The person with the most points wins.

Launch
Demonstrate a game by choosing a volunteer and playing in front of the class.

Work
After the students have learned the rules, let them play several rounds using the different boards.

Tips for the Classroom
1. Play enough demonstration games with students so that the rules are clear.
2. Use different colored crayons or pencils for a clearer game.
3. Try different boards to re-engage students in the game. Or let them create their own.

Closer
Ask students what they noticed about the game.

If they were going to make their own board with their own numbers inside each box, what numbers would they pick to make the game as fun as possible?

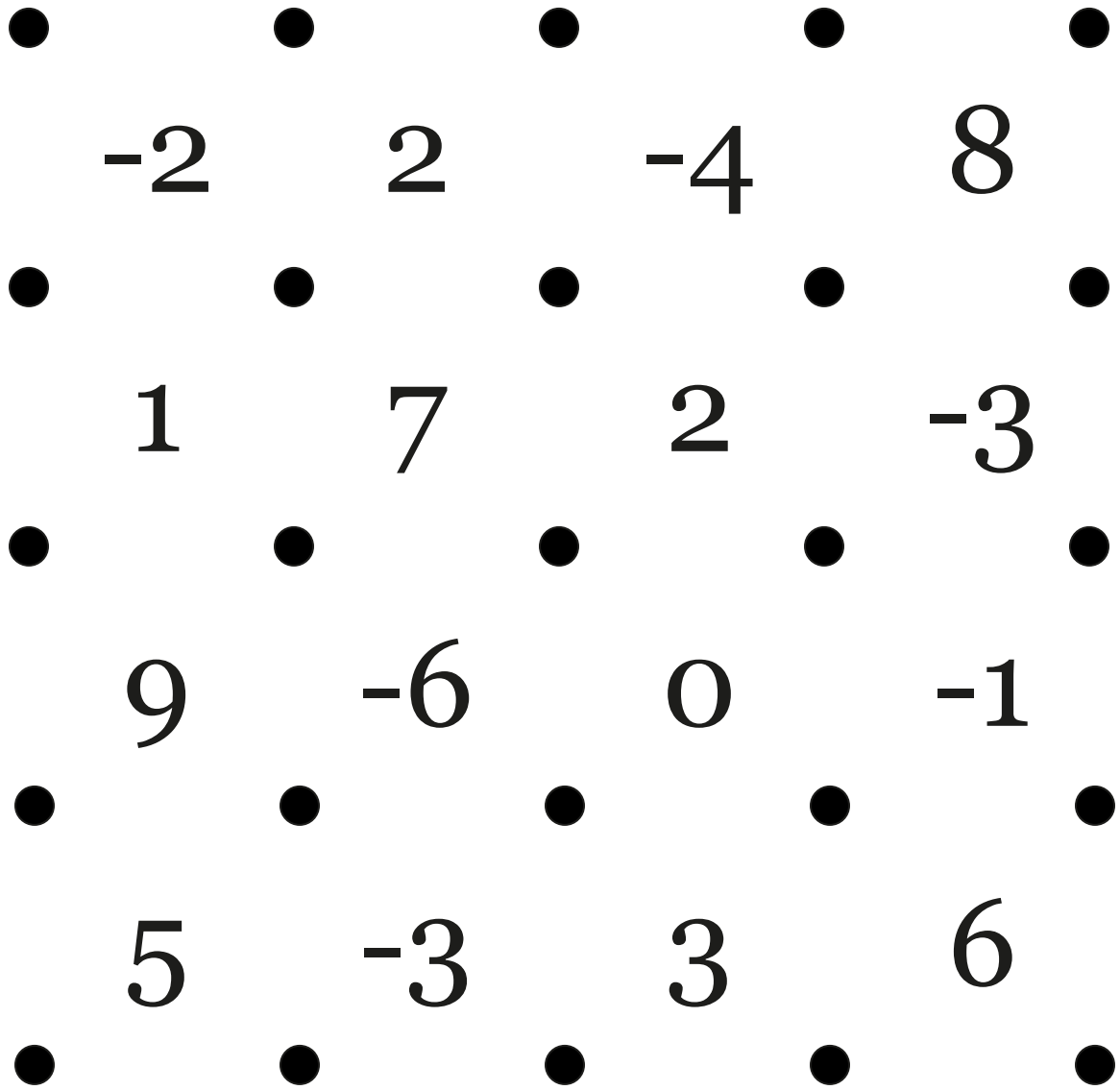
Choice Time
- Challenge Problems
- Prime Climb
- Odd Pig Out
- Damult Dice Division

Launch Key Points
- You don't need to play a whole game with the volunteer—just enough so that students understand the rules.

Prompts and Questions
- How did you calculate that?
- What mental math strategies could you use to find your score?
- Are your checking each other's work?
- What are some winning strategies you're figuring out?

Day 5

Box the Numbers 1



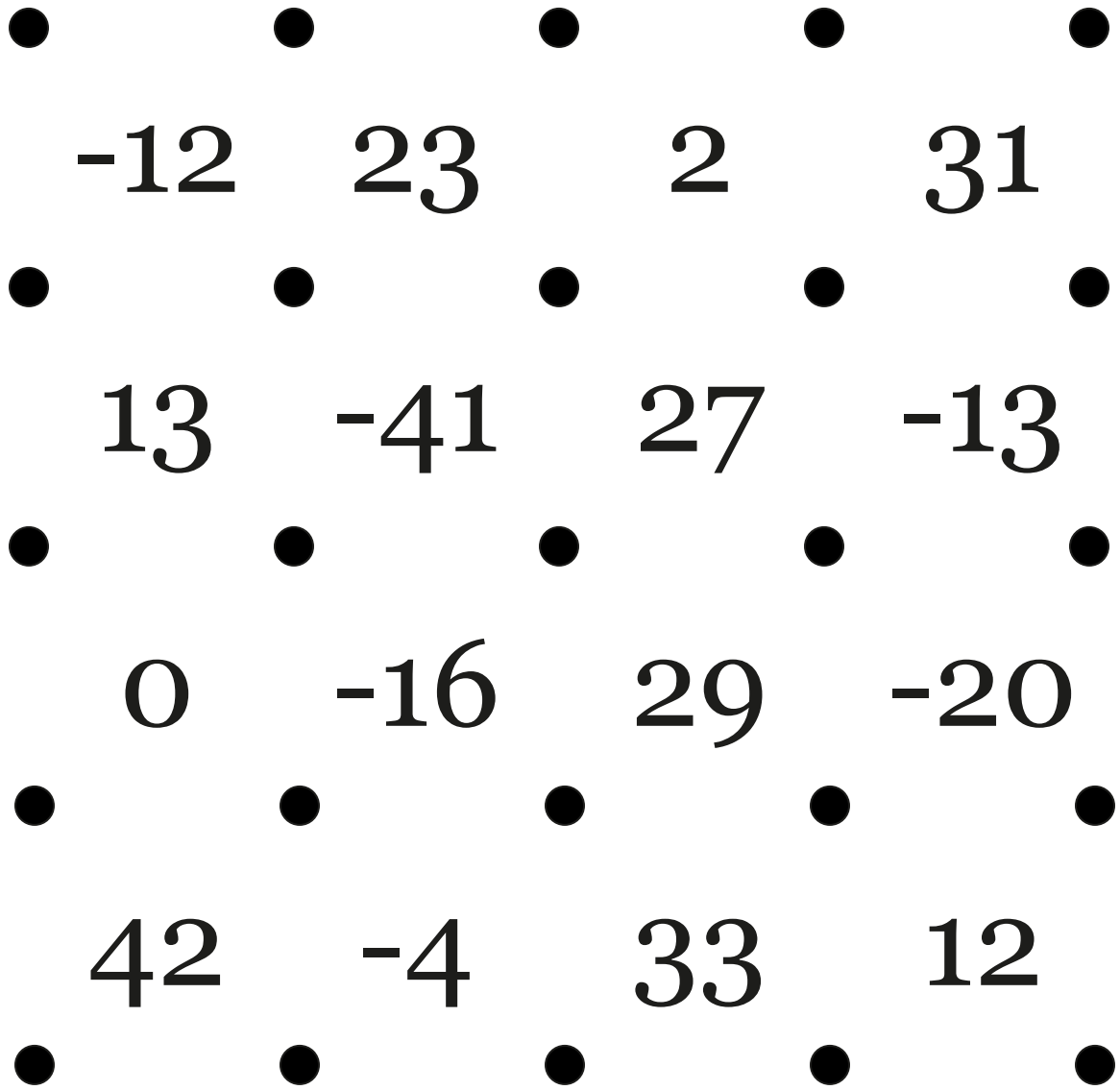
Box the Numbers is a 2-player game.

On your turn, add a vertical or horizontal edge between dots. If you complete a square, you claim the number inside it **and get to go again**.

Your score is the sum of all the numbers you box. Whoever has the highest score at the end wins

Day 5

Box the Numbers 2



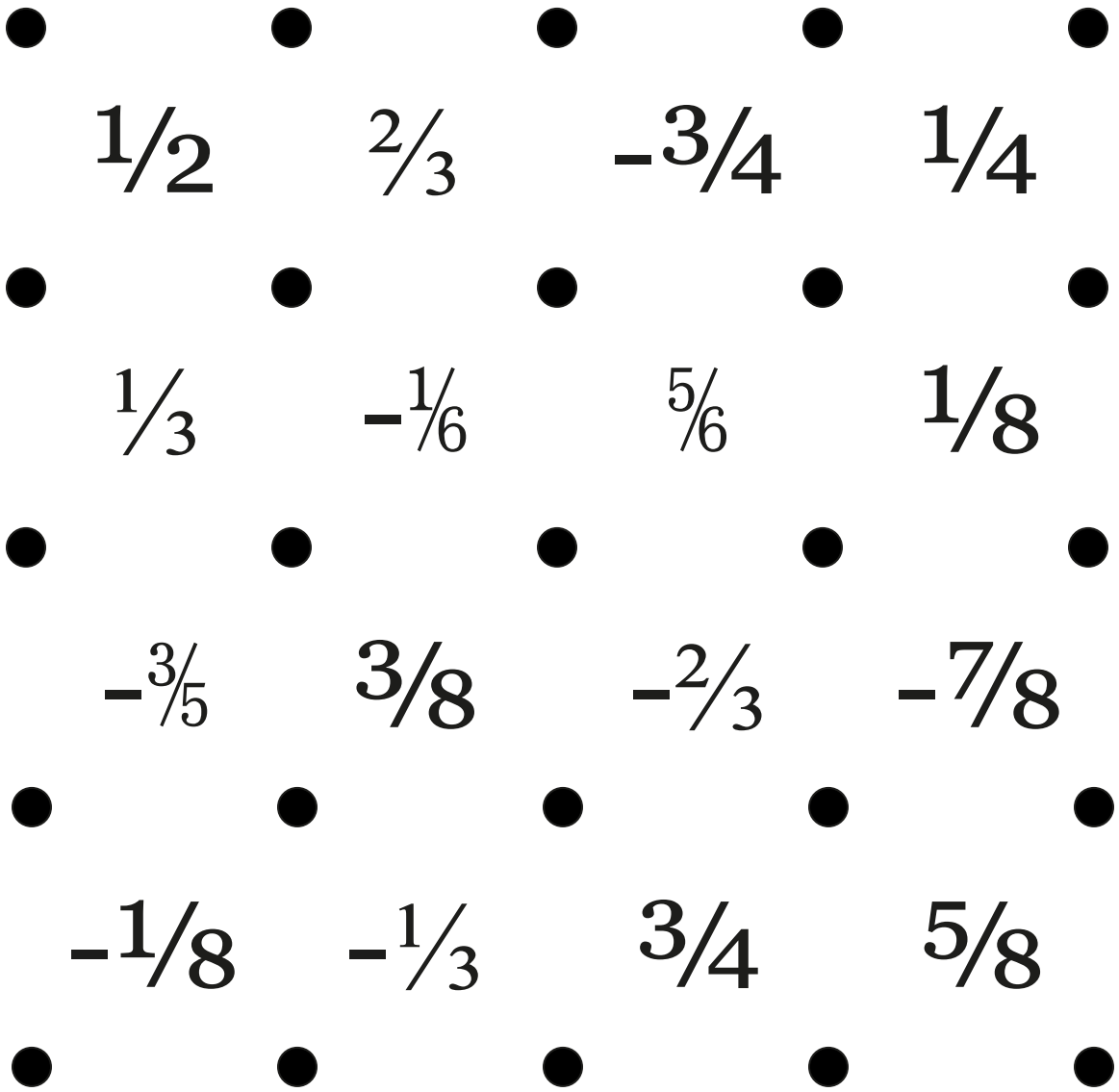
Box the Numbers is a 2-player game.

On your turn, add a vertical or horizontal edge between dots. If you complete a square, you claim the number inside it **and get to go again**.

Your score is the sum of all the numbers you box. Whoever has the highest score at the end wins

Day 5

Box the Numbers 3



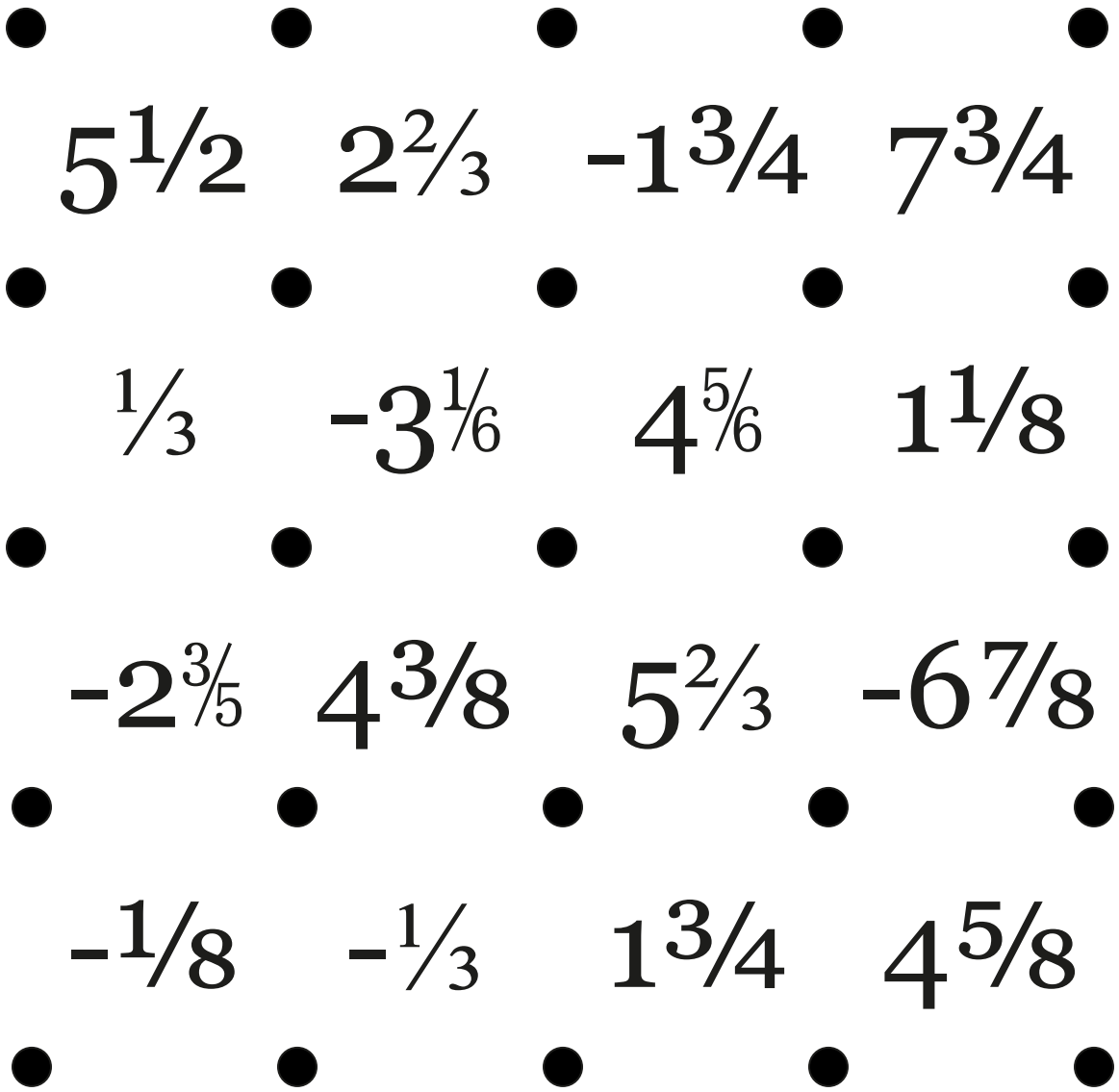
Box the Numbers is a 2-player game.

On your turn, add a vertical or horizontal edge between dots. If you complete a square, you claim the number inside it **and get to go again**.

Your score is the sum of all the numbers you box. Whoever has the highest score at the end wins

Day 5

Box the Numbers 4



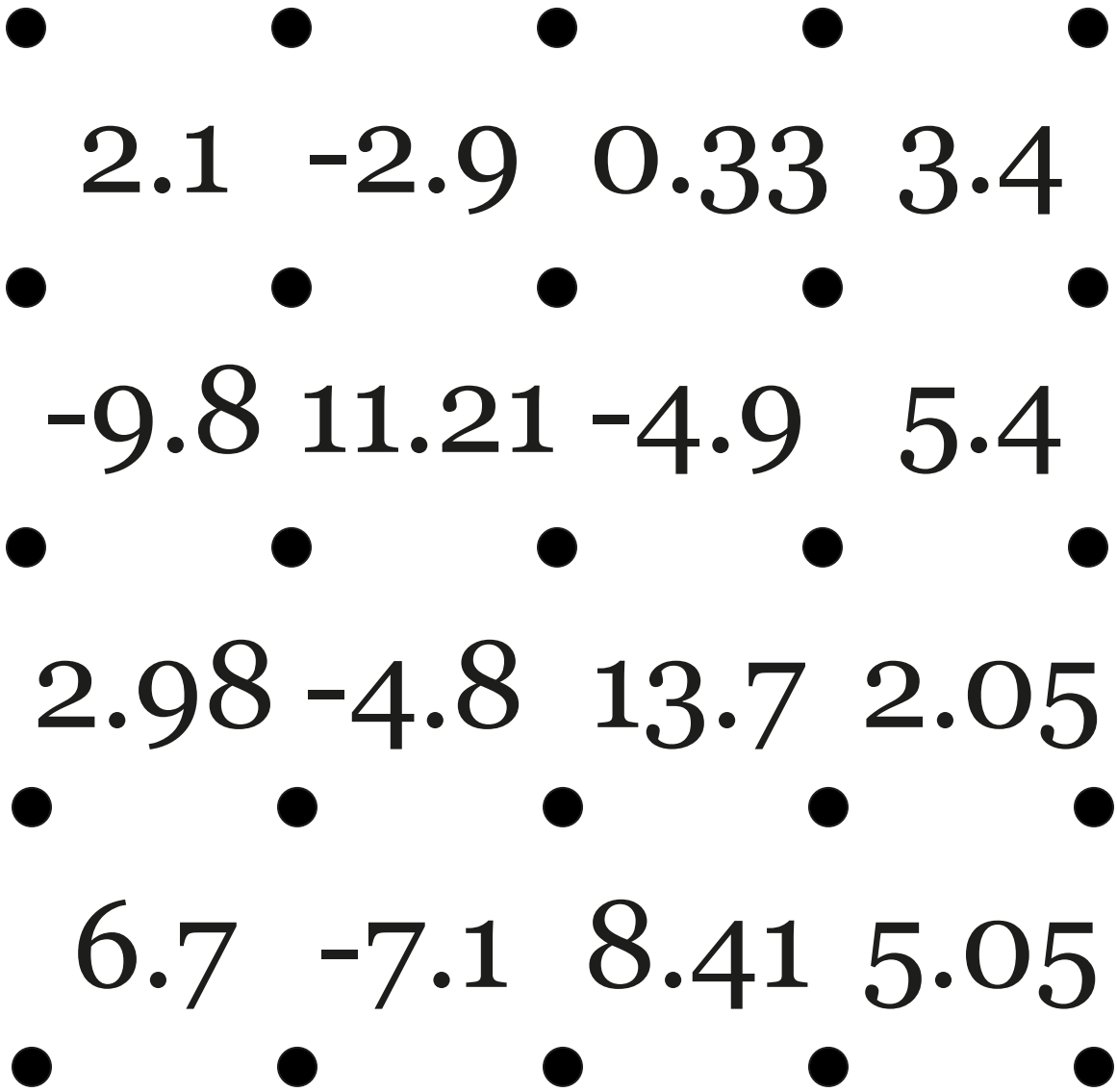
Box the Numbers is a 2-player game.

On your turn, add a vertical or horizontal edge between dots. If you complete a square, you claim the number inside it **and get to go again**.

Your score is the sum of all the numbers you box. Whoever has the highest score at the end wins

Day 5

Box the Numbers 5



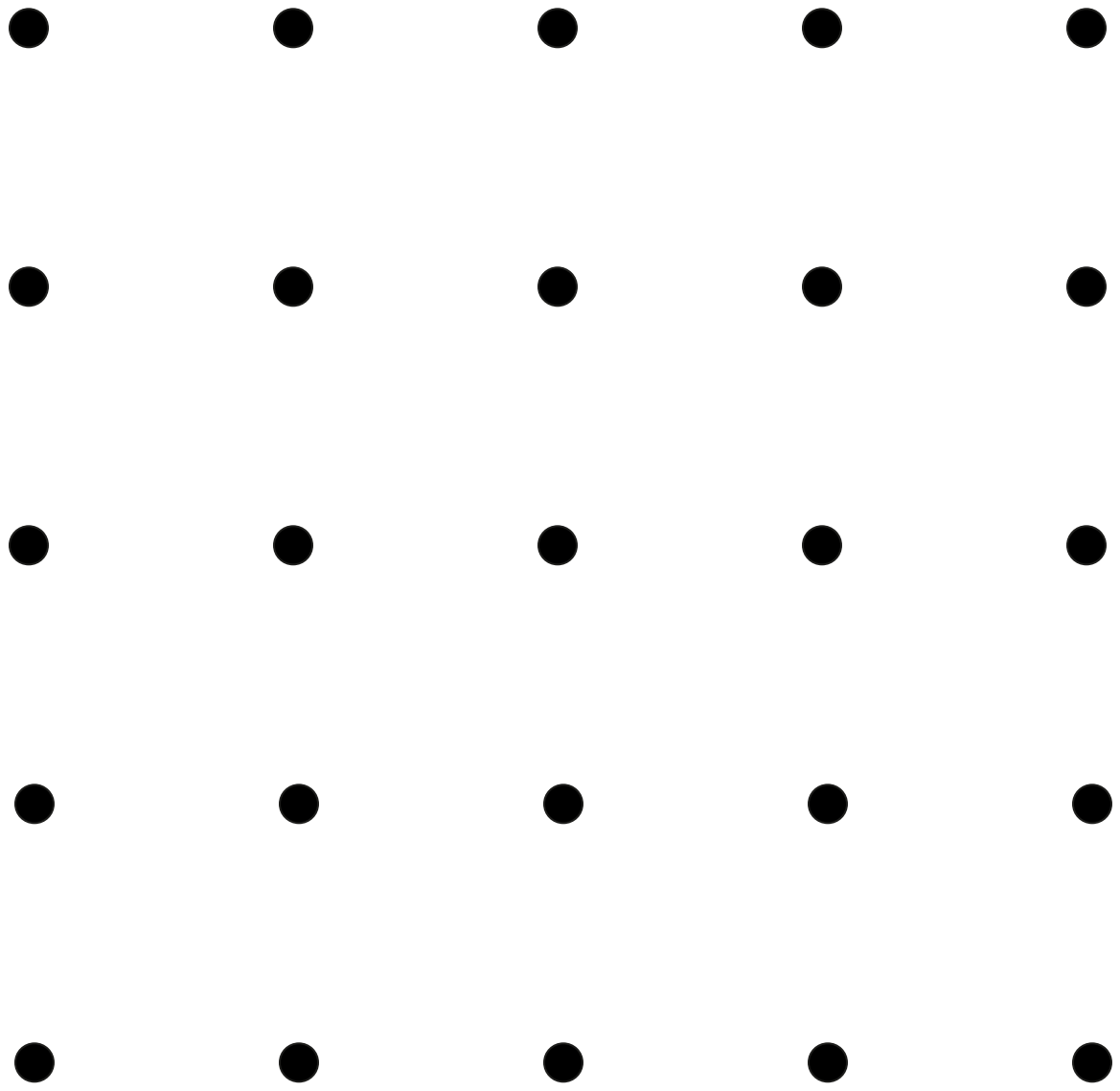
Box the Numbers is a 2-player game.

On your turn, add a vertical or horizontal edge between dots. If you complete a square, you claim the number inside it **and get to go again**.

Your score is the sum of all the numbers you box. Whoever has the highest score at the end wins

Day 5

Box the Numbers 5
Create Your Own!



DAY 6	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

MP7 Look for and make use of structure.

6.EE.1 Write and evaluate numerical expressions involving whole-number exponents.

Materials: 10-sided dice, scratch paper, pencil.

Opener	**Bullseyes and Close Calls**	10 – 15 minutes
Main Activity	**Horseshoes**	20 – 40 minutes
Closer	**Horseshoes Strategies**	5 – 10 minutes
Choice Time	• Challenge Problems • Prime Climb • Odd Pig Out • More Horseshoes!	5 – 25 minutes

Standards Connections

MP6 | MP8 | 5.OA.B

Bullseyes and Close Calls Tenths

Secretly choose a three-digit number with digits in the tens, ones, and tenths place. Make sure it has no repeated digits and write it down where no one can see it. For example, 12.6.

Students attempt to guess the number. After each guess, respond with the following options:

Outcome of Guess	Feedback
Correct digit in the wrong place	"Close Call"
Correct digit in the correct place	"Bullseye"
No correct digits	"Nothing"

Note: you might need to say "2 Close Calls," or "1 Bullseye and 2 Close Calls," or some other combination. DON'T say "first digit Close Call, second digit Bullseye." Your responses apply to the entire number, not individual digits.

Play 1 - 3 games. Vary the difficulty depending on student comfort. For each variation, continue to make decimal numbers to the tenths place.

Mild: 3-digit numbers
Medium: 3-digit numbers with repeated digits allowed
Spicy: 4-digit numbers
Super spicy: 5-digit numbers!

Tips for the Classroom

1. Note that students DON'T get a Bullseye or Close Call for each digit. The clue applies to the entire 3-digit decimal number.

Prompts and Questions

- What numbers can I cross off after that guess?
- Is there anything you know after that guess? Any number that is or isn't in our mystery number?
- Why are you so sure the number doesn't have a 5 in the tenths place?

Horseshoes

Materials and Prep

10-sided dice, scratch paper, pencil.

How to Play

Start with a target number (given below). Roll four dice to generate your working digits. The goal of the game is to create an equation that uses only these digits, each exactly once, and equals an amount as close as possible to the target number. It doesn't matter if you go over or under the target, as long as you get close.

Since this is the first time students play Horseshoes, start with a target number of 12. Future iterations of Horseshoes will have more complex variations.

Example Game:
A student rolls a 2, 4, 4, and 9. Write these digits and the target number (12) on the board. Give students quiet work time to write their attempts and equations down on their own paper.

After about three minutes, invite students to share what they got and how they got it. You can pose this as a question about how close the whole class was able to get, considering all their answers.

Possible student responses:
Student 1: I got 11 by doing 9 + 2 + 4 - 4. I was off by 1.
Student 2: I got 15 by taking 44 – 29. I was off by 3.
Student 3: I got 12.5 by doing $(9 + 2^4) /2$. I was off by 0.5.
Student 4: I got 12 exactly! 9 + 2 + (4/4).

Launch

Choose a volunteer to help roll four numbers. Write these numbers and the target number (12) on the board. Then explain how to play. Demonstrate a few solutions (like the ones above) as well as non-solutions, where you use a digit too many times, use a digit that didn't get rolled, or don't use all the digits.

Work

Give students 3 - 5 minutes of quiet work time to create equations using the four digits and a target number of 12. Then ask students to share their answers and equations. "How close were we able to get?"

Time permitting, play more rounds with four new random digits each time and increase the target number to 20, then 24, then 30.

Launch Key Points

- Ask a student volunteer to help you generate the random numbers.
- Create some equations as examples that can be improved upon. For example: "2 + 4 + 4 + 9 = 19, can you do better than that? What about 29 + 44 = 73?"

Prompts and Questions

- How close have you gotten so far?
- Have you tried using division to create a fraction? Would that help?
- What strategies have you figured out?
- Have you tried using exponents or parentheses?
- What is similar/different about these two equations?

Tips for the Classroom

1. Make the game more accessible by starting with three digits rather than four.

2. You can also drop the restriction that players need to use all four digits exactly once. For example, they could just use three of the four digits, or use one digit multiple times.

3. Students may need much more than 3 minutes to think of equations. If they're working diligently, you can extend the time per round and play fewer rounds.

4. Horseshoes lends itself to cooperative play. It's more like a group challenge than a competition between individual students.

Closer

Ask students what strategies they are developing as they play Horseshoes. Are any tricks being used to get as close as possible to their target?

Then draw four new cards from the deck and write them on the board.

"Up to this point, you have been working in pairs or trios to challenge each other to get as close as they can to target numbers. For the closer, you're going to work together in groups in a class-wide challenge. Out of all of us, who can get closest to 16?"

Give groups about 3 minutes of work time. Ask each group to share a solution they came up with. Write examples of students' equations on the board for discussion.

Prompts and Questions

- Are there any moves or strategies that help you get closer to a target number?
- Can you improve on one another's equations?
- Is it always possible to reach the target number exactly? Is there a way to tell if it is possible to reach the target number exactly?

Choice Time

- Challenge Problems
- Prime Climb
- Damult Dice Division
- More Horseshoes!

DAY 7	Opener	Main Activity	Closer	Choice Time

Overview

Focus Standards

MP6	Attend to precision.
6.NS.3	Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.

Materials: 6-sided dice, scratch paper, pencil.

Opener	**Don't Break the Bank**	10 – 15 minutes
Main Activity	**Spending Spree 1**	20 – 40 minutes
Closer	**What Strategies Did You Use to Reach the Target Amount?**	5 – 10 minutes
Choice Time	• Challenge Problems • Odd Pig Out • Damult Dice Division • Prime Climb	5 – 25 minutes

Standards Connections

MP1 | MP7 | MP8 | 5.NBT.7

Don't Break the Bank

How to Play

Roll a 6-sided die. After each roll, everyone enters the number in one of the nine spots on the board. After nine rolls, the board becomes an addition problem with three 3-digit numbers to add together. The goal is to get the highest sum without going over 999.

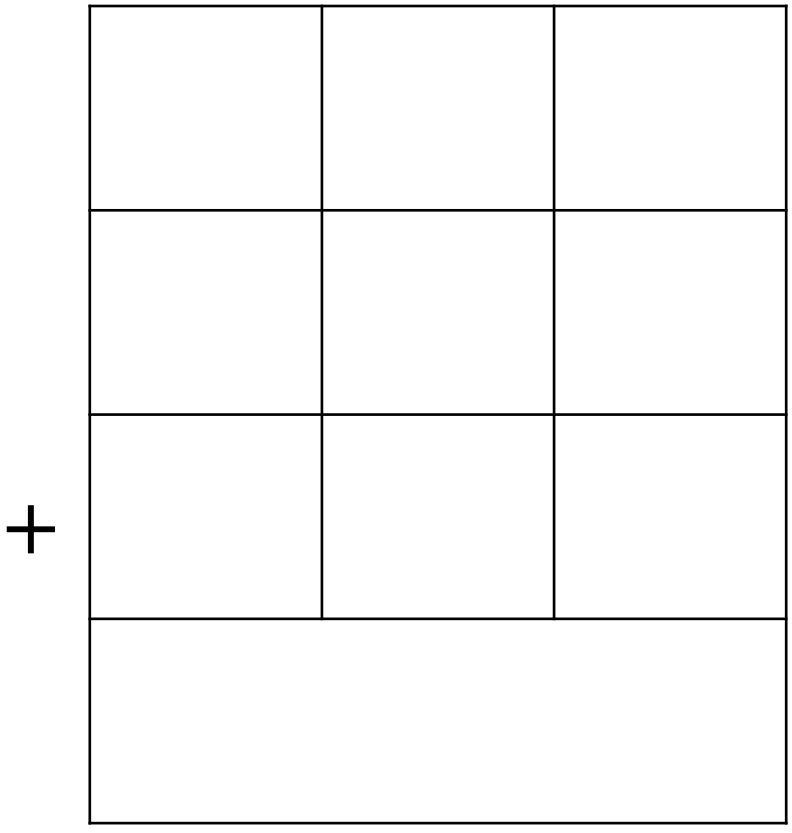
Everyone makes their own board (see image) on their paper. Briefly explain the rules. Start play as quickly as you can. Minor confusion over the rules can be worked out during play.

Play nine turns, slowly enough that everyone can make their decisions and keep up, but quickly enough that students can't work out exactly what their current total is, and have to estimate. Once a game is complete, share your score, ask who busted, and how close students got to 999 who didn't bust. It is often nice to have the player with the highest score explain where they put their digits to win - and for the class to check that they didn't make any arithmetic errors!

Play 1 – 3 games, as time allows.

Prompts and Questions

- Where should I put this 5... I think I'll put it in the tens column.
- Where are you going to put that 3? You don't have to place it where I did.
- Is there a strategy you used that helped with each round?



Spending Spree 1

Materials and Prep
Scratch paper, pencil.

How to Play
Students are given a spending goal and a list of items that they can purchase from the bookstore. They can choose to spend their money on any of the listed items, but they have to spend exactly the goal amount for each round or they lose everything.

Launch
Introduce the activity by sharing the following story:

"Everyone's a winner! Each of you just won a $500 spending spree at a bookstore! There is a catch however. You have to spend every dollar of your $500. If any is left over, you don't get to keep anything you bought."

Write the following prices on the board:

- Hardback books cost $15 each.
- Paperback books cost $8.25 each.
- Comic books cost $4.50 each.

"What combination of these books can you buy so that you spend all of your $500?"

Give students about 5 minutes to work, then invite them to share solutions.

Work
Continue to play two more rounds of Spending Spree. For Round 2, the target number is $1000. For Round 3 (time permitting), it's $1665.

Look for and share student solutions to highlight in the Closer.

Tips for the Classroom
1. Adjust the amount of time you give students to work on a round, depending on what's needed. If you have some students who are working faster, extend their work by asking them to solve their problem by either buying the most books possible (they have a new bookshelf they want to fill up), or by buying the least books possible (they only have a couple bags to carry all the books home).

2. Students should keep track of their work. They can try using a table or writing out a equations as they go.

Launch Key Points

- Keep the opening story simple and brief so students can dive into the problem.
- Walk around the room while students work looking for interesting solutions and strategies that are worth discussing.
- If students are struggling, consider asking them how much 10 hardbacks cost ($150) and see if they can use that number to make the problem simpler.

Prompts and Questions

- What combinations have you tried?
- How much is a comic book and a paperback book together? What about 30 comic books and 30 paperbacks?
- Does it help if you start by just getting as close to the target number as you can?
- Can you use previous calculations to help in this round?

Closer

Invite students to share their work. Were they able to hit the goal amount? After discussing the strategies and ideas they came up with, pose the following question:

Is is always possible to reach a spending goal, no matter what that goal is?

You can begin by stating a conjecture: "It seems like for each goal amount we tried, we were able find a way to reach it exactly. So here's a conjecture: given these book prices, it's always possible to reach a spending goal, no matter what that amount is." Invite students to try to prove you wrong with a counterexample.

Prompts and Questions

- How did your approach change for each round?
- What strategies or tricks did you figure out?
- How did you keep track of your work and organize your thinking?

Choice Time

- Challenge Problems
- Odd Pig Out
- Damult Dice Division
- Prime Climb

Overview

Focus Standards

MP7	Look for and make use of structure.
7.NS.1	Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers.

Materials: Scratch paper, pencil**.**

Opener	**Would You Rather**	10 – 15 minutes
Main Activity	**Escape Room 1**	20 – 40 minutes
Closer	**How do we escape?!**	5 – 10 minutes
Choice Time	• Challenge Problems • Prime Climb • Damult Dice Division • Horseshoes	5 – 25 minutes

Standards Connections

MP6 | MP8 | 6.NS.C

Would You Rather

Project the image of the Would You Rather question, and encourage students to:

1. **Come up with their own answer**
2. **Convince their peers using mathematics**.

Groups of 3 are generally ideal for small group discussion.

Transition to a full class discussion after groups have talked for 3 – 5 minutes, and see if a consensus emerges. Students may have questions and requests for more information.

Possible student observations and questions.

- $10,000 in my hand is a lot of money. I'm keeping a sure thing.
- I'm choosing $10,000 because I have a ⅚ chance (~83%) of losing it all if I roll the dice.
- A 1 in 6 chance to win more than 100x more money? I'm choosing to roll the dice.
- One-sixth of $1 million dollars is about $166,667. The expected value is greater than $10,000.

Possible extension:
As a whole group, would you rather each get $10,000 or each roll the die and then share any winnings equally?

Prompts and Questions

- What additional piece(s) of information would help you make a decision?
- What is the expected value for rolling the die to win $1 million?
- How much more is $1,000,000 compared to $10,000?

WOULD YOU RATHER...

Win $10,000

or roll a die and get a million dollars if a 6 comes up?

Escape Room 1

Materials and Prep
Scratch paper, pencil.

Motivating Question
How can we use these buttons to get out of the "escape room?"

Launch
Start by inviting students to share what they know, if anything, about escape rooms. If some students have been in one, invite them to share a story. Describe the basic premise of an escape room: a room with puzzles to solve in order to secure your (pretend) escape.

Then share the following story.

"You wake up in a room. There's nothing there except a door with the number 50 on a screen above it. Next to the door are two buttons, one says +4 and the other says -7. How do you escape from the room?"

Give students a minute to figure out what they think the task might be. Then pose the first challenge.

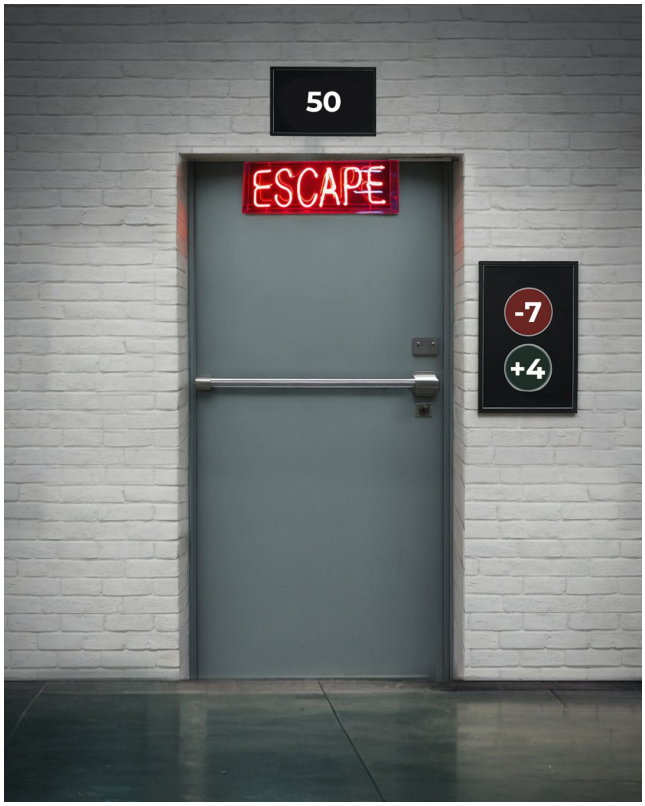
"Your first challenge is to make 50 using only these two buttons."

Display the image on the next page. Give students 1-2 minutes to work on solutions. A common approach is to add up to 50 by pressing the '+4' button 16 times and then pressing the '-7' button twice.

Look for students who make use of repeated reasoning. For example, a solution worth discussing is to recognize that +4, +4, -7 results in 1. And so we can just do that combination 50 times. Or we can do +4, +4, +4, -7 to make 5s and do that 10 times.

When students are ready to move forward:

"Congratulations! You made it out the first escape room. You're on to the next challenge."



Launch Key Points

- A classic feature of an escape room is that the tasks themselves aren't initially clear. The process of escaping involves first figuring what you are supposed to do and then figuring out how to do it.
- One of the stronger problem solving approaches here is using a smaller combination of presses to make a useful number.

Day 8

Work

The next challenge is to make -50 using only these two buttons.

As with the first challenge, there are multiple solutions. One potential strategy is pressing -7, -7, +4 to get -10 and doing that combination 5 times.

The last challenge is to make 0, but you must do so in the fewest number of button presses possible.

The fewest number of presses is 11. A common solution is to press +4 seven times to get 28 and then press -7 four times. Or we can reverse that order and make -28 first.

Another solution is to press +4 and -7 to make -3, and then press the combo +4, +4, -7, three times.

Tips for the Classroom

1. Allow groups to move at their own pace. You can make more challenges for them, or even change the numbers on the buttons. How would that change strategies to get solutions?

2. Consider the extension question: Are there any numbers you can't make using these buttons? (All positive whole numbers are possible since you can always add 1 to whatever number you have. All negative whole numbers are also possible by using +4 five times and -7 three times to make -1.)

Prompts and Questions

- Can you combine a small set of button presses to make a useful number?
- What would happen if you alternated more between the operations?
- Can you reach the target number with fewer presses of buttons?
- Do you think there are other solutions?

Day 8

Day 8

Closer

Gather the class and discuss the following questions.

If we were in an escape room with an 8 and a -5, what might be some ways we could easily create a target number of 30?

10(8 + -5) or 10(-5 + 8) are two possible ways. Take time to show that these expressions are equivalent.

What if the target number was -100? What be some ways we could create -100 efficiently?

-5 + -5 + 8 = -2. Therefore 50(-5 + -5 + 8) = -100.

Another group was in a different escape room and came up with this expression: 12(-3 + -3 + -3 + -3 + 2).

What buttons did they have on their door? -3 and +2.
What target number are they trying to reach? -120

Prompts and Questions

- What useful numbers can we create with +8 and -5?
- Why is 8 + -5 the same thing as 8 - 5?
- Does 8 + -5 + -5 equal the same thing as -5 + -5 + 8?
- Does the order of the buttons ever matter? Why or why not?

Choice Time

- Challenge Problems
- Prime Climb
- Damult Dice Division
- Horseshoes