



# NumberSense

## *Meet the Cast*

STANDARD EDITION

# Spark & Anvil

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This book collects 5 chapter books from the NumberSense cast — each character embodies a different curricular primitive; together they teach the full subject.

Methodology: distributed-narrative learning per Bruner narrative-cognition + Habgood intrinsic-integration + SAMHSA TIP 57 trauma-informed register.

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*For everyone who learns by hearing a story first.*

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# Introduction

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The NumberSense cast was authored to embody the curriculum, not decorate around it. Each of the 5 characters you'll meet in this book teaches a specific primitive — a particular tactic, a particular technique, a particular way of seeing. Together they form an ensemble: the cast IS the curriculum.

Read in any order. Each chapter stands alone.

Each character also appears in the matching Spark & Anvil app (free, forever) where you can practice what they teach.

— *The editors at Spark & Anvil*

# Ernie and Sasha

*round-and-rearrange — estimation and decomposition are the same friendliness move at different scales*



The spring fair came to Maya's school on the last Friday in April. The whole gym smelled like popcorn and fresh paint. There were ring tosses and a beanbag race and a face-painting booth where you could be a tiger or a galaxy. Maya wandered between the tables until she found the one she had heard about.

A giant glass jar of jellybeans sat in the middle of a card table. A handwritten sign said *Guess how many. Closest guess wins the jar.* Underneath the sign, in slightly smaller letters: *Tiebreaker: nearest WITHOUT going over.*

A small crowd of kids had gathered around. Maya pushed forward to look. The jar was almost as tall as her arm. It was packed all the way to the lid with jellybeans of every color. Three hundred kids would guess by the end of the day, the sign promised. Only one guess could win.

Maya stared at the jar.

Then she pulled her phone out of her pocket. Because her two favorite guides were on the NumberSense app. And if anyone was going to help her think about a jellybean jar, it was them.

She opened the app, hit the prompt button, and waited.

Estimator Ernie appeared first. He was eating a jellybean.

"Where are you?" he asked. "What are those colors behind you?"

"The spring fair," Maya whispered. "Look at the jar."

Ernie's face lit up so brightly that Maya thought he might leap right through the screen. "A guessing jar. A guessing jar! Oh, this is the best day. This is a perfect day. Sasha, get out here, this is a *jellybean jar.*"

Splitter Sasha popped in next to him. Her three pompoms wobbled excitedly.

"What's the prize?" she asked.

"The whole jar," Maya whispered.

"Okay, okay," Ernie said, rubbing his hands together. "We need a plan. Sasha, you have the friendliest brain in the app. I have the jellybean memory. Let's do this together."



"First we estimate," Ernie said. "We get a guess in the right neighborhood. Then we make it nicer."

Maya held up the phone so both of them could see the jar.

"Okay. Tell me what you see," Ernie said.

Maya squinted at the jar. "It's tall."

"How tall?"

"As tall as my arm. From my elbow to my fingertips."

"What's that, in inches?"

Maya thought about it. "Eighteen?"

"Sounds right," Ernie said. "Now. A jellybean is about an inch long. How many jellybeans tall is the jar?"

"Eighteen," Maya whispered.

"Good. Now look at the bottom of the jar. How wide is it?"

"As wide as my hand."

"Four jellybeans?"

"Yeah, about four."

"So a flat layer at the bottom is roughly four by four," Ernie said. "That's sixteen jellybeans per layer. Eighteen layers tall. Multiply, and you get..."

Maya's brain froze. *Sixteen times eighteen*. In her head. Without a pencil.

Sasha leaned forward through the screen. "Hold on, hold on. Don't multiply yet, Maya. Let me make those numbers friendlier first."

She tapped a finger in the air, like she was poking the numbers themselves. "Sixteen is just ten plus six. And eighteen is twenty minus two. So sixteen times eighteen is the same as sixteen times twenty, minus sixteen times two. Sixteen times twenty is three hundred and twenty. Sixteen times two is thirty-two. Three hundred and twenty minus thirty-two is..."

"Two hundred eighty-eight," Maya said.

Sasha's pompoms wobbled. "Yes! Two hundred eighty-eight. That's the square-jar guess."

"But the jar is round," Ernie said. "So we have to fix that."



Maya turned the jar slowly with her free hand so both of them could see all sides. The jellybeans on the curved edge were not packed in neat layers. They were jostled together.

"How do we fix for round?" Maya asked.

Ernie tapped his chin. "Round jars hold a little more than square jars of the same height. Maybe a quarter more. Maybe a fifth. Let's say a fourth."

"Two hundred eighty-eight plus a fourth," Sasha said. "Sasha-friendly math. A fourth of two hundred and eighty-eight is..."

"Seventy-two!" Maya said. She had practiced that one. *Halve, halve again.*

"Look at you!" Sasha cheered. Her pompoms went wild. "So two hundred eighty-eight plus seventy-two is..."

"Three hundred and sixty," Maya said.

Ernie grinned. "Three sixty. That's our first guess. We're in the right neighborhood."

But Maya was staring at the jar with a slightly worried face.

"What?" Ernie asked.

"The jellybeans look really small. Smaller than an inch. They look more like half an inch."

Ernie's grin got bigger. "Now THAT is a good observation. That changes everything. Sasha?"

Sasha was already nodding. "Half-size jellybeans means we can fit way more in. Twice as many per layer, and twice as many layers. Two times two is four. So we have to double-double our guess."

"Double-double?" Maya said.

"Multiply by four," Sasha said. "Friendly. Three hundred sixty times four. That's three hundred sixty, plus three hundred sixty, plus three hundred sixty, plus three hundred sixty. Or — friendlier — three hundred sixty times two is seven hundred twenty. Times two again is..."

"One thousand four hundred and forty," Maya whispered.

She stared at the jar. The number sounded enormous. But the jar was very, very full.



"Tiebreaker," Sasha reminded them. "Closest *without going over*. So we should guess a little under our best guess. Just to be safe."

"How much under?" Maya asked.

Ernie thought about it. "Round to a friendly number that's a little below. One thousand four hundred is friendlier than one thousand four hundred forty. And it's safely under."

"But what if the real answer is, like, one thousand five hundred?" Maya asked. "Then I'd lose by being too low."

"You might," Ernie agreed. "That's the risk. Estimation isn't certainty. It's your best guess based on what you can see. And if the rule is *closest without going over*, you have to leave yourself a tiny cushion."

Sasha was nodding. "And one thousand four hundred is friendlier than, say, one thousand three hundred ninety-nine. Easier to remember. Easier to feel proud of."

Maya thought about it. The jar looked very full. The jellybeans were definitely small. She made a decision.

"I'm going with one thousand four hundred," she said.

She wrote it on the slip of paper from the table. She folded it carefully. She dropped it into the entry box.



Maya walked home that afternoon with one slightly tired arm and a small flutter in her chest.

That evening, she opened the NumberSense app. She just wanted to talk to them.

Ernie appeared first, then Sasha right behind him.

"How do you feel?" Ernie asked.

"Good," Maya said. "I don't know if I'll win. But the guess felt right. We thought about every part of it."

"That's the whole game," Ernie said warmly. "You looked at the jar. You broke it into parts. You estimated the parts. You decomposed the math. You adjusted when you noticed something new. Then you backed off a hair for the tiebreaker. That's the entire estimating-and-decomposing toolkit, in one fair-day jellybean jar."

"It was a lot of moves," Maya said.

"And every one of them was friendly," Sasha said. Her pompoms wobbled gently. "That's the secret. Hard problems aren't actually hard. They're just made of friendly pieces stacked on top of each other. You and Ernie and me — we just untangled the friendly pieces."

Maya smiled.

"We'll see what happens at the end of the fair," Ernie said. "But here's the part I love. Even if you don't win the jar, you walked up to a jellybean jar today and you didn't freeze. You knew exactly what to do. That's the prize. That's the prize we've been training for."

Maya nodded. She closed the app and went to bed thinking about jellybeans.

The next afternoon, the principal called her name over the loudspeaker. Maya did not win the jar. The closest guess without going over was nine hundred eighty-seven. The real answer was nine hundred ninety-three.

But Maya was not sad. Because Ernie had been right. The prize was already hers.

**Listen along + meet more of the cast at:**



<https://spark-and-anvil.com/cast/numbersense/ernie-and-sasha>

# Estimator Ernie

*gut-feel estimation — guessing first then computing*



The first thing Maya learned about Estimator Ernie was his jellybean story. He had won a giant jar of them when he was eight.

He told this story at the start of almost every conversation. He wasn't embarrassed at all. He told it with a cheerful confidence, like it was the most amazing thing that had ever happened. And maybe it was. There was a county fair. A wobbly card table. A huge glass jar packed with jellybeans. A sign said *Guess how many. Closest guess wins the jar*. Three hundred kids guessed. But only one kid—eight-year-old Ernie—guessed 847. He was off by only nine.

He took the jar home. For a whole week, he didn't eat a single jellybean. He was too busy just looking at them.

"That was the day I knew," he would always say, his voice full of wonder. "That was the day I knew estimation was the best thing in the whole world."

Maya was ten. She'd been using the NumberSense app for three weeks. And she was skeptical. To her, estimation was just a fancy word for guessing. And guessing was basically cheating. It was what you did when you didn't know the real answer. How could that be the best thing in the world?

Estimator Ernie had a very clear answer.

"Estimation isn't guessing," he said, on Maya's third day with the app. "It's making your guess *smart*. You use what you already know to get as close as you can. It's the opposite of cheating. Cheating is when you skip the thinking. Estimation is doing the thinking in ten seconds instead of ten minutes. The thinking is harder, not easier. It's just way faster."

"Why is it harder?" Maya asked.

"Because when you calculate, you just follow the rules. You add this, you multiply that. But when you estimate, there are no rules on paper. You have to look at a problem and just... *feel* where the answer lives. You have to know a little bit about how the world works."



Maya wasn't so sure, but she was curious.

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The NumberSense app always started the same way. A problem would pop up. Then a ten-second timer would start ticking. You had to type in a guess before it ran out. No pencils. No paper. No calculators. Only after you guessed did the app show the real answer.

Maya hated the estimate phase at first.

The ten-second timer was a tiny, ticking bomb. Her brain would freeze. She just wanted to write the problem down, the way her teacher taught her. But the timer took all her tools away. *Tick. Tick. Boom.*

"Those tools are for calculating later," Ernie said when she complained. "The estimating part has its own tool."

"What tool?" Maya asked.

"Your gut," Ernie said. "What feels true?"

"That's not a tool," Maya grumbled.

"It's the most important one you've got," he said. "You use it all the time. When your mom asks how long till you're ready and you say 'like, five minutes,' you're estimating. You're just practicing it on purpose here."

Maya thought about that.



The next problem flashed on the screen: *How many words does the average book have?*

Ten seconds.

Her mind went completely blank. A million? A thousand? She'd read hundreds of books. She had never once thought to count the words. With three seconds left, she jabbed at the screen. She typed 10,000. It was a nice, round number. That was her only reason.

The timer buzzed. The real answer appeared: about 70,000 for a typical novel.

She was off by sixty thousand words. She felt her face get hot. It was a terrible guess.

Estimator Ernie popped up on the screen. He was munching on a jellybean.

"That was a good first guess," he said.

"It was sixty thousand words off!"

"Yep," Ernie said, not bothered at all. "But now you know something new. You know books are way bigger than you thought. Your next guess will be better. That's the whole point. Estimation isn't about being perfectly right. It's about getting closer and closer."

"I want to be perfectly right," Maya muttered.

"That's a different job," Ernie said. "That's for calculating. Estimating's job is to make you a pro at being roughly right."



Maya thought about it for a long time.

The next day, a new prompt appeared. *How many seconds are in a week?*

Ten seconds.

Okay, don't panic, she told herself. Break it down. Sixty seconds in a minute. Sixty minutes in an hour. That's 3,600 seconds per hour. A day has 24 hours. That's roughly... 86,000 seconds. A week has seven days. Seven times 86,000 is... she rounded again... about 600,000.

She typed 600,000 just as the timer hit zero.

The compute phase revealed the answer: 604,800.

She was so close!

Ernie appeared again, holding another jellybean. "Now THAT was a good guess," he said, with a huge grin.

Maya stared at the screen.

"That felt... different," she said.

"How so?"



"It felt like I actually knew what I was doing."

"You did," Ernie said. "You just used a real estimation technique. You broke the problem into pieces. You rounded at each step. You did it without even thinking about it."

Maya thought about that first story. The one about the jellybean jar.

"Is that what you did?" she asked. "When you were eight?"

"Exactly," Ernie said. "I looked at the jar. I figured it was about as tall as my arm from my elbow to my fingers. About 18 inches. A jellybean is about an inch long. So, 18 jellybeans stacked up. Then I looked at the bottom. It was as wide as my hand. Four jellybeans across. A layer on the bottom would be four-by-four. That's sixteen jellybeans. So, sixteen in a layer, times eighteen layers..." He paused. "That gets you to about 288. But that was for a square jar. This one was round. So I doubled it. The jellybeans were also pretty small. So I doubled it again. Then I added a little more, just for luck. And I landed on 847."

Maya's jaw dropped. "You did all that in your head?"

"Took me about twelve seconds," Ernie said. "I was a little slow back then. I'm faster now."

Maya stared at his smiling face on the screen.

"Teach me," she said.

Estimator Ernie's smile got even wider.

"That's what I'm here for."

**Listen along + meet more of the cast at:**



<https://spark-and-anvil.com/cast/numbersense/estimator-ernie>

# Pivot Pia

reframing — the "would-you-rather" character; restating the question



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## Pivot Pia and the Question That Wasn't Quite the Question

The first time Maya met Pivot Pia, Pia didn't say hello. She just asked a question.

"Would you rather have a quarter of a pizza or one-fifth of a pizza?"

Maya blinked. She was ten years old. She expected a normal "hello." Maybe something like, "Hi, I'm Pivot Pia!" Not a quiz about pizza.

"Um," Maya said. "The bigger one, I guess."

"Which one is bigger?"

"A quarter? A quarter is one-fourth. And one-fourth is bigger than one-fifth, right?"

"Right. So you'd rather have a quarter."

"Yes."

"Okay. Now, would you rather have a quarter of a pizza or one-fifth of a LARGER pizza?"

Maya paused.



"Twice as large."

"Oh. Then... one-fifth of the larger one. Because one-fifth of a huge pizza is like two-fifths of the first pizza. And two-fifths is bigger than one-quarter."

"Right."

"Is that right? Let me think."

"Take your time," Pia said. "The question changed when I changed the pizzas. So your answer should change, too. Most kids stick with their first answer. They don't like to change their minds. But you re-thought it. That's what I teach."

"That's the skill you teach?"

"Yep. It's a small skill. But you'll see it everywhere."

Pia had a small, tricky smile. Maya noticed it never went away.

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Over the next few weeks, Maya learned Pia's first skill. It was simple. Notice when you're about to answer the wrong question.

This happened a lot more than Maya thought.

One day, Pia gave her a problem. "There are 20 marbles in a jar. 8 are red. The rest are blue. What's the ratio of red to blue?"



Pia said, gently, "That's red to total. The question asked for red to BLUE. Read it again."

Maya read it again. Pia was right. Maya typed a new answer: 8 to 12.

"There you go," Pia said. "You answered a different question the first time. That happens all the time. The best way to catch it is to read the question. Then, before you answer, say it again in your head. Make sure your answer matches the question."

Maya thought about this.

"That seems easy."

"It is easy," Pia said. "And almost nobody does it."

"Why not?"

"Your brain is fast," Pia explained. "Super fast. It skims the words and sees a pattern. It sees 'red marbles, 8, total 20.' Then it starts solving. Vroom! But it solved before it finished reading. It missed the word BLUE. The trick is to catch your brain. Slow it down before it gives the wrong answer."

"That sounds hard, actually."

"It's hard at first," Pia said. "But it's the most useful trick for math. It catches tons of wrong answers. Just read the question twice. If you do that, you'll get about half as many problems wrong. I'm not making that up. I read it somewhere."

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Pivot Pia had another trick, too. It was the one she was named for.

The trick was **pivoting**.



For example: "If you walk at 4 miles per hour, how many minutes does it take to walk a quarter mile?"

That sounded complicated. It had decimals and hours and minutes.

But a pivot could help. An easier question was hiding inside. "If it takes an hour to walk 4 miles, how long to walk one mile? Fifteen minutes. So how long to walk a quarter of a mile? A quarter of fifteen minutes. A little less than four minutes."

Same answer. Different question. The second one was way easier.

"That's pivoting," Pia explained. "You take the question and flip it around. You find an easier way to ask the same thing. Sometimes the flip is small. Sometimes it's huge. When you find a flip that makes the problem super easy? That's the best feeling in the world."

Maya started looking for pivots on her own.

She found them in weird places. A problem about sharing cookies: "How do 4 friends share 13 cookies?" That pivoted to a different question. "If each friend gets 3 cookies, how many are left over?" It was easier to think about, but it gave the same answer. Three cookies each, with one left over.

A problem about a recipe: "If a recipe for 6 people uses 2 cups of rice, how much for 9 people?" That pivoted, too. "How much rice per person? One-third of a cup. Okay, so for 9 people? Three cups."

A problem about percents: "What's 15% of 80?" That pivoted into two smaller questions. "What's 10% of 80? That's 8. What's 5% of 80? That's 4. So 15% is 8 plus 4. It's 12."

The pivots were always the same trick. Find an easier question with the same answer. Then answer THAT one.

"That's the secret," Pia said when Maya told her this. "Most hard problems have an easy twin. The trick is finding it. That's what real mathematicians do all day. People think they just crunch numbers like a calculator. Nope. They pivot. They turn hard questions into easy ones. Then the answer just pops out."

Pia paused.

"Also," she added. "Would you rather have ten dollars now, or one penny that doubles every day for thirty days?"



She said, "The penny that doubles. I read about that one."

"Smart kid. How much does it become?"

"I don't remember. A lot."

"Over five million dollars," Pia said. "The penny pivot wins every time. You'd think everyone would pick the penny. But most grown-ups take the ten dollars. They look at the small thing and grab the big thing. They don't pivot. They don't ask what the small thing becomes."

She smiled her tricky smile.

"That's most of my job," she said. "Teaching kids to ask what the small thing becomes."

## Meet Pivot Pia

Pia is cool and casual, but she's secretly a genius. She loves to ask "would you rather" questions. She almost always has a little smile, like she knows a secret you're about to figure out. She teaches two big skills:

1. Always check that you're answering the *real* question.
2. Find an easier question that has the same answer. (That's a **pivot**!)

### Things you'll hear Pia say:

- "Would you rather have a quarter of a pizza or one-fifth of a LARGER pizza?"
- "Read the question, then say it in your head before you answer. It's the best way to catch mistakes."
- "Find an easier question that has the same answer. Then answer THAT one."
- "People think mathematicians are calculators. Nope. They're question-pivoters."
- "Most grown-ups take the ten dollars. They forget to ask what the small thing becomes."

## Your Journey with Pia

At first, you'll just be answering Pia's weird pizza questions. That's how it starts.

But soon, you'll start catching your own mistakes. You'll stop yourself just before you answer the wrong question. It feels great.

A few weeks later, you'll find your first **pivot**. You'll turn a hard problem into an easy one all by yourself.

Then you'll start seeing pivots everywhere. You might even help your friends (or your older brother!) with their homework. By the end of the year, you'll be teaching Pia's tricks to other people.

## Pia's Crew

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- **With Estimator Ernie** (friends, but they drive each other nuts): Ernie likes to guess the answer right away. Pia always wants to change the question first. They tease each other about it all the time.
- **With Splitter Sasha** (a friendly rivalry): Sasha is an expert at splitting big numbers into smaller, friendlier pieces. Pia is an expert at splitting hard questions into easier ones. They love to argue about which skill is more important.
- **With Ratio Rio** (a team): Rio turns ratios into simple "per one" amounts. Pia turns questions into simple versions. They're both using the same kind of thinking, just in different ways.

## A Note from the Creators

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Why did we make a character like Pivot Pia?

We think she teaches two of the most important skills in all of math.

First: **Read the question carefully**. So many wrong answers happen because someone solves a slightly different problem than the one they were asked. Pia's trick of saying the question back to yourself is a real-life superpower for school.

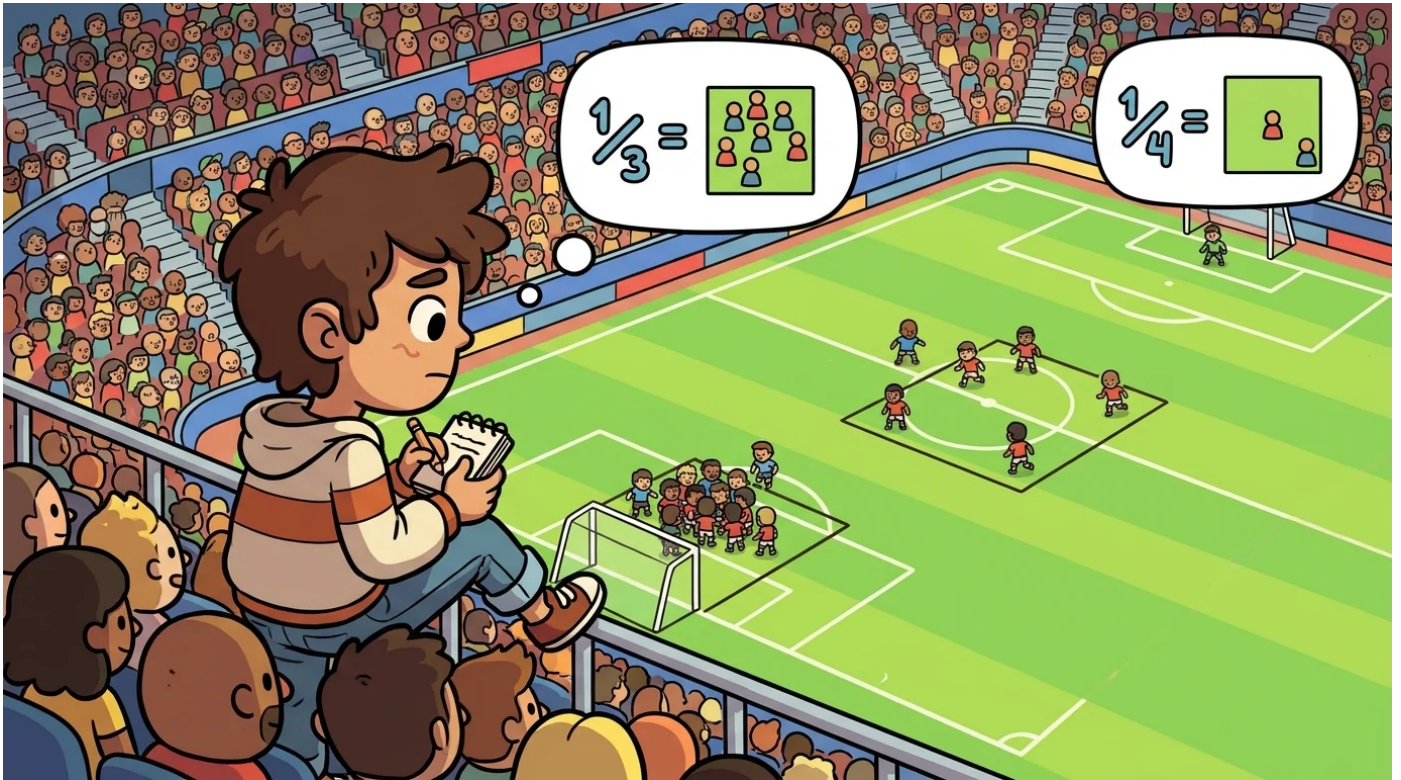
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<https://spark-and-anvil.com/cast/numbersense/pivot-pia>

# Ratio Rio

*proportional reasoning — thinking in ratios, rates, and per-one units*



Ratio Rio loved soccer.

This was not unusual. Plenty of people love soccer. But Rio watched the game differently than anyone else. He didn't watch for the thrilling goals. He ignored the acrobatic saves by the goalie. He didn't care about team rivalries or which superstar player had the coolest haircut.

Ratio Rio watched soccer for the ratios. He had been doing it since he was eleven.

"It all started when I was eleven," he told Maya one afternoon. She had just groaned about a tricky ratio problem. "My big brother took me to my first real pro game. The noise of the crowd was huge. I sat way up in the stands, just watching. And after about ten minutes, I noticed something weird. The players weren't just running around. They were moving in clumps."

He leaned forward. "There were tight clumps near the ball. Then there were looser groups far away from it. The clumps had different densities. Near the goal, you'd see way more attackers packed into one little square of grass."

"Per square of grass?" Maya repeated.

"Exactly. I started counting in my head. In the middle of the field, maybe three players per ten-by-ten-foot square. But near the goal, there were six players in the same size area. Sometimes more. The DENSITY of players was a ratio. It was players per area. The whole game became a slow, shifting pattern of densities. I never watched soccer the same way again."

Maya, who was ten and thought soccer was just okay, frowned.

"That sounds kind of boring."

"It's the most exciting thing in the world!" Rio said. "The whole game is a flow of ratios. When the density of attackers near the goal goes up, the goalkeeper's job is to raise the density of DEFENDERS to match. When the attackers spread out, the defenders spread out. Every single moment is two ratios trying to balance each other. If you watch enough, you can feel when a team is about to score. The attacker-density rises, but the defender-density isn't rising fast enough. You can see the goal coming."



Maya thought about this.

"You really watch the whole game like that?"

"Always. Every game. I don't know how to watch it any other way now."

"What about the actual players?"

"They're just flowing dots," Rio said with a shrug. "They flow in ratios. The ratios are the real game."

---

Maya was stuck on a NumberSense problem. It was one of the ten-second estimates. *A recipe makes 12 cookies and uses 2 cups of flour. How many cups of flour for 30 cookies?*

She had tried to set up a proportion in her head. She tried to cross-multiply. But she ran out of time. Every single time.

"Stop trying to set up big, formal proportions," Rio told her gently. She had just thrown her hands up in defeat. "You don't have time for that. The estimate phase wants you to *feel* the ratio. Just ask yourself one simple question." He held up a finger. "**How many of THIS for one of THAT?** Then you just multiply or divide. That's the whole trick."

"That doesn't feel like real math."

"It IS real math. It's the secret, faster version of cross-multiplication. Watch. 12 cookies for 2 cups of flour. So, how many cookies for ONE cup of flour?"

"Six," Maya said.



"Right. Six cookies per one cup. That's your rate. Now you want 30 cookies. How many cups do you need?"

Maya thought. "Thirty cookies... divided by six cookies per cup... is five cups."

"You did it!" Rio grinned. "In your head. In about three seconds. No messy proportions. Just **per-one thinking**."

Maya tried it on the next problem.

*8 markers cost 12 dollars. How much for 5 markers?*

She thought: *Okay. 8 markers for \$12. How much for ONE marker? Twelve dollars divided by eight markers was \$1.50 per marker. So, 5 markers would be 5 times \$1.50. That's \$7.50.*

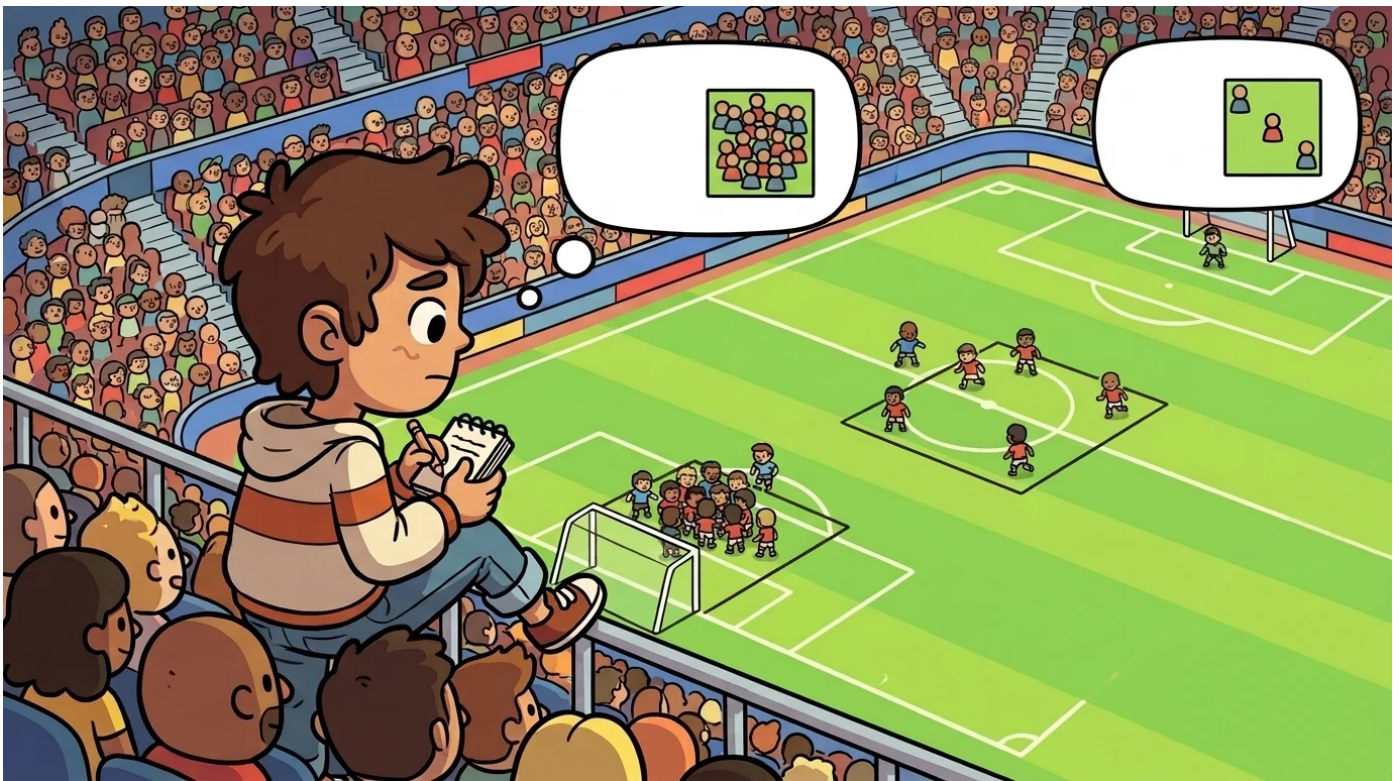
She typed in 7.50.

The screen flashed green. Correct.

She had solved it in four seconds.

"That was fast," she said, surprised.

"**Per-one thinking** is the fastest way," Rio said. "Always. You find the 'per-one' amount first. Then you can find any other amount easily. Most grown-ups can't even do this. They still pull out paper and pencil to cross-multiply. You're already way ahead of them."



Maya started practicing **per-one thinking** in the real world.

When her family went out for pizza, the bill came. Before her dad could open his calculator app, she would estimate how much each person owed. Her dad was usually pretty impressed.

On family hikes, her mom might say, "We've walked half a mile in fifteen minutes." Maya would quickly figure out their per-mile time. Then she'd estimate how much longer the whole hike would take. She got good at it.

She used it grocery shopping. Two pounds of grapes for six dollars meant three dollars per pound. Four cans of soup for twelve dollars was three dollars per can. She compared the per-unit prices on the shelf tags to find the best deal. Her mom started asking for her help.

Rio was delighted whenever she shared one of these stories.

"That's the whole point," he said. "The goal isn't just to solve ratio problems on a screen. It's to see ratios hiding all over the world. Once you see them, they're everywhere. And once they're everywhere, they get easier."

He paused, a twinkle in his eye.

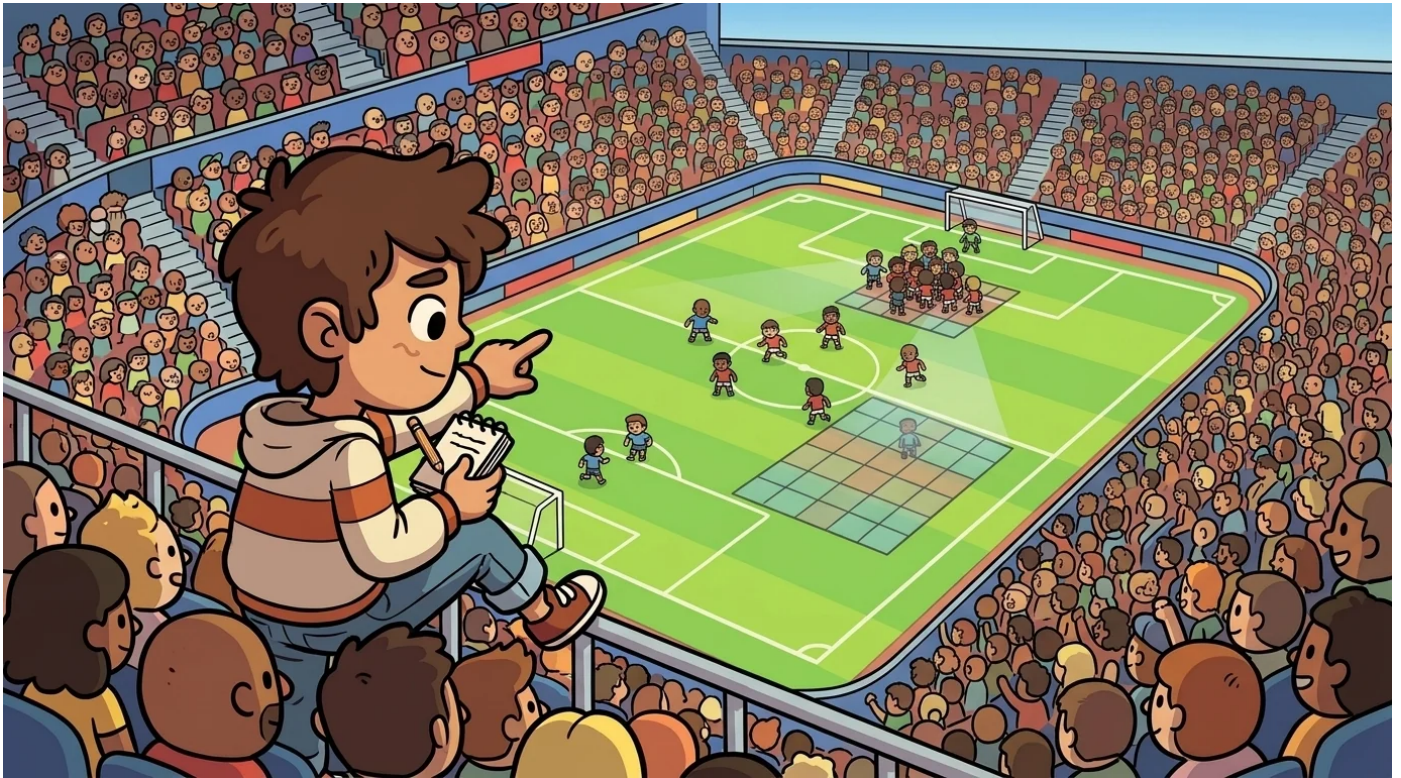
"Also," he added, "now you can watch soccer the right way."

"I still don't really care about soccer," Maya said.

"That's okay. You can watch any sport this way. Basketball, hockey, you name it. The density patterns are in any game where players move on a field. They're in board games. They're definitely in traffic jams. They're in flocks of birds and schools of fish. **Per-one thinking** lets you see the secret structure underneath it all."

Maya thought about that for a long time.

She did not start watching soccer.



But on the drive home from school, she did start noticing the traffic patterns. She saw how the cars bunched up at red lights and spread out on the open road.

Which was, Rio thought when she told him, a perfectly fine place to start.

## About Ratio Rio

Rio is warm, practical, and a little obsessed with soccer. But he doesn't watch it for the goals. He watches for the patterns, the secret math hiding on the field. He believes the fastest way to solve any ratio problem is with **per-one thinking**. It's a trick most adults never learn. He gets super excited when he hears about kids spotting ratios out in the real world.

**He often says things like:**

- "It's just cross-multiplication, but all in your head, with no messy symbols."
- "**Per-one thinking** is the fastest way. Always."
- "Just ask: how many of THIS for one of THAT?"
- "Once you learn to see ratios, they're everywhere. And that makes them easier."
- "The density of attackers was rising. I could see the goal coming a mile away."

## Maya's Big Year with Ratios

- **At the start:** Maya tries to solve ratio problems the slow, school way. She keeps running out of time. Ugh.
- **A week later:** She tries Rio's **per-one thinking** for the first time. It actually works!
- **One month in:** At a restaurant, Maya figures out how to split the bill in her head. She beats her dad's calculator app.
- **Three months in:** Maya helps her mom find the best deals at the grocery store by comparing prices.
- **Six months in:** Stuck in traffic, Maya suddenly notices the patterns, just like Rio's soccer players.
- **By the end of the year:** Maya is so good at **per-one thinking** that she teaches the trick to a friend.

## Rio's Friends

- **Estimator Ernie:** Ernie and Rio are a great team. Ernie likes to solve problems one step at a time. Rio's ratio-thinking

is often one of those key steps. They see the same problem from different angles.

- **Splitter Sasha:** Sasha is an expert at breaking down big numbers into smaller, friendlier pieces. Rio does the same thing with ratios. They're always borrowing each other's best tricks.
- **Pivot Pia:** Pia and Rio have a friendly rivalry. Pia is amazing at looking at a problem and flipping it around to find a new way in. Rio does the same thing, turning confusing ratios into simple "per-one" units.

## A Note from the Team

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We gave Ratio Rio his special way of watching soccer for a reason. It's easier to understand a math idea when you can see it in the real world. Watching players get crowded on a field is a great way to start *seeing* what a ratio really is. From there, it's a short hop to seeing them with numbers.

Most grown-ups were taught to solve ratio problems with a complicated method called cross-multiplication. It works, but it's slow and you need paper. Rio teaches **per-one thinking** instead. It's a faster, simpler way that you can do in your head. Our goal is for you to get really good at this powerful trick. It will help you with more than just math class.

Listen along + meet more of the cast at:



<https://spark-and-anvil.com/cast/numbersense/ratio-rio>

# Splitter Sasha

decomposition — breaking hard numbers into friendlier pieces



- "4728"
  - "4000"
  - "700"
  - "20"
  - "8"
  - "7"
  - "2"
  - "3"
  - "5"
  - "23"
  - "28"
  - "47"
  - "253"
  - "Sandwich Trick"  
gate-allow-text-pattern: '^([0-9])+\$'

## Splitter Sasha and the Number Hiding Three Friendlier Numbers Inside

Splitter Sasha wore a tall, silly knit cap. Three bright pompoms bounced on top when she talked. And she talked a lot. Her older sister had given her the hat when she was nine. Sasha was now twenty-seven, but she still wore it every single day. Some things are too good to outgrow.



Sasha was the person who showed up when a number was being a bully.

Most numbers, Sasha insisted, were friendlier than they looked. A tough number like 47 or 348 was just a few nice numbers wearing a trench coat. Her whole job was to pop onto the NumberSense screen and pull off the disguise. She revealed the friendly numbers hiding inside.

Maya first met Sasha while staring at  $47 + 28$ . It shouldn't have been a hard problem. She knew she could solve it on paper. But doing it in her head was another story. The timer for the estimate had ticked down from ten seconds. Maya's brain went blank. She panicked and typed 60. Totally wrong. Now she was stuck, trying to figure out the real answer without a pencil.

Suddenly, Sasha appeared on the screen. The pompoms wobbled.

"Hi! You don't need to add 47 and 28 the hard way," she said, her voice fizzing with energy. "You can use the friendly way. Want me to show you?"

Maya nodded, relieved. "Okay."

"Watch this. 47 is really just 50 minus 3. And 28 is just 30 minus 2." Sasha's fingers danced in the air. "So you're really adding 50 minus 3, plus 30 minus 2. That's the same as 50 plus 30, minus 3, minus 2. Which is 80 minus 5. And that's 75!"

Maya's jaw dropped a little. "You did all that in your head?"

"Yep."

"Without writing anything down?"



"Yep. But I've been practicing for eighteen years. You don't need to be that fast." Sasha leaned closer to the screen. "You just need to know that 47 has a 50 hiding inside it. And 28 has a 30. Once you find the friendly numbers, the math gets way easier."

Maya squinted, thinking it over.

"Why are 50 and 30 friendlier?" she asked.

"Because they're round! They end in zero," Sasha explained. "Numbers that end in zero are a piece of cake to add. So if you can turn hard numbers into round ones, you're golden. Even if you have to add or subtract a little bit."

She paused, a grin spreading across her face.

"It's officially called **decomposition**," she said. "But that's a mouthful. I just call it finding the friendlier numbers. They're always in there. You just have to look."

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Over the next few weeks, Maya started looking for them herself.

When she saw 347 in a problem, her brain automatically thought  $350 \text{ minus } 3$ . When 198 popped up, she saw  $200 \text{ minus } 2$ . The number 64 could be  $60 \text{ plus } 4$ . Or it could be  $70 \text{ minus } 6$ . It all depended on what she needed to do next.

This new trick made arithmetic feel completely different. The numbers weren't little walls she had to climb anymore. They felt more like LEGO bricks she could take apart and rearrange.



Sasha was thrilled whenever Maya rearranged a number.

"Yes! You found the friendlier number!" she would cheer. Her pom-poms would wobble like crazy. "Which ones did you use this time?"

Maya would explain her thinking. Sometimes she found the same friendly numbers Sasha would have. Sometimes she found completely different ones. Sasha always listened carefully. "Oh, that's a clever one! I hadn't thought of that. Tell me why you picked it."

Maya soon learned a surprising secret. There wasn't just one right way. Most hard numbers had several friendlier numbers hiding inside. 47 could be *50 minus 3*. But it could also be *40 plus 7*. Or *45 plus 2*. Or even *100 minus 53*. Picking the best one depended on the problem you were trying to solve.

"That's the magic of it," Sasha said one afternoon. "There isn't ONE friendlier version of a number. There are LOTS. Your job is to pick the best one for the job. Sometimes it's a round number above. Sometimes it's the one below. And sometimes—my personal favorite—it's the same number, just cut in half."

"Cut in half?"

"Totally. If I need to multiply 48 by 5, I could do it the long way. Or I can see that 48 is just 24 doubled. And 5 doubled is 10. So 48 times 5 is the same as 24 times 10. Which is 240. A nice, friendly answer."

"Wait—does that *always* work?" Maya asked, grabbing a notebook.

"It works when one number is even and the other is easy to double. Like 5, or 25, or even 2.5. It's a special trick. I'll show you more of them later."

Maya scrawled that one down.

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By the end of her second month, Maya had a small notebook full of Sasha's tricks.



- $198 = 200 - 2$
- To multiply by 5, halve the other number, then add a zero.
- To multiply by 25, divide the other number by 4, then add two zeros.
- Adding a long list? Look for pairs that make 10 first!
- Round before you multiply, then fix it at the end.

She held the notebook up to the screen one day.

Sasha beamed. "You're making your own rulebook," she said, her pompoms bobbing. "That's the whole point! The tricks I show you aren't the real lesson. The real lesson is that numbers are friendlier than they look. You can rearrange them. Once you truly believe that, you'll start finding your own tricks. And there are infinite tricks out there."

"How do you know all of them?" Maya asked.

"I don't! I only know the ones I've found so far. New ones appear all the time. Just last week, a kid on the app showed me a new way to multiply by 11. I had never seen it before. She was younger than you."

"What was the trick?"

"To multiply a two-digit number by 11, you just add the two digits together. Then you stick the sum right in the middle. So 23 times 11 is 2, then 5—because 2 plus 3 is 5—then 3. The answer is 253. Try 34 times 11. It's 3, then 7, then 4. 374. Check it on a calculator if you want!"

"Whoa," Maya breathed.

"Right? She was eight years old. She called it the Sandwich Trick."

**Listen along + meet more of the cast at:**



<https://spark-and-anvil.com/cast/numbersense/splitter-sasha>

# About Spark & Anvil

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Spark & Anvil is a 501(c)(3) public charity. We make educational apps for ages 9-14 — all free, forever; no ads; no tracking; no in-app purchases. NumberSense is one of 140+ apps in the portfolio.

## More chapter books from Spark & Anvil

Each app in the Spark & Anvil portfolio publishes its own illustrated chapter book + audio drama, available free from [spark-and-anvil.com/books](https://spark-and-anvil.com/books). Highlights include:

- **GambitTales** — chess tactics through Sir Pinwell, Lady Skewer, Queen Vesper, and the Twin Knights of Fork Hill
- **ProofQuest** — formal proof techniques through Direct-Proof Dora and the Lemma Library
- **CuriosityQuest** — Texas geography exploration through Linger, Notice, and the Lantern in the Dark
- **QuillSpell** — spelling craft through the Word Wizard cast
- **SynaForge** — sensory-affirming creative tools through Lull, Soften, and the Quiet that is Also Creating

## Methodology

Distributed-narrative pedagogy per Jerome Bruner (narrative-cognition) + Sebastian Habgood (intrinsic-integration in educational games) + SAMHSA TIP 57 (trauma-informed register).

Trauma-informed-design framework per Eggleston et al. (2025) and Stoltenburg et al. (2024).

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