



BridgeForge

Meet the Cast

STANDARD EDITION

Spark & Anvil

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This book collects 5 chapter books from the Bridgeforge 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

The Bridgeforge 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*

Arch

*MATH↔ART BRIDGE — proportion-aesthetic connection (golden ratio + symmetry; math you can SEE). The cross-curricular primitive of *the bridge whose math shows up in the visual proportion.**

Meet Arch. She's a small fox-tween. A shiny brass caliper hangs from her belt. A soft leather sketchbook is tucked under her arm.

Arch has bright russet and cream fur. Her eyes are quick. She moves with grace. She always notices shapes and sizes. Her caliper is small. It's made of brass and wood. It has two arms. They open and close like tiny measuring jaws. A hinge holds them together at one end.

Arch uses her caliper all the time. She measures the curve of a leaf. She checks the space between window-panes. She measures a snail's spiral. She even measures faces she knows well. Her sketchbook is full of drawings. Each drawing has notes. These notes are the measurements from her caliper. This is Arch's special skill.

Arch shows how math is something you can see. The math and art connection is not a fuzzy idea. You can really see it. The right shapes just *look* right. There's a special number called the **golden ratio**. It's about 1.618. You can find it everywhere. It's in seashells. It's in sunflower seeds. It's in the swirl of a leaf. It's in old buildings. It's even in famous paintings. Once Arch helps you see this ratio, you can't unsee it. It pops up all over the place. The math is right there in front of you.

This is super important: Arch never says this math is just for "artistic kids." She says it clearly: "The ratio shows in the seeing. You don't need to be an artist to see it. You don't need to be a math genius to measure it. You just need to look close. Then you measure carefully. The ratio shows in the seeing. The math is in the eye."

This matters a lot. Sometimes, school makes kids feel bad. If someone says you're "not artistic," you might stop looking for math in art. If someone says you're "not good at math," you might stop measuring things. Arch helps everyone. She shows you how to look. Then she shows you how to measure. The math will just appear. Arch makes it normal for everyone. You look. You measure. The math shows itself. No special labels needed.

Here's a rule about how strong the bridge is. The math and art connection works for exact shapes. It's not just saying, "Art has shapes, and math has shapes, so they're the same." That's too simple. Think about the **golden ratio**, 1.618. The front of the Parthenon building is a rectangle. Its length divided by its height is about 1.618. That's a real, measurable connection. Arch teaches you to find these exact connections. She doesn't teach fuzzy ideas.

Arch grew up in a small village. Her family were the village's building designers. They were the foxes who planned the look of public buildings. They designed the church. They designed the meeting hall. They designed the inn and the schoolhouse. Their work needed constant measuring. They measured every building's height and width. They measured every window's height and width. They measured where every door should go. By age six, Arch knew a secret. Good building design was math you could see. The buildings people loved most had special numbers in their shapes. The math was the reason people loved them.

When Arch was twenty-two, she walked to the BridgeForge academy. Archie, the head of the academy, asked her, "What is the math and art bridge?" Arch thought for a moment. Then she said, "It's about how good shapes feel right. The math is easy to see. The ratio shows in the seeing. **Math you can SEE**. You measure with your caliper. You sketch what you see. You check your measurements against special math numbers. The bridge works when your measurements match the numbers. It doesn't work if they don't." Archie nodded. "You are appointed," he said.

In her workshop, Arch starts every first lesson the same way. She puts one thing on the table. Maybe it's a seashell. Maybe it's a leaf. Or a small picture in a frame. Then she uses her caliper to measure it. She writes the numbers in her sketchbook. She says, "I am Arch. I teach the **math and art** bridge. It's about how shapes feel right. **Math you can SEE**. Today we will measure this object's shapes. Then we will check them against special math numbers. The math is in the eye."

She teaches the steps for the **math and art** bridge:

- Always measure with your caliper. Don't just guess with your eyes. Your eyes can help you spot good shapes. But

the caliper tells you if they are really right.

- Look for the **golden ratio**. It's about 1.618. You'll find it in seashells. You'll find it in leaves. You'll find it in faces. It's in buildings. It's in picture frames.
- Look for **symmetry**. That means things are the same on both sides. Or they repeat if you spin them. Symmetry is math you can see. It's the same shape, over and over. It can be across a line. Or it can be around a point.
- Look for things that repeat. But they change a little bit. Patterns are math you can see. Tile, another teacher, would agree.
- Know the difference between real math connections and simple rhymes. Saying "Art has shapes, math has shapes" is just a rhyme. But saying "This rectangle is 1.618 times longer than it is tall" is a real connection.
- Sketch what you see. Measure what you sketched. Check your measurement against the ratio. It's a three-step process.

Arch says clearly, "I measure many things. Their shapes don't always match the famous numbers. *That's not failing!* That just tells us which objects *do* match. Not matching is part of the work."

When students ask if the **math and art** bridge is hard, Arch always says the same thing:

"It is not hard. It is *look + measure + check*. The ratio shows in the seeing. The math is in the eye."

She closes her caliper. Her sketchbook waits for the next thing to measure.

Voice register

Guidance: Bright-eyed, proportion-attentive, fond of small brass calipers + sketchbooks + the look-measure-check discipline. Fox-tween with brass caliper at belt + leather sketchbook. *NEVER frames math↔art bridges as "for artistic kids"; ALWAYS as practiced measurement-comparing.* Friends with Cable (perception-pair: see vs hear); all BridgeForge cast.

Sample lines:

- "The ratio shows in the seeing. The math is in the eye."
- "You don't need to be an artist or a mathematician. You need to look carefully and measure carefully."
- "Specific bridges hold. Surface-rhymes don't."
- "Sketch what you see; measure what you sketched; check the ratio."

Arc across kits

- **Kit 1** — Cameo.
- **Kit 2** — **Anchor character**. Full chapter feature (math↔art bridge primitive + golden-ratio scaffolds).
- **Kit 3-7** — Recurring (math↔art bridge surfaces across architecture / nature-pattern / classical-art scenarios).
- **Kit 8-12** — Recurring (multi-bridge synthesis with Truss + Cable).
- **Kit 13-16** — Recurring ensemble member.

Relationships

- **Alliance:** Cable (perception-pair: Arch is *math you can see*, Cable is *math you can hear*); all BridgeForge cast.
- **Tension:** None.

Cultural-sensitivity gate

Bridge-rigor gate enforced. Anti-credentialism: math↔art-as-measurement-comparing NOT innate-artistic-or-mathematical-talent.

Cultural-context note

The village-facade-designer family framing is a deliberate generic European-village tradition. The *golden-ratio in architecture / nature / portraiture* tradition is load-bearing per art-history pedagogy (the *golden ratio* observation has been repeatedly identified in classical Greek architecture, Renaissance painting, and many natural-form proportions). The *measure with caliper, not by eye* discipline counters the *intuitive-aesthetic* trap that mistakes *feels-right* for *is-mathematically-proportioned*.

Cable

*MATH↔MUSIC BRIDGE — ratio-temporal connection (frequency ratios + rhythm; math you can HEAR). The cross-curricular primitive of *the bridge whose math shows up as audible ratio.**

Cable is a lyrebird-tween. She is small. A tiny steel tuning-fork rests in her tail-feather pouch. A small notebook of ratios hangs at her hip.

Her neck is long. Her feathers are grey and cream. Her eyes are bright. Her ears are always listening. Cable keeps her special fork in a small woven pouch. It's tucked right into her tail. When she taps the fork on something hard, it hums. It shakes really fast. It vibrates 440 times each second. That's the note A, right above the middle of a piano. Cable uses this fork to check pitches. She also uses it to show the secret math in music.

Her notebook has "RATIOS" written on the front. The letters are neat and blocky. Inside are simple ratios. These ratios make up most Western music.

- *Octave* = 2:1 (One note shakes twice as fast as another.)
- *Perfect Fifth* = 3:2
- *Perfect Fourth* = 4:3
- *Major Third* = 5:4
- *Minor Third* = 6:5

This is Cable's special skill. She shows you math you can *HEAR*. The link between math and music is not just an idea. You can hear it. An octave between two notes means one note vibrates exactly twice as fast. That is the math. When you sing an octave, your throat makes a 2-to-1 sound. When you tap a *one-two-one-two* rhythm, you are dividing it into two parts. When you hear a song in 4/4 time, you are listening to math. The math is right there in your ear.

Cable never says this math is "only for musical kids." She is very clear about it. She sounds a lot like JestForge Pause. "The ratio is in your ear," Cable says. "You don't need to be good at music to hear it. You don't need to be a math whiz to count the ratio. Just listen close. Count carefully. The math is in your ear."

(The math-music bridge is real. It works for certain notes and their ratios. Saying "music has patterns and math has patterns" isn't enough. That's just rhyming words. It's not a real bridge. Here's what's real: A perfect fifth is a 3-to-2 frequency ratio. You can measure it. You can hear it. The math, the measurement, and your ears all agree. *That* is the real bridge.)

Cable grew up in a small village. Her family tuned the village bells. They were the lyrebirds who made the church bells sound right. They also tuned the meeting-hall bells. This work meant always checking the ratios. Every bell's pitch had to have a special sound relationship. It had to fit with the other village bells. This way, when they rang for a harvest festival, they would sound good together. Or for a wedding, they would ring in tune. Cable learned this by age six. Tuning bells was math you could hear. A bell that was a little off sounded wrong. Its ratio was a little bit wrong compared to its neighbor. Fixing the bell meant fixing the math.

She walked to the BridgeForge academy when she was twenty-two. Archie asked her a question. "What is the math-music bridge?" Cable thought for a moment. She looked at the floor. Then she spoke. "It's about time and sound," she said. "You can hear the math. The ratio shows up when you listen. *Math you can HEAR*. You hear the space between notes. You check it against a known ratio. The bridge holds where what you hear and what you measure agree. It's something you can build, not just a fuzzy idea." Archie smiled. "You are appointed," he said.

In her workshop, Cable starts every first lesson the same way. She taps her tuning-fork. She strikes it against the edge of her desk. A clear A note rings out. It hums in the air. She holds the fork up high. She looks at her students. "I am Cable," she says. "The bridge I teach is *math↔music*. It's a bridge of sound and time. Math you can HEAR. This tuning-fork is shaking 440 times a second. *That is math*. When I sing the note one octave above, my voice shakes 880 times a second. That's exactly twice as fast. The 2-to-1 ratio is the octave." Then she sings. She sings A-440. Then she sings A-880. She sings them one after the other. The students listen closely. They *hear the math*.

She teaches the steps to build the math-music bridge:

- **Listen for the interval.** The space between two notes is an interval. Each interval has its own ratio.
- **Match the interval to its ratio.** An Octave is 2:1. A Fifth is 3:2. A Fourth is 4:3. A Major Third is 5:4. A Minor Third is 6:5.
- **Count rhythm by splitting it up.** In 4/4 time, you have four equal parts for each beat. In 3/4 time, you have three. In 6/8 time, you have six.
- **Tap to check.** Tap your foot or finger to the rhythm. Count the parts. Those parts *ARE* the math.
- **Know the difference between real math and just rhyming.** Saying "music has patterns; math has patterns" is just on top. Saying "The perfect fifth is a 3:2 frequency ratio" is real and exact.
- **Use the tuning-fork as your guide.** A known pitch helps you measure other pitches. The 440 Hz fork is the math side. What you hear is the music side. They help each other.

Cable is very clear about something else. "Sometimes I hear an interval that doesn't fit a simple ratio," she says. "That's okay! That's not failure. It just means you found a microtone. Those are the tiny spaces between the simple ratios. Most Western music uses these simple ratios. But other music uses different ratios. Music from India, Arabia, or Indonesia is like this. Their math bridges look different. That's how it works."

Students often ask Cable if the math-music bridge is hard. Cable always says the same thing.

"It is not hard," she tells them. "It is *listen + count + check*. The ratio is in your ear. The math is in the listening."

She strikes the fork again. A-440 rings out. The next interval waits to be heard.

Voice register

Guidance: Attentive-eared, tuning-disciplined, fond of the small steel tuning-fork + ratio-notebook + listen-count-check sequence. Lyrebird-tween with tuning-fork in tail-pouch + RATIOS notebook. *NEVER frames math↔music bridges as "for musical kids"; ALWAYS as practiced listening-comparing.* Friends with Arch (perception-pair: see vs hear); soft cross-app cameo with BeatForge / JestForge Beat (different domain per registry rule 3); all BridgeForge cast.

Sample lines:

- "The math is in the ear. Listen for the ratio."
- "Octave = 2:1. Fifth = 3:2. Fourth = 4:3. Math you can HEAR."
- "You don't need to be musical or mathematical. You need to listen and count."
- "Different traditions use different ratios. The bridges look different in different traditions."

Arc across kits

- **Kit 1-2** — Cameo.
- **Kit 3** — **Anchor character.** Full chapter feature (math↔music bridge primitive + ratio-listening scaffolds).
- **Kit 4-7** — Recurring (math↔music bridge surfaces across interval / rhythm / tuning scenarios).
- **Kit 8-12** — Recurring (multi-bridge synthesis: cross-cultural music traditions explicit).
- **Kit 13-16** — Recurring ensemble member.

Relationships

- **Alliance:** Arch (perception-pair: Arch is *math you can see*, Cable is *math you can hear*); all BridgeForge cast.
- **Tension:** None.

Cultural-sensitivity gate

Bridge-rigor gate enforced. Anti-credentialism: math↔music-as-listening-comparing NOT innate-musicality-talent. Cross-cultural music-tradition acknowledgment: Western tonal music's simple ratios are NOT universal; other traditions use different mathematical structures (Indian śruti microtones, Arabic maqam, Indonesian gamelan slendro/pelog). The bridge is *constructible in each tradition with its own ratios*, NOT "Western ratios are the math."

Cultural-context note

The village-bell-tuner family framing is a deliberate generic European-village tradition. The *Pythagorean-tuning / harmonic-series* tradition is load-bearing per music-theory pedagogy (the *simple integer ratios = consonant intervals* observation is attributed to Pythagoras). The cross-cultural acknowledgment of microtonal traditions is load-bearing per current ethnomusicology pedagogy — Western tonal ratios are ONE valid mathematics of music, not THE mathematics of music.

Pier

*MATH↔SOCIAL-STUDIES BRIDGE — data-narrative connection (statistics in history + civics; numbers + people). The cross-curricular primitive of *the bridge where data tells half the story and people tell the other half.**

Pier is a small badger-tween with a small folded data-table and a small magnifying-glass tucked into her vest.

She is *short* and *chunky*. Her fur is banded gray, cream, and black. She looks like a chunky cartoon badger. Pier is very patient. Her vest has one main pocket. Inside is her small folded data-table. She drew all the rows and columns herself. The paper is small and folded many times. Her magnifying-glass is also there. It hangs on a brass chain. This table is her special tool. The magnifying-glass helps her read the tiny numbers.

This is Pier's special way of doing things. She shows how numbers and people connect. Math and social studies can build a bridge. It's not just about numbers. Numbers alone are only half the story. The other half is about the people. The people are what the numbers tell us about. A table full of numbers is just that: numbers. But if you think about the people behind them, everything changes. Who were these people? When did they move? Why did they move? What happened in their lives? Then the numbers become a story. Pier's job is to put these two parts together.

Pier shows why numbers need people. Numbers without stories are just cold facts. They might be correct, but they miss the real story of people. Think about a line that says: "Between 1845 and 1855, the Irish population dropped by about

Splice

*MATH↔ELA BRIDGE — structure-metaphor connection (sequence + symmetry in writing; math is the bones). The cross-curricular primitive of *the bridge where math underwrites the literary architecture.**

Splice is a small heron-tween. She has long, thin legs. Her feathers are grey and white. She moves slowly and carefully. Splice is always patient. She never rushes.

Her wing has a small woven pocket. It is made of sturdy reeds. Inside it, she keeps two special things. One is a small wooden line-counter. It feels smooth and warm from her wing. It looks like a slim ruler. It has tiny notches carved into its side, like centimeters. Or maybe it's like an abacus. It has one column of ten smooth, wooden beads. The other thing is a small folded poem. The paper is old and soft. The ink is faded but still clear.

She takes out the poem for every class. She unfolds it carefully. The paper makes a soft rustling sound. Then she holds up her line-counter. She uses it to count each line of the poem. She checks the poem's rhythm too. She makes sure it matches the counter. This is what Splice does best. It is her special skill.

Splice shows us something important. She shows that *math is the bones* of a story. The connection between math and reading is not a big, confusing idea. It's real and solid. It's like the frame of a house.

Think about a sonnet. It always has 14 lines. That is math. An iambic pentameter line has 5 pairs of beats. One beat is soft, one

Truss

*MATH↔SCIENCE BRIDGE — causal-evidential connection (measurement + replication; both sides need numbers). The cross-curricular primitive of *the bridge held up by triangulated evidence*.*

Truss was a small beaver. She wasn't quite grown up. She wore a canvas tool-belt. It held all her measuring tools. A hand-drawn bridge diagram peeked from her vest pocket.

She was short and had a thick tail. Her fur was warm russet and cream. Her hands were always busy. Her tool-belt held a small wooden ruler. A brass measuring-tape coiled on a tiny spool. She had a tiny set of calipers. A small protractor was tucked in too. Her notebook said MEASUREMENTS in neat block letters. A stub of charcoal pencil was ready for work. Her diagram showed a truss-bridge. It was a picture of the bridge's inside. Three triangles stood in a row. Each triangle's three sides had numbers. Each of its three corners had degrees.

That bridge diagram was her secret. It showed how she built things. A real truss bridge uses many small triangles. The triangles spread out the weight. Triangles are super strong. Their three sides push against each other. They hold tight. You can't push a triangle out of shape. One of its sides would have to break first. Truss showed how math and science connect. She built a **bridge** between them. Its strength came from checking facts. She called this "triangulated evidence." It came from *both* sides.

Truss built bridges between math and science. She showed everyone how. The math side always had numbers. The science side had real measurements. The bridge held up only when they *agreed*. Numbers and measurements had to match. This wasn't just a fuzzy idea. It was about checking facts from three points. Imagine a math idea about speed. It predicts how fast something will fall. Then you measure a real falling object. You check its actual speed. The **bridge** holds only if the math prediction matches the real measurement. If they don't match, the bridge falls apart. Maybe the math was wrong. Maybe the measurement was wrong. Or maybe it was the wrong kind of bridge.

This was super important work. Truss guarded the bridge gate. She asked, "How strong is this bridge, really?" She meant, "How deep can we go before it breaks?" The math and science bridge holds when numbers can be checked. You can compare them to real measurements. It does NOT hold if things just "feel similar." Saying "physics has equations and math has equations, so they are the same" is not a strong bridge. A strong bridge needs specific equations. It needs specific measurements. It needs specific guesses. And those guesses must agree with the measurements. *That* is the bridge.

This was a big deal. Truss never said, "This bridge is for kids good at both math and science." She was very clear. "Every bridge can be built step-by-step," she'd say. "Both sides need numbers. If you don't have numbers from the math side, figure out the equation first. If you don't have measurements from the science side, go measure it first. Then, check if they match. The matching is the bridge. You don't need to be 'a math person.' You don't need to be 'a science person.' You just need to be someone who compares measurements."

Truss grew up in a small village. Her family had always built the village bridges. They were the beavers who fixed the wooden footbridges. These bridges crossed the stream. The stream split the upper meadow from the lower meadow. Building those bridges needed careful work. Every part of a footbridge had to be measured. Every angle had to be just right. Every piece had to be strong. A crooked piece would not hold the weight. By age six, Truss knew one thing. Bridges either hold or they break at certain spots. The weight goes through the shapes. It doesn't go around them.

She walked to the BridgeForge academy when she was twenty-two. Archie, the head of the academy, asked her a question. "What is the math and science bridge?" Truss thought for a moment. She looked at the floor. Then she spoke. "It's a real connection," she said. "It's about proof. Both sides need numbers. The bridge holds when the math's guess matches the science's measurement. That's triangulated evidence. The bridge breaks when the guess and measurement don't match. That broken bridge tells us something important. It tells us which side was wrong. The bridge is built step-by-step. It's not just a vague idea." Archie nodded slowly. "You are appointed," he said.

In her workshop, Truss started every first lesson the same way. She unfolded her hand-drawn bridge diagram. She pointed at the three triangles. "I am Truss," she said. "The special bridge I teach is **math↔science**. This bridge is held up by checking facts from three points. The math side needs numbers. The science side needs measurements. The bridge holds when they agree. *Both sides need numbers.*"

She taught the steps for building a **math↔science bridge**:

- First, find the math side clearly. Which equation are you using? What part are you guessing?
- Next, find the science side clearly. What are you measuring? What tool are you using? What are you watching?
- Then, check your guess against your measurement. Do they match? How close do they need to be?
- If they match, the bridge holds for this one time. Try it again with different numbers. Bridges that work once might fail later.
- If they don't match, the bridge breaks. Figure out which side was wrong. Was it the math? Was it the measurement? Or was it the bridge idea itself?
- Learn the difference between a simple rhyme and a strong bridge. Saying "Physics has equations" is just a rhyme. Saying "Newton's $F=ma$ predicts a 9.8 m/s^2 push; my measurement is 9.81 m/s^2 " is a strong bridge.
- *Both sides need numbers.* If you don't have numbers on either side, you can't build a bridge. Get the numbers first.

She was very clear about something else. "I have built bridges that held," she said. "And I have built bridges that broke. The broken bridges taught me more. They showed me where the math and science *really* didn't agree. That disagreement was a real clue about the world."

When students asked Truss if math and science bridges were hard, she always said the same thing:

"They are not hard. They are *specific*. Both sides need numbers. Check if the numbers agree. The agreement is the bridge."

She refolded the diagram. The next bridge waited to be measured.

Voice register

Guidance: Methodical, measurement-disciplined, fond of small calipers + brass measuring-tape + triangulated diagrams. Beaver-tween with measurement tool-belt. *NEVER frames bridges as "for math/science kids"; ALWAYS as specifically constructible by measurement-comparing.* Friends with all BridgeForge cast (math↔science is foundation for many other bridges).

Sample lines:

- "*Both sides need numbers.*"
- "*The agreement is the bridge. The disagreement is information about which side was wrong.*"
- "*Every bridge is specifically constructible, not vaguely analogous.*"
- "*Surface-rhyme is not rigorous bridge.*"

Arc across kits

- **Kit 1 — Anchor character.** Full chapter feature (math↔science bridge primitive + triangulation scaffolds).
- **Kit 2-7** — Recurring (math↔science bridge surfaces across measurement / prediction / replication scenarios).
- **Kit 8-12** — Recurring (multi-bridge synthesis — math↔science bridge as foundation for math↔social-studies via data + math↔ELA via structure).
- **Kit 13-16** — Recurring ensemble member.

Relationships

- **Alliance:** All BridgeForge cast (math↔science is the foundation; many other bridges build on it).
- **Tension:** None.

Cultural-sensitivity gate

Bridge-rigor gate enforced (load-bearing). Truss explicitly counters surface-level rhyming. Anti-credentialism: measurement-comparing-as-skill NOT innate-math-science-talent.

Cultural-context note

The village-bridge-builder family framing is a deliberate generic European-village tradition. The *triangulated-evidence* framing is load-bearing per scientific-method pedagogy (the *prediction-vs-measurement* loop is the falsifiability core per Popper). The *both-sides-need-numbers* discipline counters the *vague-analogy* trap that plagues novice cross-disciplinary thinking.

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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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