



CircuitForge

Meet the Cast

STANDARD EDITION

Spark & Anvil

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This book collects 5 chapter books from the Circuitforge 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.

Contents

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Contents

Introduction

Branch

Build

Voice register

Arc

Relationships

Cultural-sensitivity gate

Cultural-context note

Damp

Voice register

Arc

Relationships

Cultural-sensitivity gate

Cultural-context note

Flow

Voice register

Arc

Relationships

Cultural-sensitivity gate

Cultural-context note

Push

About Spark & Anvil

More chapter books from Spark & Anvil

Methodology

License

Introduction

The Circuitforge 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*

Branch

*BRANCH — *one path or many. the topology decides the behavior.**

Branch was a small beaver kid. He built dams. He wore a special vest. It showed how circuits worked. He also carried cards. These cards showed different ways to connect things. A tracker showed where electricity went.

Branch was warm cream-colored. His paw tips were soft amber. He was super curious. He loved how circuits were put together. He always said, "One path or many. The *topology* decides the behavior." His cards and tracker were his best tools. The cards showed one big loop. Or they showed lots of little paths. The tracker showed where the electricity flowed.

This was super important. Branch taught about *circuit topology*. That's the way parts connect. It changes *everything*. Lots of kids think a circuit is just one big loop. But *topology* is the craft of connecting things. You can wire parts in **series**. That means one after another. Think of beads on a string. All parts share the same electricity. Or you can wire them in **parallel**. Each part gets its own path. Like lanes on a highway. All parts share the same push.

In **series**, the electricity (current) is the *same* for every part. But the push (voltage) gets split up. In **parallel**, the push (voltage) is the *same* for every part. But the electricity (current) gets split up. Use the same parts. Wire them differently. You get totally different results.

Think about holiday lights. Old ones were **series**. If one bulb blew, the whole string went dark. New ones are **parallel**. If one bulb blows, the others stay lit. Choosing how to wire things is a big engineering choice. Branch's job was to show that *circuit topology* is about choosing paths. It's not just messy wires.

Branch was very clear. "One path or many. The *topology* decides the behavior." He explained it like this: "Wire two LEDs in **series**. The electricity goes through both. It's the same electricity. The push splits between them. If one LED breaks, the path breaks. Both LEDs go dark."

He continued, "Wire two LEDs in **parallel**. Each is on its own branch. They get the same push. The electricity splits between them. If one LED breaks, the *other* still works. Same parts. Different *topology*. Different behavior. The way you wire it is the engineering choice."

Branch taught these important ideas:

- **Series** connections. Parts in a single line. One loop. The electricity is the *same*. The push *splits*.
- **Parallel** connections. Parts on different branches. Many paths. The push is the *same*. The electricity *splits*.
- **Series and parallel together**. Real circuits often mix both. Find the series groups. Find the parallel groups. Solve it step by step.
- **Kirchhoff's Current Law (KCL)**. Electricity flows *into* a spot. It must flow *out*. It's like water in pipes. No electricity disappears.
- **Kirchhoff's Voltage Law (KVL)**. The total push around any loop is zero

Build

*BUILD — *every component has a job. wire them together; the circuit comes alive.**

Build was a small girl. She looked a bit like a bowerbird. She wore a chunky vest with pockets. Each pocket held a tiny electronic part. She always had her breadboard and component tray with her.

Build was small and warm. Her skin was cream-colored. Her hair had soft, bright blue tips, like feathers. She loved finding out what each part did. She always said, "Every component has a job. Wire them together; the circuit comes alive." Her favorite tools were her breadboard and component tray. The breadboard had rows of holes. You could connect parts there over and over. The tray held all the basic parts. Things like resistors, capacitors, LEDs, and tiny chips.

Build teaches about *components* and *breadboards*. She shows how each part does one special job. Lots of kids think circuits are just wires. But Build knew better. Every tiny part had its own special task.

- A Resistor: It slows down electricity.
- A Capacitor: It holds a tiny bit of power. It makes things smooth.
- A Diode: Electricity can only go one way through this.
- An LED: It lights up when power flows the right way.
- A Transistor: It makes small signals bigger. Or it turns things on and off.
- An Integrated Circuit (IC): This is a tiny box. It holds many parts. It does something complicated.

A circuit is like a team of parts. Each part does its own job. Breadboards are cool. You can build things fast. No need for hot solder. You can test your ideas. And change them easily. The trick is picking the right part. Then you put them in the right spots. That way, they all work together. Build wants you to see parts as a team. Not just a pile of bits.

Build was always clear. "Every component has a job. *Wire them together; the circuit comes alive.*"

She would point to each part. "The resistor limits current. The capacitor stores tiny amounts of charge. It gives a quick release. It also makes voltage smooth. The diode lets current go ONE direction. The LED lights up when current flows the right way. The transistor amplifies a small input. It makes it a big output. Or it switches it on and off. The integrated circuit is hundreds of tiny switches. It's packaged for a complex behavior. Your phone's brain is one big IC. *Wire them on a breadboard; flip the switch; the circuit comes alive.*"

Build taught these important lessons:

- **Resistor.** It slows down electricity. We measure it in ohms. It has colored stripes.
- **Capacitor.** It holds a small charge. It makes power steady. We measure it in farads.
- **Diode.** Electricity goes one way. Like a one-way street.
- **LED.** It's a light. It needs a resistor. Otherwise, it burns out. Its color depends on what it's made of.
- **Transistor.** A tiny switch. Or it makes signals bigger. It uses a small signal to control a big one.
- **Integrated circuit (IC).** A tiny box. It does a complex job. Like a timer or a tiny computer.
- **Breadboard.** Build without solder. Rows are connected inside. Change things fast.
- **Power rails.** Long lines on the sides. They bring power to your parts. One for plus, one for minus.
- **Read the datasheet.** Every part has a guide. It shows how to use it. Don't blow it up! Read the guide first.
- **Polarity matters.** Some parts only work one way. LEDs, capacitors, diodes, ICs. Plug them in wrong? They won't work. Or they might burn out.
- **Don't skip the resistor.** An LED needs a resistor. Too much power makes it pop. Always slow down the power.
- **Don't just connect everything.** Plan where things go. Connect power and ground first. Put parts where they make sense. Random wires mean random results.

Build grew up near the bower-clearings. Her family were like the bowerbirds there. They were the village's 'arrangers.' They collected shiny things. They found colorful pebbles and bright feathers. They would arrange them carefully. Each object had its own special spot. "Every object has a place," they'd say. "Each piece helps the whole thing work." They built amazing bowers. These were like art, but also like lessons. The bower worked because each piece was chosen. And each piece was put in just the right place. Build learned this lesson well. She carried it with her always.

When Build was twelve, she walked to CircuitForge. Watt, her mentor, asked her a question. "What is component-craft?"

Build answered right away. "Every component has a job. *Wire them together; the circuit comes alive.* Component-team-craft."

Watt smiled. "You are appointed," he said.

In her workshop, Build showed how it worked. She used her breadboard and component tray. "Watch," she said.

Build picked up a tiny, black chip. It had eight skinny legs. "This is a 555 timer," she explained. "It's like the conductor of our little orchestra." She carefully pushed it into the breadboard. *Click.* Then came a small, striped resistor. "This slows down the power," she said. She added a tiny capacitor, shaped like a little can. "This part holds a bit of power, then lets it go." She connected a bright red LED. "And this is our light!" Build connected a small battery pack. She flipped a tiny switch. *Blink. Blink. Blink.* The LED flashed steadily. "See?" she grinned. "The resistors set the timing. The capacitor stores and releases power. The 555 chip turns the light on and off. The LED blinks. *Five parts, one cool trick.*"

She then pulled out the capacitor. She chose a different one, a bit smaller. She pushed it into place. *Click.* She flipped the switch again. The LED blinked much faster. "Faster blink!" she cheered. "*Same circuit, but different timing. That's the capacitor's job.*"

She looked at her students. "I am Build. The lesson I teach is *components + breadboarding.* The move is *every component has a job; arrange the team; the circuit comes alive.*"

Build was gentle. "Don't be scared to break parts," she said. "It's how you learn. Did you burn out an LED? Good! Now you know what too much power does. *Read the datasheet next time. Try again.* Even a bower-builder doesn't get it perfect the first time."

"Every component has a job. *Wire them together; the circuit comes alive.*"

Voice register

Workshop-bowerbird-tween. Curious-about-component-jobs, fond of breadboard + component-tray demonstrations. *NEVER frames circuit-building as wiring; ALWAYS centers "components-as-team; each has a specific job; arrangement matters" framing.*

Sample lines:

- "Every component has a job."
- "Wire them together; the circuit comes alive."
- "Read the datasheet."

Arc

- Kit 5 — Components + breadboarding primitive front-and-center.
- Kits 6-16 — Recurring (every component discussion routes through Build).
- Kit 16 — Final reflection — closes cast arc by combining Flow + Push + Damp + Branch + Build into full electronics-toolkit.

Relationships

- **Closes the cast arc:** Components assemble into circuits; topology shapes their behavior; current + voltage + resistance describe the physics.
- **Cross-app design-language continuity with MakerForge Try + EngineerForge + StyleForge Cut + iteration-as-craft cluster:** component-team-craft framework.

Cultural-sensitivity gate

Anti-mystery-of-science — village bowerbird empirical knowledge treated as load-bearing. Anti-perfectionism (Build's "don't fear breaking parts" pairs with iteration-as-craft cluster).

Cultural-context note

Components + breadboarding pedagogy is canonical electronics (Horowitz + Hill *Art of Electronics*; Forrest Mims *Engineer's Mini-Notebook* series; Arduino + Adafruit + SparkFun + LadyAda's educational electronics tradition). Bowerbird-tween chosen for object-arrangement biomimicry (real species' careful curation of found objects); rendered chunky-cartoon arranging-pose to keep visual register warm.

Damp

*DAMP — *the slowdown. measured in ohms.**

Damp was a small sloth. She was still a tween, but she moved very slowly. Her fur was warm and cream-colored. Green moss grew on the tips of her fur. She wore a chunky vest. It had a big Ohm symbol on it. Damp always carried her ohmmeter. She also had a set of tiny resistors. They had colorful bands.

Damp was very curious. She loved to watch electrons slow down. She often said, "The slowdown. Measured in **ohms**." Her special tools were her ohmmeter and her resistors. The meter showed her numbers in **ohms**. The resistors had painted color bands. These bands told you their value. Brown-black-red meant 1,000 **ohms**.

Damp didn't just carry these tools. She *was* all about **resistance**. She loved to show how things fought the flow of electricity. This was her special craft. Most kids think wires just carry electricity. Zap! It goes right through. But Damp knew better. She knew every single thing fought the electricity a little bit. Even wires.

Copper wire fights very little. It's a great path for electricity. Rubber fights a lot. It stops electricity cold. A carbon resistor sits in the middle. It fights the flow on purpose. This fight is called **resistance**. It follows a rule called **Ohm's law**. This rule says: Voltage = Current × **Resistance**.

Voltage is the push. Current is the flow. **Resistance** is the fight. If you know two of these, you can always find the third. When electricity fights to get through, it makes heat. Think about an old light bulb. The tiny wire inside glows super bright. That's because it fights the electricity a lot. It gets hot enough to glow white. Damp's whole job was to make this fight visible. It wasn't a mystery. It was a craft.

Damp always said, "The slowdown. That's what it is." She would tap her ohmmeter. "It's measured in **ohms**." She explained how electricity moves. Tiny electrons zip through a wire. But the wire's own atoms get in their way. Some atoms are polite. They step aside for the electrons. (Like in copper wire.) Other atoms are grabby. They hold onto the electrons tightly. (Like in carbon.) Some atoms won't let electrons pass at all. (Like in rubber or glass.)

"So, **resistance** is how much a material fights the flow," Damp would say. She taught them about **Ohm's law**. "It's a secret rule," she'd whisper. "Voltage equals current times **resistance**." She held up three fingers. "If you make the push stronger, the flow gets bigger. But only if the fight stays the same. If you make the fight harder, the flow gets smaller. Even if the push is strong. These three numbers are always tied together."

Damp taught many things about **resistance** and **Ohm's law**:

- **Ohms** (Ω) tell you how much push you need. You need 1 volt to push 1 ampere of current.
- **V = I × R**. This is **Ohm's law**. You can find any missing number.
- The color-band code. Resistor bands tell you their value. Damp had a rhyme: "Bad Beer Rots Our Young Guts But Vodka Goes Well." This helped remember the colors. (Black is 0, brown is 1, red is 2, and so on.)
- Conductors, insulators, and semiconductors. Metals have low **resistance**. Rubber and glass have high **resistance**. Silicon can have its **resistance** controlled. This is how computer chips work.
- Resistors in a line add up. If you put resistors one after another, the total **resistance** gets bigger. Less current flows with the same push.
- Resistors side-by-side make less **resistance**. If you give electricity more paths, the total **resistance** goes down. More current can flow.
- **Resistance** makes heat. Electricity fighting through **resistance** turns into heat. All the formulas show this.
- A resistor doesn't block current. It just limits it. Think of a narrow pipe. It limits water flow.
- LEDs need help. Little LED lights need a resistor. This stops too much current from burning them out. Damp often helped beginners with this.
- Heating elements use **resistance**. Toasters, electric heaters, and light bulbs all use high-**resistance** wires. They turn electricity into heat on purpose.

- Damp's ideas linked to other crafts. HeatForge Hush taught about slowing things down. WaveForge taught about damping waves. StrategyForge Bide taught patience. Slowing down was a smart way to do things.

Damp grew up high in the rainforest canopy. Her family lived there. They were keepers of the slow craft for their village. These sloths taught everyone about saving energy. They showed that "resistance is craft." They said, "The slower path uses less. The faster path costs more heat. Slow is a strategy." Damp carried this lesson forward.

She walked to CircuitForge when she was twelve. Watt, her mentor, asked her a question. "What is **resistance**?" Damp thought for a moment. She looked at Watt. "The slowdown," she said. "Measured in **ohms**. It's friction-craft." Watt smiled. "You are appointed," he told her.

In her workshop, Damp showed how it worked. She used her ohmmeter and resistors. "Watch closely," she said. She measured a resistor. It had brown, black, and red bands. "That's 1,000 **ohms**," she explained. She hooked up a 9-volt battery. Then she added the 1,000-**ohm** resistor. Next came an LED light and an ammeter. The ammeter measured current.

"The current is 7 milliamps," Damp said. "That's **Ohm's law** at work." She swapped the resistor. Now she used a 470-**ohm** one. "The current is about 15 milliamps now," she pointed out. The LED glowed brighter. She swapped it again. This time, she used a 100-**ohm** resistor. "Now it's about 70 milliamps," she warned. The LED was dangerously bright. "It might burn out," she said. "That's why you pick the right resistor size."

She looked at her students. "I am Damp," she told them. "I teach **resistance** and **Ohm's law**. Remember: $V = I \times R$. **Resistance** fights the flow. Current spreads out as heat."

Damp was always gentle. "Don't think **resistance** is bad," she said. "**Resistance** is a craft. Without it, every circuit would short-circuit. Resistors help shape the current. They decide how bright an LED gets. They control where voltage drops. They even make the wire warm. The resistor is like a tuner for the circuit."

"The slowdown. Measured in **ohms**."

Voice register

Heat-shedding-sloth-tween. Curious-about-electron-slowdown, fond of ohmmeter + color-band demonstrations. *NEVER frames resistance as obstacle to avoid; ALWAYS centers "resistance-as-craft; Ohm's law; friction-craft" framing.*

Sample lines:

- "The slowdown."
- "Measured in ohms."
- " $V = I \times R$."

Arc

- Kit 3 — Resistance + Ohm's-law primitive front-and-center.
- Kits 4-12 — Recurring (every resistance discussion routes through Damp).
- Kit 16 — Capstone full-electronics-toolkit synthesis.

Relationships

- **Trio with Flow + Push** — Ohm's law ties all three: $V = I \times R$. Knowing any two determines the third.
- **Cross-app design-language continuity with HeatForge Hush + WaveForge damping + StrategyForge Bide slow-craft cluster**: slow-as-craft framework.

Cultural-sensitivity gate

Anti-mystery-of-science — village sloth empirical knowledge treated as load-bearing. Anti-credentialism: slow is a strategy, not a deficit.

Cultural-context note

Resistance + Ohm's law pedagogy is canonical electronics (Halliday-Resnick-Walker; Horowitz + Hill *Art of Electronics*; Georg Ohm's 1827 work). Sloth-tween chosen for slow-craft biomimicry (real species exemplary low-energy slow-strategy); rendered chunky-cartoon slow-pose to keep visual register warm.

Flow

*FLOW — *electrons moving through wires. measured in amperes.**

Flow was a small river otter. She was also an electrician, barely a tween, but very smart. She wore a chunky vest, bright orange, with a little current meter pinned right on it. A tiny arrow glowed next to the meter, always pointing.

Flow was small and quick. Her fur was warm cream, with soft copper-colored paw tips. She loved watching electrons move. She always said, "Electrons moving through wires. *Measured in amperes.*" That current meter and arrow were her special tools. The meter showed how many amperes were flowing. The arrow showed the way the electrons were really going through each wire.

Flow knew all about *electric current*. That's the craft of making electrons move. Lots of kids thought electricity was some kind of magic. Flow knew better. She knew current was just electrons flowing. It was like water moving in a pipe. The amount flowing each second was measured in *amperes*. One ampere meant zillions of electrons zipping past a spot every second.

The direction mattered too. Engineers usually said current flowed from plus (+) to minus (-). That was the "conventional" way. But the tiny electrons themselves actually moved the other way, from minus (-) to plus (+). Both ways worked for thinking about it. Flow's job was to show everyone that current was real, moving stuff, not a mystery.

Flow always made things clear. "Electrons moving through wires. *Measured in amperes.*" She explained that when you hooked up a battery, electrons left the negative side. They traveled through the wires and parts. Then they came back to the positive side. "That flow is the work," she'd say. "If the wires are all connected, it's a complete loop. The current flows."

She'd hold up a broken wire. "But if a wire breaks, the loop opens up. The current stops. It's like a dam in a river. Current needs a complete loop. No loop, no flow."

Flow taught some important things about current:

- *Amperes (A)* measure how much charge moves each second. (One ampere is a super huge number of electrons passing by every second.)
- You need a *complete loop*. No closed circuit means no current. An open switch stops it. A closed switch lets it go.
- There's the "conventional" current (plus to minus). And there's the *actual* electron flow (minus to plus). Engineers mostly use the conventional way.
- The current is *the same* everywhere in a simple loop. What goes in must come out.
- *Direct current (DC)* goes one way, like from batteries. *Alternating current (AC)* wiggles back and forth, like from wall outlets.
- You measure current with an *ammeter*. You have to cut the wire and put the meter right in the gap.
- Current isn't "used up." The electrons just keep moving. Energy gets used, but not the electrons themselves.
- Wires don't just "have electricity in them." They have electrons. But those electrons only flow when there's a complete circuit and a power source.
- A *short circuit* is when wires touch and skip a part of the circuit. This makes a super high current. The wire gets hot. It can start a fire. Fuses and breakers stop this.

Flow grew up near the slow-moving streams of CircuitForge. Her family had watched currents for generations. They were the otters who tracked eddies and counted fish per second. They taught everyone that "flow is something you can measure." A river per second. Electrons per second. Same idea, just different tiny things moving. Flow carried that lesson forward.

She came to CircuitForge when she was twelve. Watt, her mentor, asked her, "What is current?"

Flow stood tall. "Electrons moving through wires," she said. "*Measured in amperes*. It's the craft of moving charge."

Watt nodded. "You are appointed."

In her workshop, Flow loved to show things with her current meter. "Watch this," she'd chirp. She took a battery, a small light-up LED, and her ammeter. She carefully wired them all in a line. The LED glowed a soft blue.

"See?" Flow pointed to her meter. "It reads 20 milliamps. That's twenty thousandths of an ampere. It's flowing through *every single wire* in this loop." She tapped the wires. "The same amount here, here, and here."

She reached for a tiny switch she'd added. *Click!* She opened it. The LED light went out. The meter dropped to zero. "Open loop," she explained. "No flow."

Click! She closed the switch again. The LED lit up. The meter jumped back to 20 mA. "See? The electrons are moving again."

Flow picked up two bare wires. She held them carefully with thick, insulated gloves. "Some kids think the wire itself has electricity inside it," she said. "But wires only have electrons. They only *flow* when there's a complete path and a battery pushing them."

She showed a short-circuit next, with extra safety gear. She touched the two bare wires together, bypassing the LED. *Zzzzzt!* A tiny spark flew. The wire got hot, fast. A special safety fuse in her circuit popped with a soft *thwip*. The current stopped.

"When current spikes too high, the wire heats up," Flow said, pointing to the blown fuse. "That's why fuses exist. They break the loop to keep us safe. Safety always comes first."

She looked up, her eyes bright. "I am Flow. The lesson I teach is *current*. It's all about *electrons in motion*. We measure it in *amperes*. And remember, you always need a *complete loop*."

Flow was gentle when she spoke. "Don't think of electricity as mysterious," she said. "It's just electrons moving. That's all it is." She smiled. "When you understand the loop, you understand everything. You know why a single broken wire stops the whole circuit. You know why short-circuits are dangerous. And you know why every part on the same loop has the same current."

"Electrons moving through wires. *Measured in amperes*."

Voice register

River-otter-electrician-tween. Curious-about-electron-motion, fond of current-meter + flow-direction-arrow demonstrations. *NEVER frames current as mysterious; ALWAYS centers "electrons in motion; complete loop; amperes per second" framing.*

Sample lines:

- "*Electrons moving through wires.*"
- "*Measured in amperes.*"
- "*Complete loop required.*"

Arc

- Kit 1 — Introduces *current* primitive (front-and-center).
- Kits 2-12 — Recurring (every current discussion routes through Flow).
- Kit 16 — Final reflection — joins Push + Damp + Branch + Build in capstone full-electronics-toolkit.

Relationships

- **Anchors the cast arc:** Current is the foundational concept; voltage + resistance + topology + components all relate

to it.

- **Cross-app design-language continuity with HeatForge Drift + WaveForge + PrismForge flow-as-craft cluster:**
flow-craft framework.

Cultural-sensitivity gate

Anti-mystery-of-science — village otter empirical knowledge treated as load-bearing.

Cultural-context note

Current pedagogy is canonical electronics (Halliday-Resnick-Walker; Horowitz + Hill *Art of Electronics*; Feynman Lectures Vol II Ch 13-14). Otter-tween chosen for river-current biomimicry (real species track flow + eddies expertly); rendered chunky-cartoon current-pose to keep visual register warm.

Push

*PUSH — *the pressure difference. measured in volts.**

Push was a small armadillo. He wore a chunky volt-vest. It looked like a cartoon. He always stood ready, like he was about to pump something. His armor was soft stone-grey. His fur was warm cream. Push loved to learn about electrical pressure. He always said, "The pressure difference. Measured in volts."

His special tools were a voltmeter and a set of battery cards. The voltmeter showed volts. It measured between any two points. The cards showed different power sources. An AA battery was 1.5 volts. A 9V battery was, well, 9 volts. USB was 5 volts. A wall outlet could be 120 or 230 volts. Push knew them all.

Push taught about **voltage**. It was a big idea. Many people got **voltage** and current mixed up. But Push knew the truth. **Voltage** was like a push. It made tiny electrons want to move. Current was the flow of those electrons. No push? No flow. Simple as that.

Think about water pipes. **Voltage** is the water pressure. Current is how fast the water flows. A tall water tower has lots of pressure. It pushes water through pipes super fast. A battery works the same way. Its **voltage** pushes electrons. More **voltage** means more push. Push wanted everyone to see this. It wasn't a mystery. It was just pressure.

Push would explain it clearly. "It's the pressure difference," he

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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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