

The CRAFT Pedagogical Cycle

A five-phase instructional framework for integrated STEM teaching. Print this page for a quick reference.



C — Contextualize

Activates prior knowledge. Frames *why* this matters through real-world applications, careers, and societal connections.

Open with a real-world problem or scenario. Ask: "Where have you seen this?" Poll or brainstorm to surface what students already know and believe.

R — Reframe

Surfaces the wrong mental model and installs the correct one. Creates productive cognitive dissonance.

Present a counterexample, demo, or poll result that challenges assumptions. Name the misconception explicitly. Students discuss in small groups.

A — Assemble

Scaffolded skill-building through I Do → We Do → You Do. This is where the hands-on learning happens.

I Do (5 min): Brief facilitator demo. **We Do** (10-15 min): Guided practice together. **You Do** (15-25 min): Independent or group application. Aim for 1:5+ talk:do ratio.

F — Fortify

Verify, test, and stress-test understanding. Errors are features, not failures. Apply the Check the Machine protocol.

Students verify their work against known references using CtM: **Task** (what I asked) → **Before** (what I expected) → **After** (what happened) → **Takeaway** (what I

learned).

T — Transfer

Connects forward to the next concept, a new context, or the student's own world. Makes learning portable.

Students design, plan, or create something that applies what they learned to *their* context. Share out. Debrief the CRAFT structure itself so students see the pedagogy.

The Check the Machine (CtM) Protocol

A 4-step verification framework used in the **Fortify** phase. Teaches students to verify AI and computational outputs like engineers.

1. Task

What did you ask the AI/tool to do?

2. Before

What do you *expect* the answer to be?

3. After

What did the AI/tool actually produce?

4. Takeaway

What does the gap reveal?

Design Principles

Talk:Do Ratio of 1:5+

For every 1 minute of facilitator talking, participants should be doing for 5+ minutes. If you're talking more than 20% of the time, restructure.

Standalone Sessions

Each session should work independently. Participants who miss one session can still benefit from the others.

Light and Fun Tone

Low-stakes, creative energy. "An experienced colleague explaining to a capable newcomer." Humor welcome.

Research-Connected

Pre/post surveys (anonymous, linked by participant ID) enable data collection without changing the PD experience.

Standards-Aligned

Every activity maps to NGSS, and participants practice the alignment themselves.

- | **Attribution:** The CRAFT pedagogical cycle was developed by Dr. Mike Borowczak and Dr. Andrea C. Borowczak at the University of Central Florida.

BBC micro:bit V2 Sensor Reference Guide

All onboard sensors, how to access them in MakeCode and MicroPython, and calibration notes for classroom use.

- | The micro:bit V2 has 7 onboard sensors — no external wiring needed. All are accessible through MakeCode blocks or MicroPython code.

Onboard Sensors

| | | | | |
|------------------------|------------------------------|-------------|---------------------------------|----------------------------|
| Temperature | CPU die temperature (°C) | -5 to 50°C | input.temperature() | temperature() |
| Accelerometer | Motion / tilt (x, y, z) | ±2g default | input.acceleration(Dimension.X) | accelerometer.get_x() |
| Compass | Magnetic heading (°) | 0–359° | input.compassHeading() | compass.heading() |
| Light Level | Ambient light via LED matrix | 0–255 | input.lightLevel() | display.read_light_level() |
| Microphone (V2) | Sound level (dB approx) | 0–255 | input.soundLevel() | microphone.sound_level() |
| Touch Logo | Capacitive | Boolean | input.logoIsPressed() | pin_logo.is_touched |

(V2) touch ()

Buttons A, B, A+B Boolean input.buttonIsPressed(button_a.is_pressed
press Button.A) ()

Calibration Notes

Temperature Sensor — Critical Calibration Issue

The temperature sensor reads the **CPU die temperature**, not ambient air

temperature. It typically reads 3–8°C higher than the actual room temperature,

and the offset varies by device and workload.

Classroom fix: Have students measure the offset by comparing the

micro:bit reading to a known thermometer, then subtract the offset in code.

This is a real engineering calibration exercise!

```
let offset = input.temperature() - KNOWN_ROOM_TEMP
```

```
basic.forever(function () {
```

```
let calibrated = input.temperature() - offset
```

```
basic.showNumber(calibrated)
```

```
}
```

Compass — Requires Calibration Dance

On first use, the micro:bit displays "TILT TO FILL SCREEN" — tilt the board to

light up all LEDs. This calibrates the magnetometer. Nearby magnets, metal

desks, and electronics can interfere.

Light Sensor — Uses the LEDs

The light sensor works by briefly reversing the LED matrix to sense ambient

light. This means the display flickers very briefly during readings. In a dark

room, readings may be inaccurate if the LEDs are actively displaying something

bright.

Microphone — V2 Only

The built-in MEMS microphone is new in V2. It measures sound *level*

(loudness), not frequency or pitch. Values are relative (0-255), not calibrated to

actual decibels. Good for "loud vs. quiet" experiments, not precise acoustic

measurement.

Multi-Sensor Project Ideas

| | | | |
|----------------------------|-------------------------|-------------------------------------|-----|
| Greenhouse Monitor | Temperature + Light | PS3.D: Energy in Chemical Processes | 6-8 |
| Earthquake Detector | Accelerometer | ESS3.B: Natural Hazards | 6-8 |
| Noise Pollution Map | Microphone + Buttons | ESS3.C: Human Impacts | 3-5 |
| Compass Navigator | Compass + Accelerometer | PS2.A: Forces and Motion | 6-8 |
| Light Intensity Experiment | Light Level | PS4.B: Electromagnetic Radiation | 6-8 |
| Step Counter | Accelerometer | LS1.A: Structure and | 3-5 |

| | | | |
|---------------|--------------------------------|---------------------------------|------|
| | | Function | |
| Comfort Index | Temperature + Light + Sound | ETS1.B: Developing Solutions | 9-12 |

Quick Reference: MakeCode vs MicroPython

| | | |
|-------------|---|--|
| Interface | Block-based (drag & drop) or JavaScript | Text-based Python |
| Editor URL | makecode.microbit.org | python.microbit.org |
| Best for | Beginners, visual learners, K-8 | Text-ready students, 6-12, CS courses |
| LLM Support | Ask LLM for "MakeCode JavaScript" — translates well to blocks | Ask LLM for "MicroPython for micro:bit" — specify V2 for mic/touch |
| Deployment | Download .hex, drag to MICROBIT drive | Flash directly from editor, or download .py |

NGSS Alignment Crosswalk: IoT & Sensor Activities

How micro:bit sensor activities map to Next Generation Science Standards Performance Expectations.

How to use this crosswalk: Find your grade band and discipline, then pick

a sensor activity that maps to a PE you're already teaching. The micro:bit

becomes the data collection tool for a standard you already cover.

Physical Science

| | | | |
|-----------|---------------------------------------|--|--------|
| PS1. A | Structure and Properties of Matter | Temperature changes during state transitions (ice melting near sensor) | 5, MS |
| PS2. A | Forces and Motion | Accelerometer measures force/motion during cart experiments | MS, HS |
| PS3. A | Definitions of Energy | Light sensor measures energy transfer from light sources at distances | 4, MS |
| PS3. B | Conservation of Energy | Temperature sensor tracks energy transfer between objects | MS, HS |
| PS4. A | Wave Properties | Microphone captures sound level at | 4, MS |

distances from source

| | | |
|-------------------------------------|--|--------|
| PS4. Electromagnetic B Radiation | Light sensor measures intensity vs. distance (inverse square) | MS, HS |
|-------------------------------------|--|--------|

Life Science

| | | |
|----------------------------------|---|--------|
| LS1. Structure and A Function | Accelerometer as step counter / movement tracker for organism behavior | 3-5 |
| LS1. Information D Processing | Build a stimulus-response system (sound triggers light) | 4, MS |
| LS2. Ecosystem C Dynamics | Light + temperature monitoring in terrarium/aquarium over time | MS, HS |

Earth and Space Science

| | | |
|----------------------------------|--|--------|
| ESS2. Weather and D Climate | Temperature + light logging throughout the school day | 3-5 |
| ESS3.B Natural Hazards | Accelerometer as seismograph (shake detection + magnitude) | 4, MS |
| ESS3.C Human Impacts on Earth | Microphone for noise pollution mapping around school campus | MS, HS |

Engineering, Technology & Applications (ETS)

| | | |
|---|--|---------|
| ETS1. Defining and Delimiting A Engineering Problems | Identify a school environment problem that sensors can measure | 3-5, MS |
| ETS1. Developing Possible B Solutions | Design and prototype a sensor-based solution (e.g., classroom comfort monitor) | MS, HS |
| ETS1. Optimizing the Design C Solution | Iterative testing and calibration of sensor systems | MS, HS |

CTE Pathway Connections

| | | |
|--------------------------|---|---|
| Information Technology | IoT systems, data collection, edge computing | Multi-sensor data logger with radio transmission |
| Engineering & Technology | Embedded systems, prototyping, calibration | Sensor calibration experiment + design optimization |
| Health Science | Biomedical monitoring, patient sensing | Step counter + heart rate proxy (accelerometer patterns) |
| Agriculture | Precision agriculture, environmental monitoring | Greenhouse monitor (temp + light + soil moisture via external sensor) |

STEM Prompt Library

Tested prompts for AI-assisted STEM teaching. Copy, customize, and iterate. Works across ChatGPT, Claude, and Gemini.

- Pro tip: The best prompts include your **grade level, specific standard, time constraint, and student context**. Generic prompts get generic results.

Lesson Planning

Generate a Standards-Aligned Lesson

W1All Platforms

I teach [GRADE] [SUBJECT]. Create a [DURATION]-minute lesson aligned to

[SPECIFIC NGSS STANDARD].

Include:

- A real-world hook that connects to students' lives

- 3 differentiated activities (approaching, on-level, extending)

- One formative assessment check

- Materials list (assume a typical classroom budget)

Format the lesson as: Objective > Hook > Activities > Assessment > Extension

Differentiate an Existing Lesson

W1All Platforms

Here is my existing lesson: [PASTE LESSON]

Differentiate this for three levels:

1. Approaching: Students who need scaffolding with [SPECIFIC SKILL]

2. On-level: Students meeting grade-level expectations

3. Extending: Students ready for deeper challenge

Keep the same core learning objective but adjust complexity, vocabulary, and

support structures.

Generate a Week of Inquiry Problems

W1Best on Claude

Create 5 inquiry-based [SUBJECT] problems for [GRADE] students, one per day.

Requirements:

- Each problem should take 15-20 minutes

- Progress from concrete to abstract across the week

- Include at least one problem that connects to [CAREER/REAL-WORLD CONTEXT]

- Aligned to [NGSS STANDARD]

- Include teacher notes for common misconceptions

Assessment & Rubrics

Create a Rubric from a Standard

W1All Platforms

Create a 4-level rubric (Beginning, Developing, Proficient, Advanced) for this

standard:

[PASTE NGSS PE]

For each level, describe:

- What the student CAN do at this level

- Observable evidence (what you would see/hear)

- Example student work or response

Format as a table.

Verification & Error Checking

Generate a Verify-able Output

W2All Platforms

Generate a [SUBJECT] explanation of [TOPIC] for [GRADE] students.

IMPORTANT: Intentionally include 2-3 subtle errors that a student should be

able to catch using:

- Their textbook

- A calculator

- Prior knowledge from [PREVIOUS UNIT]

I will use this as a "Check the Machine" classroom activity. Do NOT tell me

where the errors are.

Debug AI-Generated Code

W2W3

I asked an AI to write this code: [PASTE CODE]

The code is supposed to: [DESCRIBE INTENDED BEHAVIOR]

But instead it: [DESCRIBE ACTUAL BEHAVIOR]

walk me through the debugging process step by step. Explain what each line

does, identify the error(s), and show the corrected version with comments

explaining the fix.

Physical Computing & IoT

Generate micro:bit Code from Description

W3Best on Claude

Write MakeCode JavaScript for BBC micro:bit V2 that:

[DESCRIBE WHAT THE PROGRAM SHOULD DO]

Sensors to use: [LIST SENSORS]

Output: [LED display / sound / radio / serial]

Include comments explaining each block. Also provide the equivalent MakeCode

blocks description so I can rebuild it visually.

Create a Sensor Data Collection Plan

W3All Platforms

I want my [GRADE] [SUBJECT] students to use BBC micro:bit sensors to

investigate:

[SCIENCE QUESTION]

Design a data collection plan that includes:

- Which sensor(s) to use and why

- How often to collect readings

- How many trials/samples needed

- A data table template

- Potential sources of error and how to control them

- How to connect findings to [NGSS STANDARD]

Administrative Time-Savers

Parent Communication

W1All Platforms

Draft a parent newsletter paragraph explaining that our class is starting a

unit on [TOPIC].

Tone: Warm, professional, excited

Length: 150 words max

Include: What students will learn, one way parents can support at home, and a

sentence about how we're using AI tools responsibly in class.

IEP/504 Accommodation Suggestions

W1Best on Claude

I have a [SUBJECT] lesson on [TOPIC] for [GRADE].

A student has the following accommodation: [DESCRIBE ACCOMMODATION]

Suggest 3 specific ways to modify the lesson activities while maintaining

rigor and access to the same core learning objective. Be practical – suggest

modifications I can implement with the materials I already have.

Remember: Always verify AI-generated content before using it with

students. Use the Check the Machine (CtM) protocol: Task → Before → After →

Takeaway.

