Inspiring Innovation:

STEM Makerspace Strategies and Mentorship

STEM Leadership Institute

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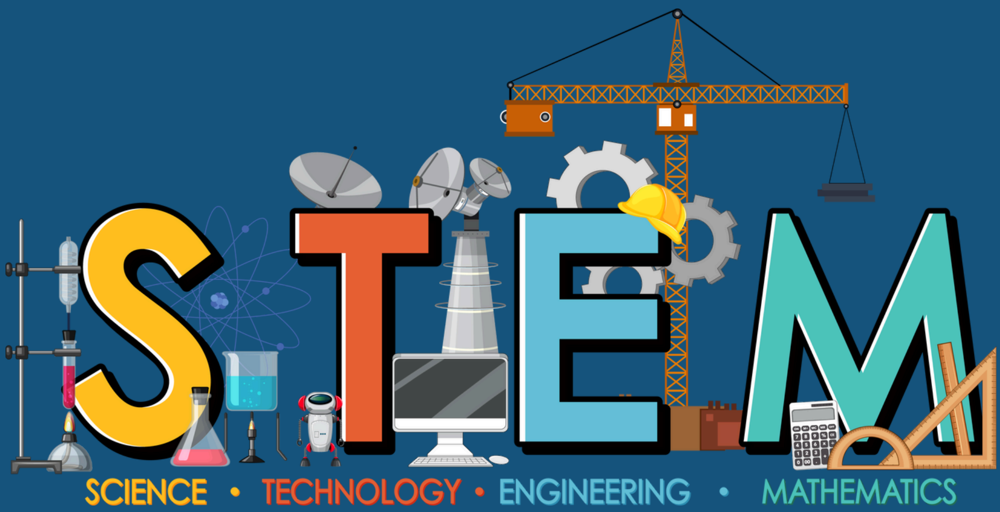

MAKER STRATEGIES

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Maker-centered learning transforms STEM classrooms into spaces of innovation, collaboration, and authentic problem solving.

For middle and secondary STEM educators, these strategies create opportunities to deepen content knowledge through real-world applications.

Herein are a few practical, adaptable strategies designed to integrate maker approaches into existing science, technology, engineering, and mathematics curricula.

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STEM MAKER STRATEGIES

- Ensure makerspace materials are organized, labeled, and accessible to all students, promoting independence.
- Adapt activities and provide multiple entry points for students with different abilities and backgrounds.
- Plan for project storage, easy access to materials, and clear organization to streamline workflow.
- Use visual labels and designated areas for different tools and supplies to foster student independence.
- Shift from direct instruction to facilitation, guiding students through inquiry, problem-solving, and collaboration.
- Provide support, encouragement, and formative feedback throughout the maker process.

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MATERIALS EXPLORATION LABS

Prepare Labs or Maker Spaces in your classroom. Develop a schedule. Allow students to rotate through “maker stations or labs”, where they experiment with different materials and tools (e.g., soldering at one station, coding at another). Encourages the use of multimaterial and multi-tool fluency.

DESIGN THINKING PROCESS

Use the empathize → define → ideate → prototype → test model to approach interdisciplinary challenges. Students define problems and create solutions using a mix of skills and materials, which mirrors real-world engineering and tech development. Here is the definition of each component of the model.

1. **Empathize:** Understand the real needs, feelings, and problems of the people you are trying to help.
2. **Define:** Clearly state the problem you are solving, based on what you learned.
3. **Ideate:** Brainstorm lots of possible solutions without judgement - be creative!
4. **Prototype:** Build a quick version of one idea so you can test it.
5. **Test:** Try out the prototype, get feedback, improve it.

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MICRO-CHALLENGES/SKILL BUILDERS

Weekly or biweekly mini-challenges focused on a single component (e.g., blink an LED with Arduino, print a gear). Then combine these into a culminating capstone that requires all the skills. Here are some examples.

CHALLENGE	SUBJECTS INTEGRATED
Smart Clothing for Safety	Physics (light,sound), Technology (microcontrollers), Engineering (wearables)
Design a Low-Cost Water Purifier	Environmental Science (water quality), Chemistry, Engineering
Noise Pollution Detector	Physics (sound waves), Computer Science (coding sensors), Engineering
Build a Smart Plant Monitor	Biology (plant needs), Technology (sensors), Math (data collection)
Emergency Solar Charging Kit	Physics (solar energy), Engineering (circuits), Environmental Science (energy conservation)
Design an Anti-Theft Backpack	Engineering (design thinking), Computer Science (sensor coding), Physics (motion detection)
Create a Personal Air Quality Monitor	Environmental Science (pollution), Tech (IoT devices), Math (graphing air quality data)
Develop a Smart School ID	Computer Science (RFID or QR coding), Engineering, Design

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MICRO-CHALLENGES/SKILL BUILDERS

Weekly or biweekly mini-challenges focused on a single component (e.g., blink an LED with Arduino, print a gear). Then combine these into a culminating capstone that requires all the skills. Here are some examples (continued from previous page).

EXAMPLE PROJECT IDEA
Create a jacket that flashes lights when it senses darkness to keep pedestrians or cyclists safe.
Build a small filtration system using everyday materials and measure its effectiveness.
Program a noise sensor device that tracks sound levels in different school areas and alerts when limits are exceeded.
Create a soil moisture monitor that alerts students when plants need watering.
Design a solar-powered device that can charge a phone or an emergency light in disaster situations.
Build a backpack with a motion or open sensor that triggers an alarm if tampered with.
Construct a wearable sensor that alerts users about dangerous air quality levels.
Prototype a student ID badge that tracks attendance or can double as a library checkout card.

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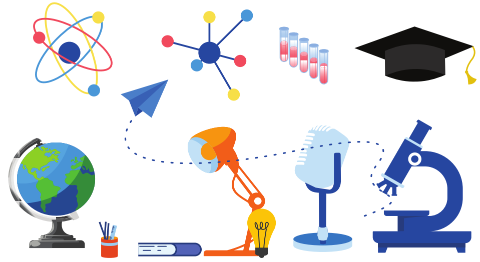
STEM MAKER STRATEGIES



INDUSTRY AND COMMUNITY MENTORSHIP

Connect students with STEM professionals for guidance and feedback.

- Example: Invite engineers to review student prototypes and discuss career paths.
- STEM Integration: Career-readiness, real-world application

STEM MAKER EXHIBITIONS

Host public events for students to present their projects.

- Example: School-wide STEM fair featuring student inventions and prototypes.
- STEM Integration: Applied STEM, Presentation Skills, Feedback Loop

REVERSE ENGINEERING PRACTICES

Disassemble devices or systems to understand how they work.

- Example: Take apart a mechanical clock to learn about gears and energy transfer.
- STEM Integration: Engineering, Physics, Systems Thinking

AUGMENTED REALITY (AR) AND 3D VISUALIZATION

Use AR tools or 3D modeling software to visualize scientific concepts.

- Example: Model and explore a human heart using AR apps.
- STEM Integration: Biology, Technology, Visualization

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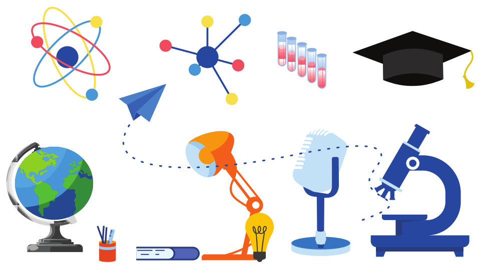

GAMIFIED STEM MAKING

Incorporate game design and gamification to enhance STEM engagement.

- Example: Build board games that teach mathematical functions or science content.
- STEM Integration: Math, Science, Computer Science

MAKER JOURNALS AND PORTFOLIOS

Encourage students to document and reflect on their maker journeys.

- Example: Maintain a digital or physical notebook of designs, trials, and reflections.
- Students document projects using multimedia (videos, photos, reflections). Supports video analysis and interviews as assessments, plus shows growth across multiple STEM domains.
- STEM Integration: All domains through metacognition and communication

REAL-WORLD DESIGN CHALLENGES

Engage students in solving authentic problems through open-ended design tasks.

- Example: Design a sustainable home for a region prone to natural disasters.
- STEM Integration: Engineering (design process), Science (climate, materials), Math (measurement, budget), Technology (CAD tools)

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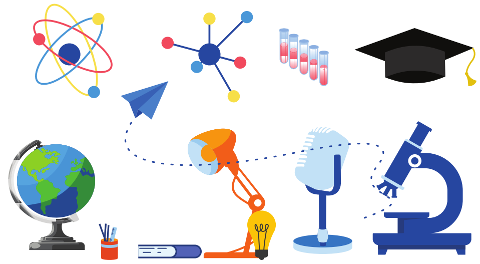

STORYTELLING THROUGH MAKING

Ask students to communicate scientific concepts using multimedia and models.

- Example: Create an animated model showing the impact of ocean currents on climate.
- STEM Integration: Earth Science, Technology (digital tools), Communication Skills

DATA-DRIVEN MAKING

Use real-world data to inform and guide the design process.

- Example: Design water conservation tools based on local usage statistics.
- STEM Integration: Data Science, Environmental Science, Design Thinking

RAPID PROTOTYPING LABS

Use low-cost materials to create iterative prototypes.

- Example: Build and improve a wind-powered car using recycled materials.
- STEM Integration: Physics (force, motion), Engineering (mechanisms), Math (ratios, speed)

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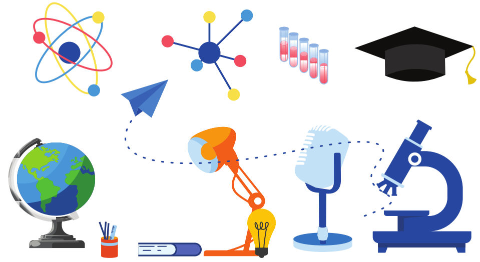

ECO-MAKING AND SUSTAINABILITY PROJECTS

Focus on environmentally sustainable design and renewable materials.

- Example: Construct furniture from recycled cardboard and test its strength.
- STEM Integration: Environmental Engineering, Earth Science, Innovation

ASSISTIVE TECHNOLOGY DESIGN

Create solutions for people with disabilities.

- Example: Design a tool that helps people with limited mobility access daily items.
- STEM Integration: Biomedical Engineering, Human-Centered Design, Empathy in STEM

CROSS-CURRICULAR MAKER INTEGRATION

Collaborate with non-STEM subjects to broaden project impact.

- Example: Build historical reconstructions using CAD and research from history class.
- STEM Integration: Interdisciplinary Literacy, Digital Humanities, Creative Arts

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STEM MAKER ACTIVITIES WITH ROBOTICS

- Here are some maker activities integrating robotics (continued on next page).

CHALLENGE	SUBJECTS INTEGRATED	EXAMPLE PROJECT IDEA
Build a Line-Following Robot	Design and program a robot using IR sensors to follow a black line on the ground.	Physics (light/sensors), Coding, Engineering
Trash-Sorting Smart Arm	Create a robotic arm or servo-driven gate that uses sensors to detect and sort paper vs. plastic.	Robotics, Sensors, Environmental Science
Obstacle-Avoiding Vehicle	Use ultrasonic sensors to build a robot that moves and avoids walls or objects in its path.	Engineering Design, Coding, Sensors
Automated Pet Feeder	Build a timed or sensor-triggered robot that dispenses food or water for pets.	Robotics, Programming, Real-World Design
Light-Following Robot (Phototropism Bot)	Use light sensors to create a robot that moves toward or away from a light source.	Physics, Engineering, Plant Biology (tie-in)

STEM Maker Activities With Robotics Table continued on next page.

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STEM MAKER ACTIVITIES WITH ROBOTICS

Here are some maker activities integrating robotics (continued from previous page).

CHALLENGE	SUBJECTS INTEGRATED	EXAMPLE PROJECT IDEA
Robotic Art Machine (DrawBot)	Program a robot with servo arms to draw patterns or art on paper.	Coding, Art/Design, Mechanical Systems
Wearable Gesture-Controlled Robot	Build a glove or wearable with flex sensors to control a robot's movement via gestures.	Human-Computer Interaction, Engineering
Robotic Greenhouse Assistant	Build a mobile robot that can monitor temperature, soil, or light in a greenhouse or grow area.	Agriculture Tech, Robotics, Coding
Sumo Bot Challenge	Design and code a robot that can push another robot out of a ring using strategy and sensors.	Design, Engineering, Competitive Coding
Mars Rover Simulation	Students build and control a robot to complete terrain challenges (rocks, slopes, craters) like on Mars.	Earth/Space Science, Engineering, Sensors

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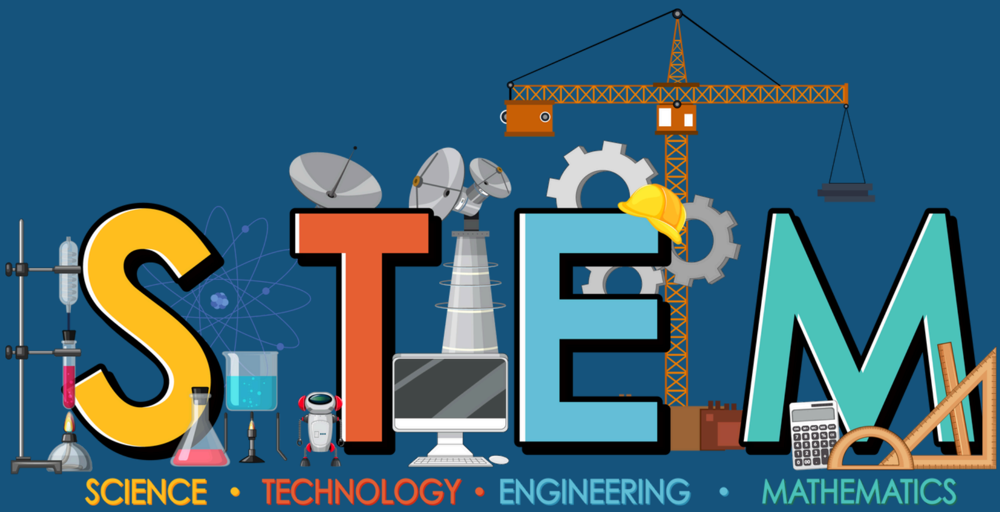

MAKER LESSONS

STEM Maker *Lessons*

WEARABLE TECHNOLOGY
Wearable Intelligence: Designing Sound-Responsive Clothing

JUNIOR STEM ROLE MODELS AND MENTORS (SRM^2) EXTENSION
Light It Up: Sound-Activated Fashion! with Elementary Partners

MATH IN MAKING
Math in Making: Building a Scale Model Suspension Bridge

JUNIOR STEM ROLE MODELS AND MENTORS (SRM^2) EXTENSION
🏗️ Mini Maker Activity for Elementary Students: Build a Mini Suspension Bridge!

BUILDING A SMART PLANT WATERING SYSTEM
Make It Grow: Building an Automated Smart Plant Waterer

JUNIOR STEM ROLE MODELS AND MENTORS (SRM^2) EXTENSION
🌱 Mini Maker Activity: Build a Water Alert System!

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WEARABLE TECHNOLOGY

Wearable Intelligence: Designing Sound-Responsive Clothing

Grade Level: 7th–12th Grade
Subject Areas: STEM (Science, Technology, Engineering, Math) — with integration of Computer Science, Fashion Engineering, and Physics
Duration: 3–4 weeks (adaptable)

🛠️ LEARNING OBJECTIVES

By the end of the project, students will:

- Understand the fundamentals of electrical circuits and microcontroller programming.
- Design and program a wearable garment or accessory with embedded sound-responsive LEDs.
- Apply engineering design principles in wearable tech construction.
- Use creative thinking to blend aesthetics and technology.
- Collaborate in teams and document a complete engineering design process.

🔧 MATERIALS NEEDED

- Microcontrollers (Arduino Uno, Micro:bit, or Adafruit GEMMA)
- Sound sensors (microphone breakout boards)
- LEDs (sewable NeoPixels or regular)
- Conductive thread or wires
- Coin cell batteries or small LiPo batteries
- Basic sewing kits, hot glue guns, or fabric adhesives
- T-shirts, hats, or accessories for embedding circuits
- Laptops or Chromebooks with Arduino IDE or MakeCode
- Scissors, fabric markers, clips

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Maker Lesson

WEARABLE TECHNOLOGY

Wearable Intelligence: Designing Sound-Responsive Clothing

KEY VOCABULARY

- Wearable technology, Conductive thread, Microcontroller, Input/output, Sensor (sound), Event-driven programming, Prototyping, and Iteration

STANDARDS:

Learning Objective	Middle School TEKS Alignment	High School TEKS Alignment
Understand the fundamentals of electrical circuits and microcontroller programming	Science: Investigate and explain how electrical energy in circuits can be transformed into light or sound; identify requirements for a functioning circuit - Technology Applications: Apply computational thinking (decompose problems, create algorithms) and use software/hardware to solve real-world problems	Physics: Calculate current, voltage, resistance, and power in circuits - CTE STEM: Apply Ohm's law, Kirchhoff's laws, and build/test circuits; implement microprocessor applications; use simulation software and lab equipment for circuit analysis
Design and program a wearable garment or accessory with embedded sound-responsive LEDs	- Technology Applications: Use creativity and innovation to design, create, and iterate digital solutions; integrate hardware and software in projects. - Computational thinking: Break down the design into steps, use algorithms for programming LEDs, and debug as needed.	CTE STEM: Design analog/digital circuits, use microcontrollers, and build prototypes; present projects using a variety of media. - CTE: Use software applications to simulate and present circuit behavior; document design and modifications in a project notebook.

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Maker Lesson

WEARABLE TECHNOLOGY

Wearable Intelligence: Designing Sound-Responsive Clothing

STANDARDS:

Learning Objective	Middle School TEKS Alignment	High School TEKS Alignment
Apply engineering design principles in wearable tech construction	- Science & Engineering Practices: Use the engineering design process- define the problem, brainstorm, plan, create, test, and improve; document and reflect on the process - Technology Applications: Plan, create, test, and iterate on solutions; manage data and document results	CTE Engineering: Apply the engineering design process, including problem definition, prototyping, testing, and iteration; use project management methodologies - CTE: Test and evaluate prototypes, analyze data, and present solutions
Use creative thinking to blend aesthetics and technology	Technology Applications: Use creativity and innovation to develop new products; integrate design and technology to solve real-world problems - Data literacy: Publish and present data and designs for an audience	CTE STEM: Explore innovative technologies, improve designs for quality and aesthetics, and present final products using various media - CTE: Use a variety of technologies and creative approaches in design and presentation
Collaborate in teams and document a complete engineering design process	Technology Applications: Collaborate using digital tools, document the design process, and communicate effectively - Engineering Practices: Work in teams, contribute ideas, and reflect on group solutions; maintain an engineering notebook	CTE STEM: Participate in team projects, apply effective teamwork and problem-solving, assume different roles, and document the process - CTE: Present oral and written communication, manage project phases, and demonstrate time management and responsibility - Engineering: Maintain an engineering notebook and use project management methodologies

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PROCEDURE (WEEKS 1-2)

Week 1: Introduction and Planning

1. **Launch Activity:**
    a. Show examples of LED fashion and wearable devices.
    b. Discuss: How can clothing become responsive or intelligent?
2. **Skills Workshop:**
    a. Learn to blink an LED using a microcontroller.
    b. Learn to use a sound sensor to detect claps or music.
3. **Team Formation:**
    a. Form teams of 2–4 students.
    b. Define project goals, sketch concepts, and assign roles:
        i. Programmer
        ii. Circuit Builder
        iii. Designer
        iv. Documentarian

Week 2: Design and Prototype

1. **Circuit Prototyping:**
    - Build a sound-to-light prototype on a breadboard.
    - Code the LEDs to flash when sound is detected.
2. **Wearable Design:**
    - Plan LED placement and sensor integration.
    - Test conductive thread or glue circuits on scrap fabric.

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WEARABLE TECHNOLOGY

Wearable Intelligence: Designing Sound-Responsive Clothing

PROCEDURE (WEEKS 3-4)

Week 3: Build and Test

1. **Fabrication and Assembly:**
   - Transfer circuit to wearable item.
   - Use sewing, fabric adhesives, or 3D-printed enclosures.
2. **Testing and Iteration:**
   - Debug code.
   - Test in different sound environments.
   - Reinforce weak connections or short circuits.

Week 4: Final Presentation and Reflection

1. **Showcase:**
   - Runway-style display of LED wearables.
   - Students present design process and function.
2. **Reflection:**
   - Written prompt: “What technical and creative skills did I grow?”
   - Evaluate design using rubric and self-assessment checklist.

ASSESSMENT

Category	**Points**
Participation & Teamwork	20
Circuit Design & Functionality	20
Code Quality & Sensor Integration	20
Aesthetic and Creativity	20
Final Presentation & Reflection	20
Total	**100**

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✏️ Student/Team Sheets, Self-Assessments, and Rubrics

📓 Project Tracking Sheet - Page 1

Team Name: ____

Team Members: ____

____

1. Project Overview

What real-world problem are you solving? ____________________________

____

2. Roles and Responsibilities

Role	Lead Name(s)
Programmer	
Circuit Designer	
Wearable Designer	
Documentarian	

3. Project Timeline

Task	Planned Completion Date	Actual Completion Date
Design sketch completed		
Build initial circuit prototype		
Code functionality		
Transfer to wearable		
Final test and revision		
Presentation ready		

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✏️ Student/Team Sheets, Self-Assessments, and Rubrics

🧮 Project Tracking Sheet - Page 2

Team Name: ____

Team Members: ____

____

4. Daily Progress Log

Date	What We Worked On	Next Steps

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✅ Student Self-Assessment Checklist

Name: ______________________________ **Team Name:** ________________________

1. Team Collaboration

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I actively participated in team discussions and work.			
Our team divided responsibilities fairly.			
I helped solve problems when challenges came up.			

2. Design and Building

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
Our design included input/output elements and sensors.			
Our circuit worked as planned (or after troubleshooting).			
The construction was safe and clean.			

3. Coding and Technology Use

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I contributed to or reviewed the coding.			
Our code ran without errors.			
We tested and refined the code more than once.			

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✅ Student Self-Assessment Checklist

Name: ______________________________ **Team Name:** ____________________________

4. Final Prototype

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I actively participated in team discussions and work.			
Our team divided responsibilities fairly.			
I helped solve problems when challenges came up.			

5. Presentation

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I clearly explained my role in the project.			
We demonstrated a working prototype.			
We answered questions confidently.			

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Maker Lesson

JUNIOR STEM ROLE MODELS AND MENTORS (SRM^2) EXTENSION

Light It Up: Sound-Activated Fashion! with Elementary Partners

Mentorship Target Group: Elementary Grades 3–5
Mentor Group: High School Science Students (Grades 10–12) who completed the *Wearable Intelligence* project

🎯 PURPOSE OF THE EXTENSION

To promote vertical mentoring and STEM leadership, high school students will guide younger students through a simplified version of the wearable tech activity, reinforcing their own understanding while inspiring future STEM learners.

🧠 ELEMENTARY STUDENT ACTIVITY: MINI-MAKER CHALLENGE: "LIGHT UP WHEN YOU HEAR IT!"

Students create a simple sound-responsive LED using either:

- Pre-wired sound-triggered LED modules, or
- A Micro:bit pre-loaded with "on loud sound" → "turn on LED" block code

📚 HIGH SCHOOL STUDENT MENTORSHIP PLAN:

- Present their wearable project to the class (live or via video).
- Help each elementary student build a wearable paper badge or wristband with an LED that lights up when sound is detected.
- Explain the concept of "input" (sound) and "output" (light).
- Ask simple guiding questions:
  - "What makes the light turn on?"
  - "How could this be used to help someone?"

🧪 MATERIALS FOR ELEMENTARY ACTIVITY:

- Micro:bit (or LED + sound module + battery)
- Cardstock or foam for badge design
- Adhesive or Velcro, tape, markers, safety scissors
- Optional: Conductive tape for simple circuit traces

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Junior STEM Role Models and Mentors (SRM^2) Extension
🧮 Elementary Activity Sheet: My Sound-Sensing Badge

My Name: ____

My Mentor's Name: ____

⬢ What does my badge do when it hears a sound?

____

____

When the room is quiet, the light is...

✏️ **Circle One:** **Off** / **Dim** / **Flashing**

When the room is loud, the light is...

✏️ **Circle One:** **Bright** / **Flashing** / **Changes color**

⬢ What's one way this technology could help someone?

____

____

⬢ Would you want sound-sensing clothes? Why or why not?

____

____

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Junior STEM Role Models and Mentors (SRM^2) Extension
High School Mentor Reflection Prompt

Mentor Name: ____

School/Class: ____

How did you explain wearable tech to younger students?

____
____
____

What surprised you about the way they learned or asked questions?

____
____
____

What STEM communication skill did you practice today?

____
____
____

Would you want to mentor again? Why or why not?

____
____
____

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Junior Wearable Technology Award

Awarded To:

____

For successfully completing the **“Sound Responsive Wearable Tech” Challenge**

You used science, sounds, and circuits to make your creativity light up the world!

👏 **We are proud of your curiosity, innovation, and teamwork.** 👏

Presented by:

________________________ *(Mentor Name)*

⚛️ **Junior STEM Role Models and Mentors (SRM^2) Extension**

📅 Date: ____________ 🏫 School: ________________

🎉**You’re A Junior Wearable Tech Maker!** 🎉

JUNIOR STEM ROLE MODELS AND MENTORS (SRM²) EXTENSION

Light It Up: Sound-Activated Fashion! with Elementary Partners

📚 **Recommended Teacher References**

1. **Buechley, L., Peppler, K., Eisenberg, M., & Kafai, Y. (2013). *Textile messages: Dispatches from the world of E-Textiles and Education.* Peter Lang Publishing**
2. **Martinez, S. L., & Stager, G. S. (2013). *Invent to learn: Making, tinkering, and engineering in the classroom.* Constructing Modern Knowledge Press.**
    - **A foundational book on integrating maker-centered learning into K–12 education, with emphasis on student creativity, invention, and cross-disciplinary learning.**

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MATH IN MAKING

Math in Making: Building a Scale Model Suspension Bridge

Grade Level: 7th–12th Grade
Subject Areas: STEM (Science, Technology, Engineering, Math) — with integration of Computer Science, Fashion Engineering, and Physics
Duration: 3–4 weeks (adaptable)

🛠️ LEARNING OBJECTIVES

By the end of this project, students will:

- Apply scale factors, ratios, and proportions in designing a real-world structure.
- Use geometry and algebra to calculate angles, forces, and dimensions in a scale model.
- Understand engineering principles of tension, compression, and load-bearing structures.
- Collaborate effectively, manage a multi-phase project, and communicate design choices.
- Test and analyze the strength and stability of their bridge designs.

🔧 MATERIALS NEEDED

- Graph paper
- Rulers, protractors, and compasses
- Popsicle sticks, dowels, or balsa wood
- String or fishing line (for cables)
- Hot glue guns and glue sticks
- Cardboard or foam board (for base platforms)
- Small weights (washers or sandbags for load testing)
- Laptops/tablets (optional: Tinkercad or other simple CAD tools)
- Measuring tape
- Scissors and craft knives (with supervision)

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MATH IN MAKING

Math in Making: Building a Scale Model Suspension Bridge

Grade Level: 7th–12th Grade
Subject Areas: STEM (Science, Technology, Engineering, Math) — with integration of Computer Science, Fashion Engineering, and Physics
Duration: 3–4 weeks (adaptable)

🧠 KEY VOCABULARY:

- Suspension Bridge, Scale Factor, Tension, Compression, Load, Span, Anchor, Truss, Ratio, Proportion, and Structural Integrity

⚙ STANDARDS:

Learning Objective	Middle School TEKS Alignment	High School TEKS Alignment
Apply scale factors, ratios, and proportions in designing a real-world structure	- Represent and solve problems involving ratios, rates, and scale factors - Solve problems involving proportional relationships, including scale drawings and models	- Algebra I: Apply proportional and algebraic reasoning to real-world problems - Geometry: Use proportionality in similar figures and scale drawings
Use geometry and algebra to calculate angles, forces, and dimensions in a scale model	- Model and solve problems involving geometric relationships, including angles and triangles - Solve problems involving volume and surface area	- Geometry: Apply geometric concepts to solve problems - Physics: Calculate and analyze forces using algebra and trigonometry

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MATH IN MAKING

Math in Making: Building a Scale Model Suspension Bridge

STANDARDS:

Learning Objective	Middle School TEKS Alignment	High School TEKS Alignment
Understand engineering principles of tension, compression, and load-bearing structures	- Science: Identify and describe the types of forces (e.g., tension, compression) and their effects - Science: Investigate the relationship between force and motion in structures	- Engineering Design: Analyze and calculate forces in structures - Physics: Apply Newton's laws to analyze tension, compression, and equilibrium in structures
Collaborate effectively, manage a multi-phase project, and communicate design choices	- Science/Math Process Standards: Communicate and justify ideas, work in teams, and manage projects - STEM Framework: Emphasizes collaboration and communication skills	- Science/Math Process Standards: Collaborate in teams, communicate findings, and manage project phases - STEM Framework: Emphasizes 21st-century skills (collaboration, communication, project management)
Test and analyze the strength and stability of their bridge designs	- Science: Plan and conduct investigations, collect and analyze data - Math: Represent and analyze data from experiments	- Engineering: Test, evaluate, and refine engineering designs based on data - Physics: Plan and conduct investigations, analyze experimental data, and draw evidence-based conclusions

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Math in Making: Building a Scale Model Suspension Bridge

PROCEDURE (WEEKS 1-2)

Week 1: Launch and Planning

1. **Launch:**
   a. Show iconic bridges (e.g., Golden Gate Bridge, Brooklyn Bridge).
   b. Discuss real-world math used in bridge construction: scale, ratios, forces.
2. **Skills Workshop:**
   a. Teach basic bridge types and forces (focus on suspension bridges).
   b. Mini-lessons on how to calculate scale and draw to scale.
3. **Team Formation:**
   a. Students form teams of 3–4.
   b. Select a real-world bridge or design their own inspired suspension bridge.
4. **Planning:**
   a. Each team sketches a scale model design using graph paper.
   b. Approve plans with the instructor before moving to construction.

Week 2: Prototype and Scale Construction

1. **Prototype Building:**
   a. Begin building scaled structures (towers, deck, cables).
   b. Use correct measurements according to plans.
2. **Material Testing:**
   a. Pre-test string cables and deck parts for strength.
   b. Adjust designs as needed (iteration encouraged).

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MATH IN MAKING

Math in Making: Building a Scale Model Suspension Bridge

PROCEDURE (WEEKS 3-4)

Week 3: Construction and Load Testing

1. **Bridge Assembly:**
    a. Assemble suspension cables, towers, and anchor points.
    b. Ensure structures are neat, balanced, and symmetrical.
2. **Load Testing:**
    a. Add weights carefully until the bridge reaches the failure point.
    b. Record maximum load held, sagging, and breakage points.

Week 4: Construction and Load Testing

1. **Team Presentations:**
    a. Share scaled designs, explain math/geometry involved.
    b. Demonstrate load testing live.
2. **Reflection:**
    a. Students complete individual reflection sheets about the design process, math use, teamwork, and improvements for future designs.

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🧩 Student Materials

📓 Project Tracking Sheet - Page 1

Project Title: ____

Team Members: ____

____

🌟 **(Optional) Inspiration Bridge:** ____

1. Sketch

2. Materials List:

-
-
-
-
-
-
-
-
-
-
-

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🧩 Student Materials

📓 Project Tracking Sheet - Page 2

Team Members: ____

____

3. Daily Log

Date	Tasks Completed	Problems or Changes

4. Load Testing Results – *Maximum load your bridge held before failing*

____

____

____

____

____

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✅ Student Self-Assessment Checklist

Student Name: ____

Team Name: ____

✅ **Student Self-Assessment Checklist:**

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
Our bridge matched the scale drawing.			
We used accurate math for scale and measurement.			
Our bridge demonstrated correct tension and compression forces.			
Our final bridge held weight successfully.			
We collaborated and communicated as a team.			
Our presentation explained the math and design choices.			

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🎯 Teacher Grading Rubric

Student Name: ____

Team Name: ____

🎯 **Teacher Grading Rubric (100 Points):**

Criteria	4 (Exceeds)	3 (Meets)	2 (Approaching)	1 (Needs Improvement)
Team Collaboration				
Mathematical Accuracy (Scale, Ratios, Geometry)				
Structural Design and Build Quality				
Load Testing (Strength and Documentation)				
Presentation and Reflection				

🚀 Extensions:

- **Advanced Engineering:** Calculate the forces acting on the main suspension cables.
- **Budget Challenge:** Assign material costs and work within a "budget" for construction.
- **CAD Modeling:** Students design their bridge digitally using Tinkercad or SketchUp.
- **Environmental Engineering:** Modify the bridge for wind resistance or different climates.

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Maker Lesson

JUNIOR STEM ROLE MODELS AND MENTORS (SRM²) EXTENSION

🏗️ **Mini Maker Activity for Elementary Students: Build a Mini Suspension Bridge!**

Target Audience:

- Elementary Students (Grades 3–5)
- Mentored by Middle/High School Students

🚀 DESCRIPTION OF THE EXTENSION

*Middle and high school students will **mentor elementary students** in building a **mini version of a suspension bridge** using simple materials.*

*The mini-bridges will demonstrate basic **tension** and **compression** forces.*

🧪 MATERIALS FOR ELEMENTARY ACTIVITY:

- String (for cables)
- Craft sticks (Popsicle sticks)
- Construction paper or thin cardboard (for roadbed)
- Tape and glue
- Scissors
- Small objects for load testing (coins, erasers, marbles)

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Maker Lesson

JUNIOR STEM ROLE MODELS AND MENTORS (SRM²) EXTENSION

🏗️ **Mini Maker Activity for Elementary Students: Build a Mini Suspension Bridge!**

Steps:

1. **Show and Tell (5–10 min):**
    - Big kids explain what a suspension bridge is.
    - Show how bridges "hang" using cables.
2. **Mini-Build (25–30 min):**
    - Elementary students tape two "towers" (vertical craft sticks) onto a base (cardboard or paper).
    - Attach string cables across the towers and tape a paper roadbed below the cables.
    - Secure cables to the cardboard base for "anchors."
3. **Test and Reflect (5–10 min):**
    - Place small objects gently onto the bridge.
    - See if it holds or sags — and fix/improve together!

Key Concepts for Elementary Students:

- **Tension** (string cables pulling)
- **Compression** (roadbed pushing down)
- **Balance** and **design**

Why It's Great:

- Simple, hands-on, visual learning.
- Builds mentoring skills in older students.
- Connects math, science, and engineering concepts at the right level for each group.

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Junior STEM Role Models and Mentors (SRM²) Extension
🧮 Mini Maker Student Handout (for Elementary Students)

My Name: ____

My Mentor's Name: ______________________________________

✏️ **What is tension?** ______________________________
____
____

✏️ **What is compression?** __________________________
____
____

🖍️ **Draw your bridge here!**

(Big rectangle for base, two towers, string cables, roadbed.)

✏️ **What would you add to make your bridge even stronger?**

____
____

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JUNIOR STEM ROLE MODELS AND MENTORS (SRM²) EXTENSION

🏗️ Mini Maker Activity for Elementary Students: Build a Mini Suspension Bridge!

📚 Recommended Teacher References

1. Anderson, C., & Owenss, B. (2020). *Making STEM more engaging and inclusive.* Edutopia.
2. Ascioine, L. (2025). *Strategies to help girls stay engaged in STEM Learning.* eSchool News.
3. Burnett, V. (2025). *6 ways to make math more accessible for multilingual learners*. eSchool News.
4. Dené Poth, R. (n.d.). *Students as innovators: Why STEM learning matters more than ever*. Defined Solutions.
5. Karou, K. (2024). *3 keys to making math engaging*. MIND Education.

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Maker Lesson

BUILDING A SMART PLANT WATERING SYSTEM

Make It Grow: Building an Automated Smart Plant Waterer

Grade Level: 7th–12th Grade
Subject Areas: STEM (Science, Technology, Engineering, Math) – integrating Computer Science, Engineering, and Environmental Science
Duration: 3–4 weeks (adaptable)

🛠️ LEARNING OBJECTIVES

By the end of the project, students will:

- Understand basic microprocessor programming (e.g., Arduino or Raspberry Pi Pico).
- Apply principles of circuit design and sensor integration.
- Design and manufacture custom parts using 3D printing and simple fabrication tools.
- Solve a real-world problem through a multidisciplinary approach.
- Collaborate in teams, manage a project timeline, and present a working prototype.

🔧 MATERIALS NEEDED

- Microcontrollers (Arduino Uno, Raspberry Pi Pico, or similar)
- Moisture sensors
- Small water pumps
- Tubing
- Breadboards and jumper wires
- Batteries or power supplies
- Laptops or Chromebooks with Arduino IDE or similar software
- 3D printers and filament
- Tinkercad (or similar for 3D design and simulation)
- Basic tools (screwdrivers, hot glue guns, soldering iron if advanced)
- Containers (to hold plants and pumps)
- Access to a plant or soil for testing

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Maker Lesson

BUILDING A SMART PLANT WATERING SYSTEM

Make It Grow: Building an Automated Smart Plant Waterer

KEY VOCABULARY

- Microcontroller, Sensor, Circuit, Programming, 3D Modeling, Fabrication, Iteration, and Prototyping

STANDARDS:

Objective	Middle School TEKS Alignment	High School TEKS Alignment
Understand basic microprocessor programming (e.g., Arduino or Raspberry Pi Pico).	- Technology Applications: Apply computational thinking, decompose problems, create and test algorithms, use flowcharts/pseudocode, and collaborate on program design - Design and implement programs that solve real-world problems using hardware and software integration	- CTE Programming & Software Development: Code solutions, test/debug programs, use algorithms, and apply error handling - STEM: Implement knowledge of microprocessor applications and embedded systems
Apply principles of circuit design and sensor integration.	- Technology Applications: Integrate hardware (sensors, circuits) with software; use simulation tools to test circuit behavior - Science: Investigate and explain basic circuits and sensor functions - Engineering: Use project-based learning to construct and analyze circuits	- STEM/CTE: Apply Ohm's Law, Kirchhoff's Laws, and power laws to design and build series, parallel, and complex circuits; design analog and digital circuits using industry standards; integrate sensors and microcontrollers - Use simulation and measurement tools, and document circuit designs and modifications

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Maker Lesson

BUILDING A SMART PLANT WATERING SYSTEM

Make It Grow: Building an Automated Smart Plant Waterer

STANDARDS:

Objective	Middle School TEKS Alignment	High School TEKS Alignment
Design and manufacture custom parts using 3D printing and simple fabrication tools	- Technology Applications: Use digital fabrication tools, including 3D printers, to create prototypes; apply safe tool use and document process - Engineering: Plan and construct physical models as part of design projects	- STEM/CTE: Identify and use appropriate tools and equipment for prototyping; implement manufacturing processes, including 3D printing and fabrication; document steps in a project notebook - Present final products using a variety of media and communicate design choices
Solve a real-world problem through a multidisciplinary approach	- Technology Applications: Use computational thinking and problem-solving models to address real-world challenges; integrate concepts from math, science, and technology - Math: Apply mathematical process standards to real-world, multidisciplinary problems	- STEM/CTE: Use the engineering design process to identify, research, and solve authentic problems; apply knowledge from multiple disciplines - Programming: Design and implement program solutions that address real-world needs
Collaborate in teams, manage a project timeline, and present a working prototype	- Technology Applications: Collaborate using digital tools, plan and manage projects, and communicate results through presentations and documentation - Engineering: Work in teams, manage project phases, and reflect on process - Project management: Set milestones, monitor progress, and present deliverables	- STEM/CTE: Participate in team-based projects, apply project management strategies, document and present prototypes, and use a project notebook to record progress - Programming: Work in teams, manage project phases, and communicate solutions through oral and written presentations

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BUILDING A SMART PLANT WATERING SYSTEM

Make It Grow: Building an Automated Smart Plant Waterer

PROCEDURE (WEEKS 1-2)

Week 1: Launch and Planning

1. **Launch**
   a. Discuss real-world problems: "How can technology help solve agricultural and environmental challenges?"
   b. Introduce project scope: Build a smart plant watering system.
2. **Skills Workshop**
   a. Teach basic microcontroller use: Blink an LED, read a sensor.
   b. Introduce Tinkercad 3D modeling for beginners.
3. **Team Formation**
   a. Assign teams of 3–4 students.
   b. Brainstorm project designs (use planning templates).
   c. Define roles: Programmer, Circuit Designer, Fabricator, Documentarian.

Week 2: Prototype and Scale Construction

1. **Circuit Prototyping**
   a. Build basic circuits with soil moisture sensors.
   b. Write basic code to automate water delivery based on moisture levels.
2. **3D Modeling**
   a. Design housing for sensor, pump, and microcontroller.
   b. Submit 3D models for teacher review before printing.

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BUILDING A SMART PLANT WATERING SYSTEM

Make It Grow: Building an Automated Smart Plant Waterer

PROCEDURE (WEEKS 3-4)

Week 3: Build and Test

1. **Fabrication and Assembly**
    a. Print 3D parts.
    b. Assemble all components: Install circuits into 3D-printed casing.
2. **Iterative Testing**
    a. Test system: Simulate dry/wet soil conditions.
    b. Debug code, adjust sensor readings, modify casing as needed.

Week 4: Final Presentation and Reflection

1. **Presentation**
    a. Teams present their working prototypes.
    b. Each student explains their role and challenges overcome.
    c. Live demonstration: Water a real plant!
2. **Reflection**
    a. Students write a reflection: "What skills did you learn? How would you improve your design?"

ASSESSMENT

- Participation (20%) – Team collaboration, engagement during build sessions.
- Design and Planning (20%) – Quality of initial blueprints, designs, and code.
- Prototype Functionality (30%) – System reliably responds to moisture and waters plant.
- Presentation (20%) – Clear explanation of problem, design process, and results.
- Reflection (10%) – Thoughtful and specific personal learning evaluation.

Extensions:

- Add Bluetooth or Wi-Fi to create a remote-monitoring system.
- Expand to multiple plants or garden beds (scaling engineering designs).
- Analyze water conservation data (Math/Data Science).

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✏️ Student/Team Sheets, Self-Assessments, and Rubrics

📓 Project Tracking Sheet - Page 1

Team Name: ____

Team Members: ____

____

1. Project Overview

What real-world problem are you solving? ______________________________

____

____

2. Roles and Responsibilities

Role	Lead Name(s)
Programmer	
Circuit Designer	
Fabricator (3D design/printing)	
Documentarian	

3. Design Plan

Sketch or describe your device or in your notebook. (You can attach a drawing if you prefer.)

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🧮 Project Tracking Sheet - Page 2

Team Name: ____

Team Members: ____

____

4. Project Timeline

Task	Planned Completion Date	Actual Completion Date
Brainstorm and design		
Build initial circuit prototype		
Program microcontroller		
Create 3D designs		
Print and assemble		
Test and revise		
Finalize and prepare presentation		

5. Daily Progress Log

Date	What We Worked On	Problems or Discoveries	Next Steps

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📓 Project Tracking Sheet - Page 3

Team Name: ____

Team Members: ____

____

6. Final Reflection. Each team member should answer these questions individually after the project is complete and discuss with each other; be prepared to submit.

- **Take a photo of your project and name it.**
- **Describe your project: who, what, when, where this took place**
- **Analyze your project: why and how you did it (briefly).**
- **Appraise your project: What did you learn? Share your favorite part of the project? What was the most challenging part?**
- **Transform your learning/take it to the next steps: What new skill did you learn? If you could improve your device, what would you change?**

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✅ Student Self-Assessment Checklist

Name: ______________________________ **Team Name:** ______________________________

Directions: Check the box that best describes how you feel about each part of your project.
Be honest — this helps you improve and shows your learning!

1. Team Collaboration

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I actively participated in team discussions and work.			
Our team divided responsibilities fairly.			
I helped solve problems when challenges came up.			

2. Design and Building

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
Our design included sensors, coding, and custom parts.			
Our circuit worked as planned (or after troubleshooting).			
Our 3D-printed parts fit and functioned well.			

3. Coding and Technology Use

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I helped program or debug the microcontroller.			
Our device correctly senses when the soil is dry/wet.			
We tested and adjusted the system more than once.			

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✅ Student Self-Assessment Checklist

Name: ______________________________ **Team Name:** ______________________________

4. Final Prototype and Functionality

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
Our smart plant waterer functions as intended.			
Our final device is neat and durable.			
We documented our work clearly (notes, photos, code).			

5. Presentation

Criteria	Excellent (✓)	Good (✓)	Needs Improvement (✓)
I clearly explained my role and our project goals.			
Our team showed the working prototype.			
We answered questions from classmates and/or the teacher.			

🌟 Bonus Points (Optional)

Did you or your team go above and beyond? (e.g., added Bluetooth? Designed extra features? Solved a tough problem?) Tell us about it here: ______________________________

____

____

____

____

____

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🎯 Teacher Grading Rubric

Student Name: ____

Team Name: ____

Teacher Tip: You can collect these before presentations, skim them, and even use them alongside your final rubric for grading!

1. Teamwork and Collaboration (20 points)

Criteria	4	3	2	1
Actively participated and contributed ideas.				
Divided tasks effectively among team members.				
Demonstrated problem-solving when challenges arose.				

2. Design and Engineering (20 points)

Criteria	4	3	2	1
Smart device includes microcontroller, sensor, and custom 3D parts.				
Circuit and physical assembly are neat and functional.				
Project showed evidence of planning and iteration (testing and revising).				

3. Coding and Technology Application (20 points)

Criteria	4	3	2	1
Code works reliably with the device (e.g., sensor triggers watering).				
Students demonstrated understanding of programming basics.				
Device response to environmental input (dry soil) was correctly implemented.				

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🎯 Teacher Grading Rubric

Student Name: ____

Team Name: ____

4. Final Prototype Functionality (20 points)

Criteria	4	3	2	1
Smart plant waterer operates as intended (waters plant automatically).				
Device is structurally sound and visually organized.				
Device demonstrates real-world problem-solving.				

5. Presentation and Communication (20 points)

Criteria	4	3	2	1
Clear explanation of problem, design process, and prototype.				
Team effectively demonstrated and showcased working device.				
Each team member spoke knowledgeably about their role.				

Total Score: ______ / 100

💬 **Teacher Comments:**
(Strengths, suggestions, overall feedback)

____

____

____

____

This way, each major skill area is equally weighted (20 points each × 5 categories = 100 points total), making grading fair, balanced, and super clear both for you and the students.

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BUILDING A SMART PLANT WATERING SYSTEM

Make It Grow: Building an Automated Smart Plant Waterer

🗂️ LESSON PLAN REFERENCES

The Lesson Plan is based on the following:

- **General educational best practices** for project-based learning (PBL),
- **Maker education models** (especially work influenced by experts like Sylvia Libow Martinez & Gary Stager — *Invent to Learn*, 2013),
- **Common STEM project design standards** (e.g., NGSS for Engineering Design),
  a. **Standard rubric and reflection formats** that are widely used in authentic assessment models.

Other References:

- Martinez, S. L., & Stager, G. (2013). *Invent to learn: Making, tinkering, and engineering in the classroom*. Constructing Modern Knowledge Press.
- Thomas, J. W. (2000). *A review of research on Project-Based Learning*. The Autodesk Foundation.

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Maker Lesson

JUNIOR STEM ROLE MODELS AND MENTORS (SRM²) EXTENSION

🌱 **Mini Maker Activity: Build a Water Alert System!**

Target Audience:
- Elementary Students (Grades 3–5)

Time: 30–45 minutes

*This is a **hands-on mentoring opportunity** which is **easy** — no complicated coding needed. It is visual and fun — the LED lighting up feels magical! It is directly connected to the **Smart Watering System** the older students built. This further encourages **teamwork** between mentors and younger students.*

🚀 DESCRIPTION OF THE EXTENSION

*Elementary students will **build a basic circuit** that lights up an LED when the "soil" (sponge) gets too dry, showing the plant needs water — just like the big Smart Watering System!*

🧪 MATERIALS FOR ACTIVITY:

- Small LED lights (any color)
- Batteries and battery holders
- Aluminum foil
- A small cup of soil or a sponge (simulating wet/dry soil)
- Wires or alligator clips
- Optional: simple microcontroller (like Micro:bit) if you want coding, but **can be no-code**!

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Maker Lesson

JUNIOR STEM ROLE MODELS AND MENTORS (SRM^2) EXTENSION

🌱 **Mini Maker Activity: Build a Water Alert System!**

Simple Steps:

1. **Show and Tell:**
    - 7-12 students explain how **plants need water** and how **sensors** can tell when it’s dry.
2. **Quick Demo:**
    - Show a completed mini-circuit — LED turns on when "soil" is dry.
3. **Build It:**
    a. Help the elementary students connect a **battery** to an **LED** with aluminum foil "sensors" placed in a sponge.
    b. When the sponge is wet, it won't complete the circuit.
    c. When it dries out, it will complete the circuit and the light will come on!
4. **Test and Explore:**
    a. Spray the sponge with water and watch the LED behavior change!
5. **Talk About It:**
    a. Why is it important for plants to get the right amount of water?
    b. How could sensors help farmers or gardeners?

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Junior STEM Role Models and Mentors (SRM^2) Extension

My Water Alert System!

My Name: ____

My Mentor's Name: ____

What does my system do?

____

____

____

____

____

My Circuit Drawing:

(Draw your LED, battery, and sponge/soil here!)

What Happens?

When the sponge is WET, the light: ______________________

When the sponge is DRY, the light: ______________________

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Junior STEM Role Models and Mentors (SRM^2) Extension

🌱 My Water Alert System!

My Name: ____

My Mentor's Name: ______________________________________

✏️ Why is this important for plants?

____

____

____

____

🌟 Fun Challenge!

If I could invent any other smart garden tool, it would be...

(Example: a robot that talks to plants!)

____

____

____

____

🎉 Great Job, Maker! 🎉

SRM^2 Signature: ______________________________

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Junior Maker Award

🎉 *Congratulations!* 🎉

This certificate is proudly awarded to:

____

For outstanding creativity, teamwork, and engineering skills during the: ⚛️ Junior STEM Role Models and Mentors (SRM^2) Extension

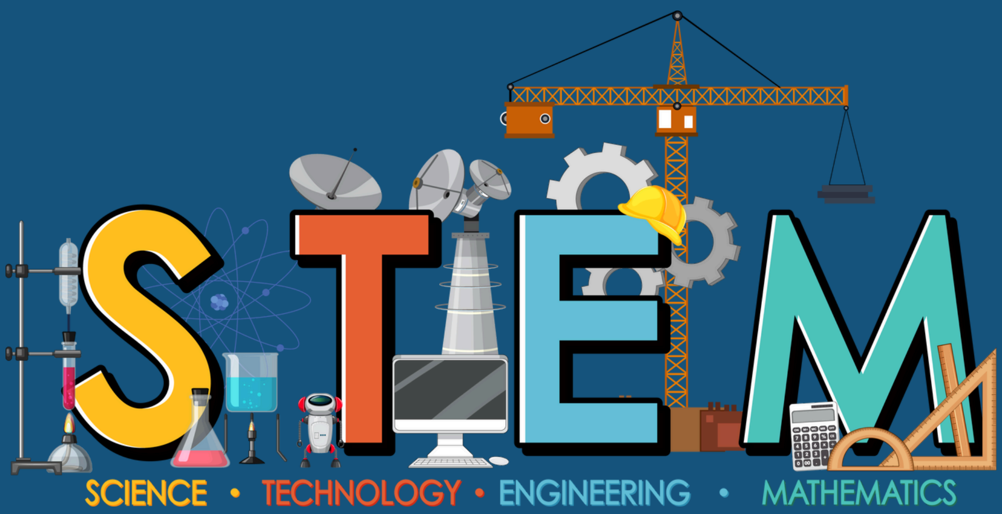
You built a real working circuit to help plants stay healthy and strong. You are officially a

JUNIOR MAKER:

WATER SYSTEMS SPECIALIST

Awarded By: ________________________ Date: ________________

✨ Keep imagining. Keep inventing.
Keep making! ✨



MENTORS

Scientists serving as mentors for middle and high school students have a significant, research-supported impact on students' academic, personal, and career development in STEM. Key findings from recent studies and program evaluations highlight the following positive outcomes.

INCREASED CONFIDENCE AND STEM IDENTITY

Mentorship programs connect students with real scientists, helping them see themselves capable of participating in STEM fields. Students, especially girls and those from underrepresented backgrounds, report greater confidence in their ability to do science and a stronger sense of belonging in STEM after participating in mentorship programs. These experiences help students envision themselves as future scientists and expand their understanding of what scientists do.

BROADER PERCEPTIONS OF STEM AND CAREER POSSIBILITIES

Interacting with scientist mentors exposes students to the diversity of STEM careers and those working in them. Students learn that scientists are not just people in lab coats, but also ecologists, engineers, marine biologists, and more. This broadens their perspectives on STEM, who can participate, and what tools and environments are used in scientific work.

HANDS-ON SKILLS AND REAL-WORLD APPLICATION

Mentorship programs often include authentic, hands-on STEM activities guided by scientists, allowing students to develop practical skills in research, experimentation, and problem-solving. These experiences make science more engaging and relevant, moving beyond rote memorization to active "doing" of science.

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ACADEMIC MOTIVATION AND ACHIEVEMENT

- Mentored students are more likely to adopt achievement-oriented goals, improve their academic performance, and think seriously about future STEM studies and careers. The support and encouragement from mentors can help students persist in STEM, even when faced with challenges.

ROLE MODELS AND REPRESENTATION

When students are mentored by scientists, especially those who share similar backgrounds in terms of sex, race, or socioeconomic status, they are more likely to identify with STEM professionals and aspire to similar careers. This is particularly important for increasing diversity in STEM fields.

SOCIAL-EMOTIONAL GROWTH AND RESILIENCE

Mentoring relationships foster resilience, adaptability, and self-advocacy. Students learn to persist, take risks, and see setbacks as opportunities for growth, all within a supportive environment. Mentors also provide guidance on navigating academic transitions and building self-confidence.

LONG-TERM IMPACT

Early exposure to scientist mentors increases the likelihood that students will continue seeking STEM opportunities, pursuing advanced STEM courses, and considering STEM careers as they progress through high school and beyond.

Scientists who mentor middle and high school students foster confidence, broaden career aspirations, build real-world skills, and support academic and personal growth. These impacts are especially profound for underrepresented students in STEM groups, helping to create a more diverse and motivated future STEM workforce.

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TURN YOUR HIGH-SCHOOL STUDENTS INTO STEM MENTORS FOR THE ELEMENTARY STUDENTS

High school students serving as STEM mentors for elementary students offers a powerful model of near-peer learning that benefits both groups. Through this collaboration, high schoolers reinforce their technical knowledge by teaching concepts like robotics, coding, and maker design in simpler, hands-on ways. Elementary students, in turn, are inspired by relatable role models who make STEM fields feel more exciting, personal, and achievable. This dynamic mentorship strengthens the high school students' leadership skills, communication abilities, and creativity while building confidence, curiosity, and foundational skills in the younger learners. You can ignite a passion for innovation across all ages and foster a strong, future-ready STEM learning community.

THREE TIPS FOR HIGH SCHOOL AND ELEMENTARY TEACHERS TO COLLABORATE EFFECTIVELY ARE AS FOLLOWS:

1. Meet as a team before the project starts to align expectations, define clear learning outcomes for both age groups, and co-develop simple activities suited to elementary skill levels.
2. Offer short training sessions where high school students learn basic communication strategies for working with younger learners (like giving simple instructions, offering encouragement, and modeling patience).
3. Include structured reflection activities after each session where both high school and elementary students write or talk about what they learned, challenges they faced, and ideas for improvement, helping deepen learning and connection.

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