# STEM Challenge: Secret Codes

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**Time Frame** 250 minutes

## Essential Question(s)

- How can we use the engineering design process to solve real world problems?

## Summary

In this activity, students design a system to encode or decode messages using ancient Egyptian systems or other cryptology methods. Once they have determined which coding system they wish to use, they will plan, create a message, test, and refine their designs, exploring problem-solving, logic, and creative thinking. In this activity, students will use not only the scientific method, but their creativity as they design their own unique language and create messages using this coding system. At the end of the lesson, students will examine and analyze their language and determine the importance of languages to every culture and explore the genius required to actually create a language.

## Learning Goals

## Attachments

- [3-2-1—STEM Challenge.docx]
- [3-2-1—STEM Challenge.pdf]
- [Activity Slides—STEM Challenge—Secret Codes.pptx]
- [Engineering Design Process Poster—STEM Challenge.docx]
- [Engineering Design Process Poster—STEM Challenge.pdf]
- [Engineering Notebook Materials—STEM Challenge.docx]
- [Engineering Notebook Materials—STEM Challenge.pdf]
- [Facilitator's Guide—STEM Challenge.docx]
- [Facilitator's Guide—STEM Challenge.pdf]
- [How to Create a Secret Code—Secret Codes.docx]
- [How to Create a Secret Code—Secret Codes.pdf]
- [My Checklist—STEM Challenge.docx]
- [My Checklist—STEM Challenge.pdf]

## Materials

- Activity Slides (attached)
- Facilitator Guide handout (attached; teacher copy)
- How to Create a Secret Code (attached; optional, one per student)
- Secret Codes Padlet (linked)
- Engineering Notebook Materials handout (attached; one per student; optional)
- 3-2-1 handout (attached; one half-page per student)
- My Checklist handout (attached; one per group)
- Engineering Design Process poster (attached; optional)
- Composition Notebooks (one per student)
- Pen/pencil
- Sticky Notes and chart paper or poster board
- Materials for STEM Activity:
    - Small whiteboards or cardstock sheets (2 per group); Coins, beads, or small counters (20 per group, for counting and encoding exercises); Envelopes (5 per group, for hiding/encoding messages); Scissors (1 per student); Tape (1 roll per group); Markers; Stamps; Invisible Ink.
- Optional 3D Printing Materials
    - 3D printer (shared across class or rotation)
    - Filament (PLA preferred) – classroom stock
    - Tinkercad or other CAD software

25 minutes

# Question

### Facilitator's Note: STEM Challenge Collection

The following activity is only part of a STEM Challenge Collection, which consists of a variety of possible STEM related activities. We recommend starting with the Engineering Explorers, which is an introduction to the engineering design process as it will best prepare students for the flow of each additional activity. Afterwards, feel free to go in any order based on student interest.

### Facilitator's Note: Scaffolding

Students will need each step of the Engineering Design Process (EDP) to be scaffolded for the first few activities. Students should become more independent as they practice the EDP and will require less teacher-directed instruction. Once students are comfortable with the process, you can update the question and criteria over time to scaffold their learning and ensure alignment as they grow and advance.

Use the **Activity Slides** to facilitate the following STEM Challenge session. Transition through **slides 2-4** to introduce the activity title, essential question, and learning objective. The essential question should be the guiding force throughout the activity and can help shape your probing questions as needed.

Display **slide 5**, which shows how students should set up the first sections of their notebook. If you are using the provided **Engineering Notebook Materials** handout, pass one copy out to every student along with scissors and tape or glue. Give students time to set up the Question & Brainstorm sections of their notebooks.

Display **slide 6**. Introduce the scenario for this session to the students and remind them to fill in that part of their notebooks. Read through the slide content in as much detail as needed. Explain to students that they should design a method for encoding and decoding information. Their goal is to create a '"message system" that could be used to send information secretly. For example, in war time, secret methods for communication protected the lives of soldiers and citizens and meant the difference between winning and losing wars. Secret codes exist all over the world. In the digital age, encryption and cryptography are very important. The importance of passwords and other codes to protect our data cannot be underestimated.

Transition to **slide 7** and explain the criteria for this engineering challenge to students in as much detail as you think necessary.

Display **slide 8**. Using the KWHL Graphic Organizer strategy, have each student go to or create their own KWHL chart in their notebooks by writing the following questions at the top of four columns:

1. Know: What do I know about the task? Based on having read some of the recommended readings, what do I know about my task?
2. Wonder: What do I not know (and want/need to know) about the task?
3. How: How will I find the information I need to complete the task?
4. Learn: What have I learned about the task?

Guide students through the **K** (What I Know) section by encouraging them to share prior knowledge, experiences, and assumptions related to the problem without judgment. Then, move to the **W** (What I Want to Know) section, prompting them to generate focused, curiosity-driven questions that highlight gaps in understanding. Allow students time to work.

Next, move to **slide 9** and have students interact with their notebook by creating their initial hypothesis or prediction based on their K and W responses and the items they listed to be successful. Remind students that this initial prediction will be revised and revisited often throughout the engineering design process.

**Facilitator's Note: Optional Scaffolding**

As an optional scaffold, use the video Hidden Figures: The Untold History of Indigenous Code Talkers to provide real-world context for how Indigenous languages were successfully used in codes and ciphers.

**Facilitator's Note: Pacing**

By the end of this phase, students should have a clear picture of the problem and an initial list of questions.

30 minutes

# Brainstorm

Display **slide 10** and revisit the KWHL chart introducing the **H** (How I Will Learn) section. Guide students to think about specific strategies they can use to find the answers to their **W** questions. This may include online research, hands-on experiments, interviews with experts, reviewing data, or consulting books and credible websites. Encourage students to match each question with at least one method or resource, considering the reliability and accessibility of their sources. With these strategies in mind, students should begin generating and sharing ideas for their secret code, using their **K** and **W** entries as a springboard for idea creation. All ideas are recorded without judgment in the space after their KWHL charts to promote creativity and ensure a wide range of possibilities for the next phase of planning.

**Facilitator's Note: Optional Scaffolding**

Unhide **slide 11** for additional research scaffolding. Students can either scan the QR code or use the provided tinyURL to navigate to the Secret Codes Padlet. Tell students that the Padlet has introductory readings, videos, and web resources related to the many aspects of cryptography. Feel free to use this resource as a springboard for idea generation.

As students are wrapping up their Brainstorming phase, transition to **slide 12** and remind students to revise their predictions based on the new knowledge gained. Explain that in the real world, scientists do this all the time. A well-trained scientist isn't someone who's always right the first time—they're someone who's willing to update their ideas as new evidence appears. Changing your mind isn't a mistake; it's part of the process and how real discovery happens.

**Facilitator's Note: Pacing**

During this phase, focus on helping students connect their **W** questions to actionable research strategies in the **H** section of the KWHL chart. Encourage them to think beyond simple internet searches. Consider experiments, direct observation, interviews, and reference materials. Reinforce that brainstorming is a judgment-free zone where creativity is valued over immediate solutions. Your role is to facilitate an inclusive environment where all voices are heard and ideas are recorded. Students will use those ideas to find potential solutions.

55 minutes

# Plan and Design

Display **slide 13** which shows how students should set up the next sections of their notebook. Give students time to set up the Plan & Design sections of their notebooks.

Move to **slide 14**. Explain that now students will review their brainstormed ideas and select the most promising option or combination of ideas that best fulfill the need of a secret code. Students will draw detailed sketches and calligraphic units to clearly show how the secret writing process takes place.

The plan should include labeled letters or other images, a materials list, and a step-by-step process for creation. Emphasize clarity—anyone who reads the plan should understand the purpose and the basic principles of the secret code. Students should design their system so that another group can use it independently during testing. This phase bridges creative ideas with practical action, ensuring that the concept is ready to use to write messages.

As students are wrapping up their Plan & Design phase, transition to **slide 15** and remind students to revise their predictions based on the new knowledge gained.

### Facilitator's Note: Supporting Code Development

In this phase, guide students to evaluate ideas critically against the original problem statement, criteria, and constraints. Encourage them to combine elements from multiple ideas if it strengthens the design. Support students in thinking through the feasibility of their design, considering safety, resource availability, and creation steps before moving forward.

### Facilitator's Note: Optional Scaffold

If students are struggling with creating their own codes, provide copies of the attached **How to Create a Secret Code** handout which can act as a guide for popular encryption methods.

55 minutes

# Create

Display **slide 16**, which shows how students should set up the next sections of their notebook. Give students time to set up the Create section of their notebooks.

Display **slide 17**. Using their completed plan, students begin building the first version of their design: the prototype — or first draft. They should follow their drawing instructions carefully. While developing their alphabet, encourage them that as they make changes, they make a note of them in their notebook and explain why those particular changes were made. The goal is to create a testable version of the solution, knowing that it may require improvement in later phases.

As students are wrapping up their Create phase, transition to **slide 18** and remind students to revise their predictions based on the new knowledge gained.

### Facilitator's Note: Pacing

During this phase, ensure students have access to all necessary materials, tools, and workspace. Reinforce safety procedures and proper tool use before creation begins. This is especially important if they are using invisible ink or some other kinds of inks. Encourage students to reference their plan frequently and to problem-solve when unexpected challenges arise. Remind them that prototypes do not have to be perfect—they are meant to be functional enough for testing and analysis. Provide guidance and troubleshooting support while allowing students to take ownership of their creation process.

55 minutes

# Test and Analyze

Display **slide 19** which shows how students should set up the next sections of their notebook. Give students time to set up the Test & Analyze sections of their notebooks.

If students need a reminder, return to slide 7 to review criteria again. Explain to students that in this phase, they will evaluate how well their secret code performs when used by others.

Display **slide 20**. Introduce the testing protocol.Each group will exchange their encoded message and key with another group. The receiving group must decode the message using only the provided instructions and materials. The original group will observe the decoding process without assistance.

Invite students to put their prototype to the test, using the criteria and constraints from the Question phase as their guide. Testing should follow a consistent process so that results are reliable and measurable. Students should gather qualitative evidence through observations, measurements, and feedback, looking for evidence about how well the design performs and where it might fall short. The purpose of this phase is to learn from the prototype, not to prove it's perfect.

After students have completed their data collection, move to **slide 21** and remind them to write up their analysis more fully in their notebooks. They can use the variables table to outline what variables their experiment(s) yielded and what they would change in the future.

As students are wrapping up their Test & Analyze phase, transition to **slide 22** and remind students to revise their predictions based on the new knowledge gained.

### Facilitator's Note: Pacing and Scaffolding

Before testing begins, help students review the original criteria so that they know exactly what success looks like. Provide clear testing procedures and make sure they are applied consistently for all groups. Encourage students to collect both quantitative data (numbers, measurements) and qualitative data (observations, feedback). Ask probing questions like, "What does your data tell you about the design?" or "What patterns do you notice?" This will prepare them to make informed improvements in the next phase.

If additional scaffolding is required, consider a whole class examination of possible collection tools.

The data collection methods should be student-generated, but if they are struggling, consider the following ideas for data collection: students could gather peer feedback, either in quotes or descriptions of facial expressions, and group or code their notes into relevant themes.

25 minutes

# Reflect and Improve

Display **slide 23** which shows how students should set up the next sections of their notebook. Give students time to set up the Reflect & Improve sections of their notebooks.

Display **slide 24**. Students review their test results and analysis to determine how well their prototype met the criteria and constraints. Using their collected observations, they identify specific strengths to keep and weaknesses to address. Students then propose targeted changes to improve the design, considering materials, measurements, features, or design methods. Students should use testing data (accuracy, time, errors, and feedback) to guide improvements. Remind students that the goal of this phase is to make the design more effective, efficient, and reliable before retesting or final presentation.

Display **slide 25.** Have students return to their KWHL charts and direct them to complete the "L" column: "What I learned about creating a secret writing system."

**Facilitator's Note: Pacing**

Guide students to base their improvement decisions on evidence rather than guesswork. Ask questions like "What change would give you the biggest improvement for the least effort?" or "Which weakness is most important to fix first and why?" Encourage them to prioritize changes that directly address test results. Remind students that this phase is part of the iterative nature of engineering: each cycle makes the design stronger. If time allows, support them in creating an updated plan, drawing, or model before rebuilding. Ideally, students will cycle through these last three phases multiple times.

30 minutes

# Communicate

Display **slide 26** which shows how students should set up the next section of their notebook.

Display **slide 27** and announce to students that they have been selected to share their findings at the annual Spark Expo. Have them brainstorm the best medium to present what they now know. Invite students to reflect and plan how they would communicate their experience.

### Facilitator’s Note: Scaffolding

Encourage students to choose a communication format that best fits their audience and resources. This could include slide decks, posters, videos, written reports, demonstrations, or even digital portfolios. Remind them that strong communication isn’t just about the final product; it’s about showing their thinking, decisions, and problem-solving skills along the way. Consider adding opportunities for peer-review and feedback during practice presentations to strengthen clarity and delivery.

# Resources


- Hidden Figures: The untold history of indigenous code talkers. Secret History Files. Video. https://www.youtube.com/watch?v=PePrbx5IAQs

- K20 Center. (n.d.). 3-2-1. Strategies. https://learn.k20center.ou.edu/strategy/117
- K20 Center. (n.d.). Canva. Tech Tools. https://learn.k20center.ou.edu/tech-tool/612
- K20 Center. (n.d.). Elevator speech. Strategies. https://learn.k20center.ou.edu/strategy/57
- K20 Center. (n.d.). Figma. Tech Tools. https://learn.k20center.ou.edu/tech-tool/3756
- K20 Center. (n.d.). Glow and grow. Strategies. https://learn.k20center.ou.edu/strategy/4962
- K20 Center. (n.d.). KWHL graphic organizer. Strategies. https://learn.k20center.ou.edu/strategy/127
- K20 Center. (n.d.). Padlet. Tech Tools. https://learn.k20center.ou.edu/tech-tool/1077
- K20 Center. (n.d.). Plus delta chart. Strategies. https://learn.k20center.ou.edu/strategy/2904
- Louridas, P. (n.d.). A history of cryptography from the Spartans to the FBI. MIT Press Reader. https://thereader.mitpress.mit.edu/a-history-of-cryptography-from-the-spartans-to-the-fbi/
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