Engineering Journals

Whether in-person or virtual, students have a chance to practice their writing skills in this hands-on activity about engineering journals.

Outline

Frame the Challenge	10 min total
Activate Prior Knowledge	5 min
Introduce the Challenge	5 min
Activity	**15 min total**
Prototype	5 min
Share and Reflect	10 min
Engineering Journals	**35 min total**
Brainstorm Best Practices for Journals	10 min
Journal Iteration	20 min
Debrief	5 min

Distance Learning

This lesson is written for virtual but includes adaptations for asynchronous and in-person implementation. For more tips on planning for distance learning, see our **Educator Tips for Remote STEM Learning**.

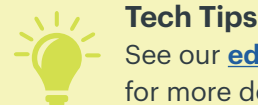**Grade Levels:** 3-8

Duration: 60 min

Concepts/Skills
Engineering, journaling, written communication

Objectives
Students will...
- Create a device based on a photo and journal entry.
- Write informative/explanatory text which organizes complex information clearly.

Tech Tips
See our **educator guides and videos** for more design challenge facilitation techniques. For this lesson check out:
- Data Collection   • Innovator Mindsets

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The Tech Challenge
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Materials and Preparation

Materials

□ 2 Student Handouts (**Challenge 1: Prototype a Paper Table** and **Challenge 2: Journal Iteration**)

□ Paper (2 sheets per student). Have student use whatever paper they have on hand.

□ Writing utensil/tool (ex: paper and pencil, Google Docs, etc.)

The Tech Challenge
This lesson can be used to prepare students for the 2022 Tech Challenge: Kinetic Commotion, presented by Amazon.

Preparation

1. Do the challenge yourself. This will give you practice with the materials and tools to be able to anticipate student questions.

2. Plan the process by which you will introduce the challenge to students and collect their work. *For example*, learning management platforms, live video sessions, collaborative documents, photos, videos, etc.

In-Person Adaptation
- Create teams of 3-4 students for the activity.
    − Sort paper and tape for each team.
    − Set aside additional paper and pencils, as they will be introduced halfway through the activity.
- Create your own model of the paper table that you will share with students during the iteration. Make sure it is hidden so that students cannot see it until that portion of the lesson.
    − Leave space around it for learners to view.
    − Make sure the paper table is stable enough to move if needed.

Frame the Activity

Activate Prior Knowledge *(5 min)*

1. Hold a live video session with students. Tell them they are going to do an activity that looks at how we communicate information.

2. **Guiding Questions** may include:
   - *What are some situations where people need to communicate information with others or themselves?*
   - *Why do people use journals?*
   - *What are engineering journals?*
   - *How do engineering journals differ from personal journals?*

Help them think about real-world examples in their own lives as well as a broader context. For example:

- Yourself: Building a project over time
- Complex Team: Mars Mission or new cell phone launch

3. Throughout the discussion students may notice that an engineering journal is:

- A record of ideas, inventions, experiments, observations, etc.
- A "living" document that changes and grows throughout the design process.
- A source that you and others can refer to in order to understand how something works, how to build it, and why specific decisions were made.

Introduce the Challenge *(5 min)*

1. Next, share the design challenge and parameters with students.

Design Problem	Recreate the paper table design based on the "journal entry."	
Criteria	Try to make your paper table look exactly like the example.	
Constraints	You have 5 minutes. See how much you can do.	

2. Address any questions students have about the design problem, criteria and constraints.
3. Share the first Student Handout (**Challenge 1: Prototype a Paper Table**) with students.

👤 **Asynchronous Adaptation**
Send the Student Handout to students. Remind students that any paper they have at home will work.

Activity

✋ Prototype *(5 min)*

1. Remind students that the goal for this part of the lesson is to have fun and see how everyone interprets the picture, not whether they finish.
2. Before beginning prototyping, double check that all students have the materials ready.
    *   Remind students that any type or size of paper will work for this challenge, and they can work with the materials that they have at home.
    *   Give them a minute to do a scavenger hunt if needed before proceeding.
3. Set a timer and give students 5 minutes to build.

💡**Tip:** If possible, expand the build time up to ten minutes, but not longer.

4. Model the process by prototyping and talking through your decisions as you build along with them.
    *   If you were previously sharing slides on the screen, stop sharing so students can see you more clearly.
    *   Encourage them to turn on their cameras as well so they can see each other on gallery view and get ideas and encouragement as they build.
5. Since you should all be referring to the same journal entry, do not answer questions like, "How long is the side?" Instead be available for questions about how to build. *For example*:
    *   How could I make this dowel shape?
    *   Can I use tape?

> **Asynchronous Adaptation**
> *   Remind students to set a timer and stick to the 5 minutes!
>   *   *We are seeing how good the journal entries are ... not how good we are at building.*

💬 Share and Reflect *(10 min)*

1. At the end of the time limit, have students share their paper tables with the rest of the class.
    *   They can share any progress they have made, regardless of whether they have a finished prototype.
2. In addition to the techniques outlined in the asynchronous adaptation, you can also do a Gallery Walk during a live video session.
    *   Make sure you are not sharing your screen, and have students go into "Gallery View" so that they can see all of the students in the class. Have everyone turn on their cameras (without virtual backgrounds) and hold up their paper tables.
3. Next have students reflect on the process and the journal entry itself.
4. Encourage them to be critical of the information provided and think about what questions they still have and details they would have found useful.
5. **Reflection questions** include:
    *   *How similar/different is your table to the original? To other tables?*

- *What parts of the journal entry were useful?*
- *What kind of information was missing? What else would you need to know?*
  - *Think of three questions you could ask the team that created the journal entry to get that information.*

6. Have students write their responses to the reflection questions before sharing their reflections with the larger class. Options include:

   - Verbally engaging in a discussion with the larger class or with smaller break-out rooms.

   - Written reflection via group chat or tools like Poll Everywhere.

Asynchronous Adaptation
Give students directions on how to share their work and reflections. Depending on their resources, it can vary from written comments to photos or videos of their prototype.
- Options for sharing their prototype and reflections include:
  - Text messages, photos or videos
  - Shared Google Slides deck for the class. Students can add their images and comments on the sharing questions.
  - Reflections and images added to Padlet
  - Videos uploaded to Flipgrid
  - Responding to questions on a class discussion board

Engineering Journals

Brainstorm Best Practices for Journaling *(10 min)*

1. Next have students consider the purpose of journals and the ways in which engineers use written communication to document and capture their process and results.

Content Connections: Famous Journals
Show students some examples of journals by famous scientists, engineers or even other youth.
Have students compare and contrast the features of these journals.

2. Have students share their ideas in a class discussion on the live video session, via a poll, or within breakout rooms.
3. Take notes and track student ideas on a shared document during this section so that students have a resource of journaling best practices they can refer back to later.
4. **Guiding Questions** can include:
   - *What kind of information is useful for engineers to include in journals?*
   - *Who is their journal for? (ex: team members, their future selves, folks who write the manual on how to repair...)*
5. Students may notice:
   - Journals help track and remember ideas. There might be an idea early on that helps you later!
   - They provide a place for creating, brainstorming and recording inspiration.

- In order to create prototypes and tests engineers need detailed schematics with measurements and data.
- Journals document the engineering process, iteration and redesign. They show how ideas have changed and how decisions were made.
- Journals may be a collaborative tool.
  - They may be used by multiple team members on an international team.
  - They may detail a small part in a more complex device.

Ideas of what to include in an Engineering Journal

- Engineers' names and date
- What they are working on that day
  - Brainstorms and ideas
  - Notes and analysis
  - Labeled sketches and drawings of prototypes
  - Test results
  - Detailed measurements and data
  - Pros/cons on designs
  - Iterations and adjustments
- What they want to try next
- What they are proud of
- Questions they have, difficulties they are working through
- Emojis to show how they are feeling about the designs

Asynchronous Adaptation
- Have students write a short response on a shared discussion board or shared document.
- Have them send a text or email response with their ideas and compile their responses into one resource which you share with the class.

In-Person Adaptation
- Take notes during brainstorming on chart paper or the board so the class has a shared resource by the end of the discussion.

Tech Challenge Resources
- Share some or all of the **Tech Tools: Journaling Video** with your students. Although the video is targeted at teams participating in the Tech Challenge itself, it includes a number of examples of student engineering journals, tips for creating them, and shows design challenges in action.
- See the **Tech Challenge** website and the Team Guide specifically for more information on participant journals.

Journal Iteration *(20 min)*

1. Introduce the second student handout (**Challenge 2: Journal Iteration**) to students. It includes some of the information students might have said was missing from the first journal entry (ex: measurements, schematics, directions).

2. Students will then use this information to iterate and improve the *journal entry (not the paper table!)* from handout 1.
   - They should add information they thought was missing, reorganize and restructure the entry.
   - **Advanced engineers:** Have them build the paper table again and add their own details and observations to the journal entry as well.

3. Have students do their journal iteration in an asynchronous tool which they can share with you when they finish. Options include:
   - Written paper (students take photo then upload or send to you)
   - Online document

4. Before students begin, collect a few ideas from the class on what they can do to improve the journal entry.
   - Call on specific students for suggestions, or have them add ideas via group chat.
   - In addition, you can model editing and creating a journal entry on the screen (to orient them to the tool).

5. **Small Group Adaptation**: Place students in teams of 3-4 and have them create the revised journal entry together. Use break-out rooms or small-group check-ins for students to collaborate using a shared document or brainstorming tool like Jamboard or Mural.

6. Use open-ended **Guiding Questions** to support students who need help, or guide student reflection on their process.
   - *Does this information answer your three questions about the design?*
     - *If not, what else is still missing? What else would you need to know?*
   - *How can you better organize the information?*
   - *What else might you do to improve the first journal entry?*

Asynchronous Adaptation
Send students the second student handout with directions for how to share their revised journal entry using an asynchronous tool (written journal or online document).

In-Person Adaptation
1. Instead of providing Student Handout 2, show teams the prototype of the paper table which you built.
2. They can then collect the specifications from it which they would need to design their journal entry.
3. Give teams just 3 minutes to iterate the journal entry. They can write directly on the first handout, or use paper and writing utensils to create their own draft.
4. After 3 minutes, have them swap journal entries with another team and do the journal swap extension.

Extension: Journal Swap *(15 min)*
1. Have students (or teams) swap their improved journal entries with each other.
2. They should try to reproduce the prototype based on the other students' revised journal entry.
3. Tell them they cannot ask questions of the original author and should try to recreate the design as described.
   - They should not assume the author meant something if it is not explained.
4. Give students a short timeframe to do this (5-7 min), then have them peer review each other.
5. They should share:
   - Something that was helpful
   - Something they wish was included
   - Something they learned in the process

Debrief *(5 min)*

1. Briefly share a couple examples of student work with the larger class. This can be done by calling on students to share verbally, or presenting some highlights yourself with the class.
2. For a final debrief, have students consider how they will apply what they have learned to their own practice and their understanding of engineering journals.
3. **Debrief** questions can include:
   - *What was challenging about this activity?*
   - *What were you proud of?*
   - *What did you notice about engineering journals and written communication in general?*
   - *What is something you want to try in your own journaling and written communication?*

Extension: Use an Engineering Journal
If you will be using an engineering journal with students longer term, take some time to discuss the details of your expectations. Make sure students know who, what, when, where, and why they will be keeping a journal.
   - Provide a list or develop one as a class of what should be included in each journal entry. For online journals it will be useful to teach students to create a Table of Contents to navigate longer documents.
   - Encourage students to decorate the cover pages of their journals to build ownership and interest in their journal.
   - Encourage students to focus on the design process by including regular self-reflection on their innovator mindsets. Try using the template from the **Innovator Mindsets Tech Tip**.

For more information on other ways to use data collection in the classroom see our **Data Collection Tech Tip**.

Standards Connections

Next Generation Science Standards
Science and Engineering Practices Practice 8: Obtaining, Evaluating, and Communicating Information *Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.*

| Common Core State Standards		
Grade	**Standard**	**Description**
K-12	CCSS.ELA-LITERACY.CCRA.W.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
K-12	CCSS.ELA-LITERACY.CCRA.W.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
K-12	CCSS.ELA-LITERACY.CCRA.W.6	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
6-8	CCSS.ELA-LITERACY.WHST.6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
6-8	CCSS.ELA-LITERACY.WHST.6-8.2.A	Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
6-8	CCSS.ELA-LITERACY.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Vocabulary

For more tips on vocabulary and common engineering terms see our **Tech Tip: The Language of Engineering**.

- **Brainstorming:** A group discussion to generate many different ideas and draw links between them to find potential solutions.
- **Data:** Facts or information which can be used to calculate, analyze or plan how to build your device.
- **Engineering Journal:** A record of all the brainstorming, research, prototyping and other work that goes into developing a device, model, or prototype. It is a "living" document that changes and grows throughout the design process. It is a source that you and others can refer to in order to understand how something works, how to build it, and why specific decisions were made.
- **Reflection:** A thought, idea, or opinion made as a result of thinking about what you have designed or built.
- **Schematics:** A simple drawing or diagram label to show the main parts of something.

Resources and References

- **Tech Tools: Journaling video**
- **The Tech Challenge**

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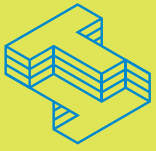
Challenge 1: Prototype a Paper Table
Ready for a little Tech Challenge fun?

Engineers, another team is sharing a journal entry of their most recent design for a paper table! Let's see if you can create your own paper table based on their notes.

Materials: You'll need some sheets of paper, tape and the Challenge 1 Journal Entry on the next page.

Ready, set, build!

1. Get your materials and set your timer for 5 minutes!
2. Use the Challenge 1 Journal Entry on the next page to try and create your own paper table.
3. Stop after 5 minutes even if you didn't finish. How much did you figure out?
4. Write down three questions for the team who created the journal entry. What else do you need to know?

Questions to ask yourself
- How similar is my paper table to the original?
- What parts of the journal entry were useful?
- What kind of information was missing? What details do you need?
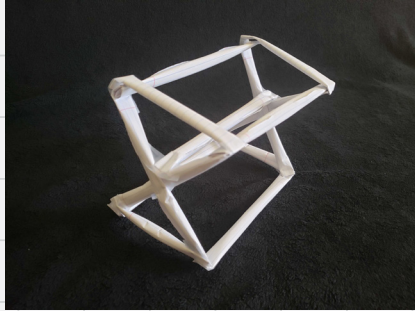
What is a prototype?
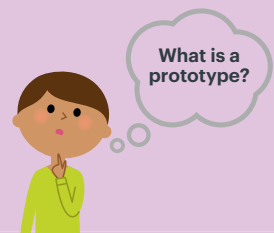
Use the space below to take notes, sketch, and reflect.
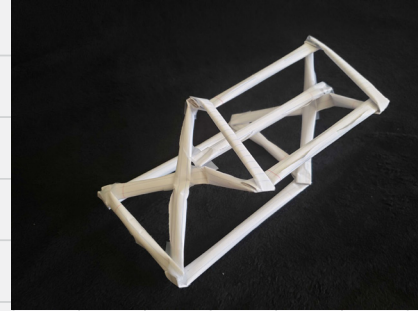
Challenge 1 Journal Entry

Version 1

We built the table from paper.

It was wobbly but stayed standing!

Version 1, Day 2

We tested by putting some books on it. The first iteration fell down!

Version 2

We made it more stable and tried again! It worked!

Our Final Design!

The Tech Challenge
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Challenge 2: Journal Iteration
Ready for more Tech Challenge fun?

Engineers, you've just received some detailed data about the other team's paper table design! It looks like they provided you with some missing information. Let's see if you can iterate and improve their JOURNAL entry from Challenge 1.

Ready, set, write!

1. Read the information in the Challenge 2 Paper Table Details on the next page.
2. Choose your materials and format. You could:
   □ Write on top of the original journal
   □ Use a blank piece of paper
   □ Try an online tool
3. Use the information to create your own journal entry.
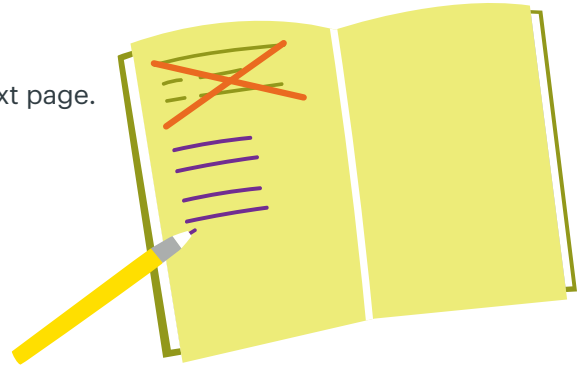
Bonus challenges

- Finished early? Share your journal entry with someone else and see if they have enough information to build the paper table themselves.
- Take it to the next level! Try to improve upon the original prototype! Build your own table and see how much weight it will hold!

Questions to ask yourself

- Does this information answer questions you asked about the design?
  – If not, what else is still missing? What else would you need to know?
- How would you improve the first journal entry?
- How can you organize the information?

What is a prototype?
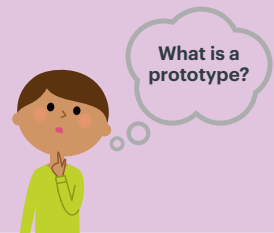
Use the space below to take notes, sketch, and reflect.

Challenge 2 Paper Table Details

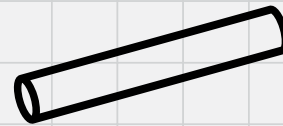Width: 8"   Height: 4 ½"   Depth: 5 ¼"

Build the top and bottom first, then the legs, and finally the diagonal cross-braces.

Rolling technique: Roll the paper into a tube
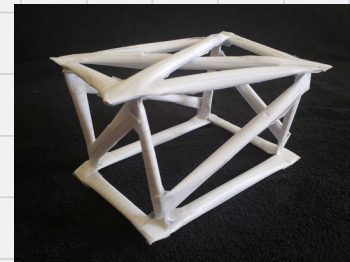
Long tubes: Roll paper on the long side

Short tubes: Roll paper on the short side

For diagonals: Tape two rolls together and cut to fit

Cross brace the table:

- Put diagonal rolls on the top and sides.
- Put the diagonal from top corner to the bottom corner of the opposite side.
- Use two rolls in the shape of an "x" on the top.

Connection Techniques:

For diagonals: Flatten the ends to tape them to the table leg

To attach table legs at the bottom, split the end of the roll and tape the split ends to the frame.

Option: Tape a piece of paper across the top to add extra support.

Test Results:

Tests	Results
1 book, approx 1 lb	Table fell down
3 books, approx 2 lbs	Table stayed up
4 books, approx 5 lbs	Table stayed up