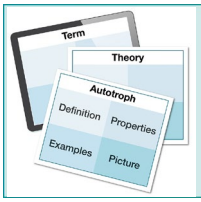

Learning Scientific Language with a Graphic Organizer

hhmi | BioInteractive

Activity
Educator Materials

OVERVIEW

Scientific language instruction can help students deepen their understanding of scientific concepts and strengthen their scientific literacy and communication skills. This activity guides students through learning and using key scientific terms (e.g., technical or specialized vocabulary), culminating in the creation of a customizable diagram that they can reference in the future. This process helps students engage with scientific language from a variety of sources, including textbooks, scientific papers, and other BioInteractive resources.

It is recommended that students learn scientific language not simply for the sake of adding to their vocabulary, but rather to leverage this language for sensemaking and deepening understanding. To this end, this and other language learning activities should occur not as isolated exercises, but rather within the context of conceptual exploration of scientific phenomena and principles. Related considerations are provided in the "Choosing Terms for Students to Learn" and "Optional Extensions/Modifications" sections.

Additional information related to pedagogy and implementation can be found on this resource's webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

- Developing multiple representations of scientific terms can build proficiency with scientific language and deepen conceptual understanding of scientific phenomena.
- Graphic organizers can be used as tools to learn, represent, and use scientific terms.

STUDENT LEARNING TARGETS

- Develop multiple representations of a scientific term.
- Connect scientific language to everyday language, prior knowledge, and science concepts.
- Create a graphic organizer to make thinking visible and present key information.

MATERIALS

- copies of the "Student Handout"
- preferred versions of the "Scientific Term Organizer" (refer to "Accessing and Customizing Materials" for info on the different versions)
- a science text (e.g., textbook chapter, scientific paper, video transcript, etc.)

TEACHING TIPS

Graphic Organizers

- Graphic organizers, like the one in this activity, are useful tools for helping students organize and develop their thoughts. They can help students break down complex ideas, better understand relationships between related concepts, and structure information within a framework.
- Using graphic organizers is beneficial for all kinds of students. This video from the Center for Inclusive Design and Innovation (CIDI) describes using graphic organizers to support students with disabilities.

- The graphic organizer in this activity is based on the Frayer Model. You may want to consult other resources on this model for more implementation ideas.

Choosing Terms for Students to Learn

- Terms may be individual words, phrases, or expressions.
- Choose terms that are relevant to your class's learning objectives and that students encounter and use in your class. There should be a clear purpose behind learning these terms — e.g., to help students make sense of and communicate about the concepts they are learning in class.
- Avoid frontloading students with a list of decontextualized terms. Introduce terms only as or after students learn the science concepts that the terms are connected to.
- Include terms that have a different meaning in everyday conversations than when used in science.
  - Some examples are "theory," "hypothesis," "culture," and "control."
  - This can also include action terms, such as "explain," "argue," or "model." In the case of "explain," for example, you may want students to recognize that a scientific explanation requires a claim supported by evidence and reasoning, whereas a nonscientific explanation may not.

Accessing and Customizing Materials

All materials can be accessed from the "Materials" box on this resource's webpage.

Parts 1–3 of the **"Student Handout"** have students go through multiple ways to explore and represent a scientific term, which is helpful for building their understanding.

- You can customize the "Student Handout" to add, remove, or emphasize certain items.
- An editable version of the handout is provided in the Google Docs format in the "Resource Google Folder."

Part 4 of the "Student Handout" asks students to fill out a **"Scientific Term Organizer"** template.

- The default template has space for three items from the "Student Handout" (not including the "Term"/Item 1 and "Definition"/Item 3). If students want to add more items, you can modify the template to have more sections or have them use multiple templates for the same term.
- Students can also make their own versions of the template by dividing a sheet of paper or slide into sections.

Different versions of the template and filled-out examples can be downloaded from the "Materials" box. The versions are:

- **Cards:** Intended for flashcard activities. Cards are more portable and easier to use for regular review, as they can be used in activities where students practice recalling the terms (e.g., by shuffling and drawing from a deck of cards).
  - The card templates are provided as PDFs. You can print out blank templates and have students fill them out by hand. Or students can fill out the template on a computer, then print it out.
  - Two types of card templates are provided:
    - **Double-sided:** Four cards per page. Print them using double-sided printing, using the "flip on the short edge" option if available. Cut along the dashed lines to separate the cards.
    - **Single-sided:** Two cards per page. Print them using single-sided printing, then fold them in half down the middle (so that the large box is on one side and the small boxes are on the other). Cut along the dashed lines to separate the cards.
- **Poster:** Intended for displays and presentations. The poster template has more space for students to add their own content than the cards do.

- The poster template is provided as a PDF. You can print out blank templates and have students fill them out by hand. Or students can fill out the template on a computer, then print it out.

- **Slides:** Intended for online use. Slides can be updated more easily than printed materials. They can also be printed out if desired.
  - Two types of slide formats are provided:
    - **PowerPoint:** Can be downloaded from the "Materials" box.
    - **Google Slides:** Can be copied from the "Resource Google Folder."
  - The slide files contain some filled-in examples, which can be deleted if needed before distributing to students.

You can direct students to use a specific version of the template if the entire class needs to use the same format. Or you can let students use whichever version of the template they prefer.

PROCEDURE

Below is an example procedure for using this activity with a resource of your choice. You can modify this procedure or develop your own based on your classroom context.

1. Ask students to read through the resource that you selected, underlining or highlighting terms that are new to them. They should make a list of these unfamiliar terms.
   a. If the resource is long, you may want to assign different students to different sections.
   b. Alternatively, skip to Step 3 below if you already have a list of terms.
2. Organize students into groups of two or three to compare the terms on their lists.
3. Help students decide which terms are **"must know" terms**, meaning that these terms are important to know for the lesson or class.
   a. Considerations for choosing which terms to learn are provided in the "Choosing Terms for Students to Learn" section above.
4. Have each group of students divide the "must know" terms among members of their group.
5. Distribute copies of the **"Student Handout"** and "**Scientific Term Organizer"** template to each student.
   a. You may want to customize the handout and organizer beforehand to add or remove sections. More information on customizing materials is provided in the "Accessing and Customizing Materials" section above.
   b. Students will need one copy of the handout and organizer per term. For multiple terms, provide multiple copies of paper handouts, or instruct students on how to make copies of the digital files (e.g., copy-and-paste slides).
6. For each of their assigned terms, have students follow the instructions in **Parts 1–3** of the "Student Handout" to learn about the term and strengthen their understanding. You may want to model this process or provide examples for students.
7. Have students follow the instructions in **Part 4** of the handout to fill out a "Scientific Term Organizer" template. Again, you may want to model how to complete the template or provide examples for students. In brief:
   a. In the **"Term"** section, write the scientific term.
   b. In the **"Definition"** section, write a definition for the term using everyday language. Students may consult references, such as online sources or textbooks, but should *not* copy definitions from the references; they need to write the definition in their own words. The goal is for students to have a definition that they understand and can explain to their classmates.

c. For the **three** remaining sections, select three items from Parts 1–3 of the "Student Handout" to add. You can specify which three items you want students to use, or you can let them choose the three items that were most helpful for their own understanding.
d. Two examples of completed organizers are shown below.
   i. For the three extra sections, this example used "Properties" (Item 4), "Examples" (Item 8), and "Picture" (Item 10) from the "Student Handout."

SCIENTIFIC TERM ORGANIZER

Autotroph	
Definition	Properties
An organism that makes its own food.	• Makes food using sunlight (photosynthesis) or chemical energy. • Eaten by other organisms (heterotrophs). • Are producers in food webs.
Examples	Picture
• Plants • Algae • Bacteria	

   ii. For the three extra sections, this example used "Properties" (Item 4), "Examples" (Item 8), and "Non-Example" (Item 9) from the "Student Handout."

SCIENTIFIC TERM ORGANIZER

Theory	
Definition	Properties
A broad explanation for a lot of different observations in the natural world.	• Backed by a lot of evidence. • Accepted by the scientific community. • Never shown to be false. • Can still change with new evidence.
Examples	Non-Example
• Theory of evolution by natural selection • Germ theory • Cell theory	Different from how we use "theory" in everyday conversation to mean "guess." "My theory is that the exam will be really easy."

8. Have students share their organizers with each other, encouraging different groups to compare their work for terms they have in common. Students should discuss and revise their organizers as needed.
9. Have students practice using the new scientific terms they have learned for sensemaking of scientific concepts. For example, students could:
   a. Pick several related scientific terms and use them to construct an explanation.
   b. Use the terms to reexplain concepts that they previously described without those terms.

   c. Reflect on how the terms may allow them to communicate some scientific concepts more effectively.

10. Encourage periodic review and assessment by having students revisit these terms throughout your class.
    a. Students can use their organizers to regularly self-assess and review the terms. For example, they could print the cards out to use as flashcards while studying.
    b. Ask students to revise or expand their organizers as they learn more. For example, students could add more detailed definitions or new/updated representations.
    c. Keep a collection of the organizers for the class, which students can use for reference. Students who worked on specific terms could also be the "go-to" experts for future questions on those terms.

OPTIONAL EXTENSIONS/MODIFICATIONS

You can customize the handout, organizer, or procedure above to incorporate additional components, such as the following:

- **Support individual learning.** The procedure above takes a group-oriented approach to learning. If your students are uncomfortable with groupwork or have varied learning goals, you could have them engage in more individual work. For example, students could:
  - Create their own set of organizers for all the "must know" terms, which they can more fully customize (e.g., adding additional sections or personal examples) to support their own learning needs.
  - Create additional organizers for other scientific terms they would like to learn, in addition to the "must know" terms.
  - Develop the organizers as optional study aids, rather than as part of a required class activity.
- **Connect to other knowledge.** Have students further explore how the scientific term connects to their personal knowledge. In addition to the items in the "Student Handout," students could, for example:
  - Create **concept maps** to connect the term to other words they know or have recently learned, which helps build associations and familiarity with new terms. They can diagram their maps on paper, use sticky notes, or use online tools such as Google Jamboard or Miro's mind map feature.
  - Develop **analogies** relating the term to other concepts/terms. To help students develop complete analogies, you may want to provide some guidance or scaffolding, such as a structured analogy map (example from BSCS: "I Can Develop an Analogy Map").
  - Add **more translations** of related concepts in other languages that they are more familiar with.

Additional strategies to support students as they encounter scientific language include the following:

- **Clarify what students should focus on early.**
  - At the start of a lesson or activity, share the learning objectives with students. Ask students to focus on addressing these objectives, rather than on memorizing terms.
  - Provide students with a short list of specific terms they *will* be expected to know and use in class (if any).
- **Help students access information about the terms.**
  - Share a glossary of the key scientific terms for students if needed.
  - Indicate places where students can find more information about the terms that they will encounter — for example, an online science dictionary, a glossary in a textbook, selectable words or links in a Click & Learn, etc.
- **Implement other strategies for helping students learn scientific language as needed.** For example:
  - **Teach content before terms.** Have students first engage with science content using their current "everyday" language, then expand their linguistic repertoire with the science terms later on. For example:

- First, have students describe the science concepts using everyday language that they are familiar with. Then, introduce the science terms and have students connect them to the everyday language they were previously using. Finally, have students reexplain the concepts using the science terms.
- For more information, refer to Brown 2019 and Brown and Ryoo 2008.

- **Create a word wall or word catcher** for scientific terms that students are using over time. This is a collection of terms in a visible place, such as on a classroom wall, to which students may refer and add new terms.
  - You may want to generate the collection using the Collect and Display routine. Begin by recording the initial language that students use (e.g., in oral discussions). Organize and display their language in a place that students can reference, build on, and update throughout your class, especially as they begin using science terms. This can provide a bridge between students' prior language and new scientific language.
  - For online environments, you could create a word wall/catcher using slides or a virtual bulletin board such as Padlet.
- **Encourage students to continually practice explaining their ideas** about science and scientific terms. Repeated practice can help students build stronger language skills.
  - For example, students could practice explaining and using scientific terms by writing, talking with peers, making an audio or video recording, etc.
  - Provide multiple opportunities for students to encounter, use, and build on their understanding of the same terms.
  - More ideas and routines for making student thinking visible are provided on Project Zero's Visible Thinking page.

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