

I Can

Develop a Scientific Explanation

Teacher Edition

Teachers often ask students to form conclusions and to write explanations about phenomena in science. And often, teachers are disappointed in the students' work. Research has found that students have difficulty differentiating between appropriate and inappropriate evidence for some tasks. Their difficulty is often their inability to determine what data count as evidence. Difficulty continues for students as they struggle to use reasoning to connect scientific principles to the evidence they use to support their claim.

The explanation tool gives students the framework to build scientific explanations that include evidence and reasoning to support their ideas—a hallmark of scientific reasoning. You can use this tool anytime you ask students to use their own data, or data that they have gained from other sources, to form conclusions or state a claim. This tool is based on work done by Kuhn and Reiser (2006), McNeill and Krajcik (2007), and Rosenshine and Meister (1994).

Using the Explanation Tool

Each part of the explanation tool is described in the student version of this I Can. Read the steps to make sure you understand what should be included in each part of the tool. You may notice that the “your claim” part comes after the “evidence” and “reasoning” parts. For teachers who are accustomed to teaching students to write scientific explanations using claim, evidence, and reasoning, this may seem strange. The reason for putting the claim in this location is to help emphasize to students that the claim must be based on evidence and reasoning. Scientists do not make a claim, and then look for evidence to support it; rather they begin with a question or a problem to solve and then conduct investigations. Some of the data they collect will help them answer the question or solve the problem. These data become the evidence that they use, along with reasoning, to formulate a claim that will answer the question or address the problem. When you use this tool, there may be times when students already have the evidence and the first task you want them to do is to make a claim. Do not let the structure of the tool force you to use it in only one way.

Reasoning is the most difficult part of writing a strong scientific explanation. And it may be the most difficult for you to teach. Modeling both strong examples of effective reasoning and examples of explanations that lack reasoning is a good way to teach students about reasoning. Reasoning is the link that connects the evidence to the claim.

The first important part of reasoning is the logical way in which students present their rationale. Students should describe why the data they are using support their claims. The second part of reasoning is using appropriate scientific principles. Students should use appropriate scientific principles in their rationale. A strong scientific explanation uses appropriate scientific principles to justify that the evidence supports the claim. However, you may want students to begin constructing explanations from their experiences before they have learned the related scientific principles. In this case, an explanation that is logical and relates the students' experiences to the claim is acceptable.

Use this tool to help students organize their work so that they can create a strong and convincing scientific explanation. As your students become more proficient in generating scientific explanations, they may not need to use the tool and can develop strong and convincing scientific explanations on their own. The goal for using the tool is to provide a scaffold for students to form habits of mind that include all the key elements for developing a scientific explanation.

You will likely use the explanation tool in many ways with your students. Included here are suggestions for introducing the tool to your students as well as for using this tool with students.

- **Model the first use of the explanation tool with your students so that they know your expectations.** Do a “think-aloud” as you fill in a tool; use a classroom demonstration or a collection of class data so that students can hear your thought process as you complete the tool. Seeing you complete a tool and hearing your thought process will help students know what you expect when they are completing the tool.
- **Have realistic expectations of your students.** Do not expect your students to be able to complete the entire tool in detail or to write complex explanations when they first begin to use the tool. English language learners may have marked difficulty with this task. Scaffold the use of the tool by filling in some of the parts first or initially working through the tool as a class. This will help all students build their understanding of writing evidence-based explanations.
- **Insist that students draw the tool, with column headings, in their science notebooks rather than you distributing it as a handout.** Physically writing the category words as headings helps students develop their classification skills. These skills, along with developing explanations, are a concept independent of the context of the activity they are working on—they are skills and understandings that will prove valuable in all their course work. In addition, extra handouts distract from the formative value of students' science notebooks by decreasing the continuity of the ongoing record of each student's learning.
- **Demonstrate how to map explicitly the contents of each part to its appearance in the final scientific explanation.** Don't assume students understand how the information in the parts of the tool is connected in a grammatically correct fashion. Demonstrate how to write the explanation, but only until students show a reasonable ability to write the summary statement on their own.

- **Assess students' ability to complete the explanation tool, both formatively and summatively.** Initially you may have students complete only parts of the tool, such as the “evidence” and “your claim” parts. Formatively assess your students' ability to identify appropriate and sufficient evidence that helps answer the question. Students will likely struggle with reasoning and using scientific principles in their explanations. At this early stage, you may want to construct the final explanation as a class. As your students become proficient at this skill, ramp up the complexity by asking students to complete this part individually. Ultimately, the goal is to guide students to construct explanations without using the tool.
- **Realize that students are likely to collect data and evidence that are contrary to an accepted claim.** Students will demonstrate the true inquiry goal that this explanation tool encourages if they can interpret their data and connect their evidence to their claims—even if these are not the accepted claims. Through class discussion or feedback from you or their peers, these students may collect new data and revise their claims. Encourage students to describe and explain any revisions or new data.
- **Modify or revise the tool to meet the needs of your class.** The individual needs of your classroom activities may dictate that you rearrange the parts on this tool and complete the process in a different order. Sometimes the question or the evidence is given, and students must use reasoning and write the explanation. Do not think of this tool as a rigid structure that you must follow precisely for every situation. Rather, think of this tool as a template to help your students organize their ideas. Adapt the tool to meet the needs of your students.

Adapting the Explanation Template Tool

Some adaptations and extensions for this tool are described below.

- **Include the focus question for the activity in the explanation tool.** Some activities include focus questions to guide students' work. These focus questions may be broader than the question that students are trying to answer for the investigation. You may want to have students include the focus question in the tool in addition to the question they are attempting to answer.
- **Ask students to complete an additional tool that highlights an alternative claim or their revised claims.** An example is shown in figure T1.

Evidence	Reasoning
The reason I chose one claim over the other is _____.	

Figure T1: Alternative explanation template.

Use this form of the template to organize alternative explanations.

- **Include a tool that has students list any evidence that does not support the students' claims.** An example is shown in figure T2.

Evidence against my claim	Reason I still think my claim is valid

Figure T2: Evidence that does not support a claim.

Use this form of the tool to acknowledge evidence that might not support a claim and to give reasons why students still think the claim is valid.

References Kuhn, L., & Reiser, B. (2006). Structuring activities to foster argumentative discourse. Paper presented at the *American Educational Research Association*. San Francisco, CA.

McNeill, K. L., & Krajcik, J. (2007). Instructional strategies to support students writing scientific explanations. In J. Luft, J. Gess-Newsome & R. Bell (Eds.). *Science as inquiry in the secondary setting*. Washington, DC: National Science Foundation.

Rosenshine, B., & Meister, C. (1994). Reciprocal teaching: A review of the research. *Review of Educational Research*, 64(4): 479–530.