Scientific Explanations

What Is a Scientific Explanation?

Scientific explanations are student responses, either written or orally presented, that explain scientific phenomena based upon evidence. Developing a scientific explanation requires students to analyze and interpret data to construct meaning out of the data. There are three main components to the scientific explanation: the claim, the evidence, and the reasoning.

Why Use Scientific Explanations?

There are four primary reasons for using the scientific explanation in the classroom. First, scientific explanations present a real world way of working as scientists do. Scientists make explanations to communicate their thoughts and what they have learned through experimentation. When scientists make explanations they make claims about the natural world as well as the evidence and reasoning to support those claims. When students develop scientific explanations they too are communicating ideas about the natural world in the same way that scientists do. Secondly, the development of scientific explanations may help to change and refine students’ image of science and scientists as well as enhance student understanding of the nature of science. A third reason for using scientific explanations is that they develop deeper student understanding of science content. Finally, scientific explanations make student thinking visible to the teacher in terms of their understanding of both process and content.

About Scientific Explanations

There are three main sections to a scientific explanation: the claim, the evidence, and the reasoning. A brief synopsis of each section is listed below.

Claim: This is a testable statement or conclusion that answers the problem or question. The claim is often the simplest part of the explanation for students to both identify and formulate.

Evidence: This data helps to answer the question or problem that the students are examining. Data can come from a variety of sources such as investigations (both numeric and observational data), text, archived data, and video. The key to evidence is that it must be both appropriate and sufficient. Appropriate signifies whether the data that is used supports the claim. A good scientific explanation only uses data that supports the claim. The term sufficient in this case refers to whether there is enough data to support the claim.

Reasoning: This is the justification that shows why the data is relevant and should be used to support the claim. Students should look to include reasoning, scientific principles, and vocabulary in this section. Students should use their own background knowledge in order to link the claim to the evidence.
Teaching Scientific Explanations

As mentioned above, scientific explanations involve students working and acting as real scientists. As a part of this process the explanation centers on a question or problem that must be answered. The most common time for students to develop scientific explanations is during the Explain phase of the 5E Instructional Model.

The questions that students answer can arise from a variety of different places. Teachers are encouraged to help students develop their own questions (guided inquiry), but it is sometimes useful for teachers to provide the questions to students (directed inquiry). A good starting place for teachers to find questions for students to answer is in each model lesson. Assign groups a specific essential question and then have students share their explanation with the class.

After students have a question to answer (they have either been provided a question or they have developed their own), they should seek out data (evidence) that answers that question. Data can come from investigations (numeric and/or observational), text, and video. Data is this case is simply information that helps to answer the question. Students should be reminded during this time that the data should be appropriate and sufficient to answer the claim.

**Misconception Alert:** It is often believed that students should formulate a claim before they obtain data. This is grounded in the belief that the claim is similar to a hypothesis. During a Scientific Explanation students are not formulating a hypothesis; instead they are organizing their thoughts around a specific question or problem by examining data, interpreting data, and applying reasoning and scientific principles and vocabulary.

After collecting the data students should make a claim. The claim is an assertion or conclusion that answers the question that the student in examining. The claim should explain how the data relates to the question or problem. Finally, students should formulate the Scientific Explanation. Students should provide a justification that uses reasoning to link their claim to the evidence that they found. Included in this justification should be the reasons that the data is relevant to the question or problem, a description of how the data can be used to support the claim and appropriate scientific principles and vocabulary.

**Instructional Hint:** To make this process a bit easier for students to see, try explaining it to them in this manner: Explanation = Claim + Evidence + Reasoning. Viewing it in this manner provides students a clearer path to write the explanation. Help students understand that when they write a scientific explanation they should restate their claim and then use reasoning, scientific principles, and vocabulary to link the evidence to the claim that they had made.

Supporting the Construction of Scientific Explanations

There are several instructional items that teachers should keep in mind when helping students construct scientific explanations.

1. Teachers should make the framework for creating a scientific explanation explicit. Teachers should be sure that students have a deep understanding of the three components of the scientific explanation: the claim, the evidence, and the explanation. The student version of the scientific explanation provides this framework for students.
2. Teacher should discuss the rationale behind scientific explanations. Students should not only know what a scientific explanation is, but also why they are used. Teachers also have the opportunity here to explain that a claim unto itself is not convincing or persuasive. Instead, providing evidence and reasoning creates a stronger case for a claim.
3. Teachers should model the construction of scientific explanations. After introducing scientific explanations, the teacher should model the construction of a scientific explanation as well as the though process behind the creation. When modeling this process, teachers should not only model the writing process but also talk through the thinking process with students. This helps to build metacognition in students and provides them insight to how scientists think.

4. Teachers should discuss the similarities and differences between everyday explanations and scientific explanations. Teachers should point out that in everyday life people try to convince others of claims that they make. Teachers can point this out through the use of musicians and athletes in the advertising industry. Teachers can show how claims that these people make can use evidence and reasoning. It is important to note here that although scientific explanations and everyday explanations can look similar they generally are not.

5. Teachers should provide multiple opportunities for students to construct explanations. These opportunities should include scientific explanations developed from investigations (Virtual Labs, Hands-On Activities, and Hands-On Labs), as well as using the text and video to answer the essential questions in a given model lesson (reading comprehension). These various opportunities allow for the scientific explanation to be used as a check for understanding.

6. Teachers should provide opportunities for students to critique other explanations through the peer review process. When teachers lead their classes through this process they should remind students to focus on the strengths and weaknesses of others observations. Students should provide each other concrete suggestions for improvement.

7. Teachers should provide students with explicit and thorough feedback. Teachers should comment on the explanation as a whole as well as the individual components: the claim, the evidence, and the explanation. While explicit feedback is necessary teachers should take this opportunity to coach students on improvements to their scientific explanations.