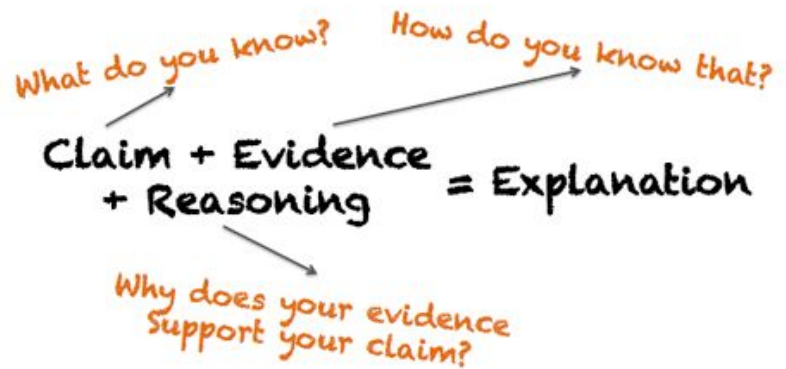# How to Write a Scientific Explanation Using C-E-R

Components
- Make a _claim_ about the problem.
- Provide _evidence_ for the claim.
- Provide _reasoning_ that links the evidence to the claim.

What do you know? How do you know that?

Claim + Evidence + Reasoning = Explanation

Why does your evidence support your claim?

Definitions
- **Claim**: A conclusion that answers the original question.
    - A one-sentence answer to the question you investigated.
    - It should describe the relationship between the variables.
- **Evidence**: Scientific data that supports your claim. Can come from an investigation, observations, reading material, archived data, etc. Must be:
    - _appropriate_ (use only relevant data that supports your claim)
    - _sufficient_ (use enough evidence to support the claim)
- **Reasoning**: Explains how the evidence supports the claim and makes a logical connection between the evidence and the claim, using appropriate scientific principles (rules, laws, or definitions).

Qualities of Communication
Write the explanation so others can understand it.
- ✓ Use precise and accurate scientific language.
- ✓ Write clearly so that anyone interested in the explanation can understand it (correct spelling, grammar, and punctuation).
- ✓ Explain your logic to help share your knowledge.

Explanation Tool Layout

The Question: _Initial question based on an observed phenomenon or situation._	
Our Claim: _Your claim is a statement that expresses the answer or conclusion to the question._	
Our Evidence: _Your evidence should always include collected data (qualitative and/or quantitative)._	**Reasoning (Justification):** _Your justification explains why the evidence supports the claim. Provide a logical connection between the evidence and claim._

Claim - Evidence - Reasoning Rubric

	0	1	2
Claim	Does not make a claim, or makes an inaccurate claim.	Makes an accurate but vague or incomplete claim.	Makes an accurate and complete claim.
	0	1	2
Evidence	Does not provide evidence or only provides inappropriate evidence.	Provides appropriate but insufficient evidence to support claim or also includes some inappropriate evidence.	Provides appropriate and sufficient evidence to support the claim.
	0	2	4
Reasoning	Does not provide reasoning or only provides reasoning that does not link evidence to the claim.	Repeats evidence and links it to some scientific principles, but not sufficient.	Provides accurate and complete reasoning that links evidence to the claim. Includes appropriate and sufficient scientific principles.

Examples of Claim, Evidence, and Reasoning (in order of increasing complexity)

Example 1

The Question: *What do plants need to grow?*	
Our Claim: *The plant that received more light grew taller.*	
Our Evidence: *The plant with 24 hours of light grew 20 cm. The plant with 12 hours of light only grew 8 cm.*	**Reasoning (Justification):** *Plants require light to grow and develop. This is why the plant that received 24 hours of light grew taller.*

Comments: This example provides a simple claim that focuses on one variable that plants need to grow— light. The example provides evidence to support the claim from an experiment that focused solely on comparing plants that received 24 hours of light with those that received 12 hours. The actual data is **not complex**; rather, it is limited to support the sense-making process and in writing the scientific explanations. The reasoning is also fairly simple, but it is **a good start** at thinking about why data counts as **evidence** to support the claim.

Example 2

The Question:	
What do plants need to grow?	
Our Claim:	
The plant that received more light grew more.	
Our Evidence: *On average, for the six plants that received 24 hours of light, they grew 20 cm, had six yellow flowers, had fifteen leaves, and they were all bright green. On average, for the six plants that received 12 hours of light, they grew 8 cm, had two yellow flowers, and had four leaves. Also, two of the plants had zero flowers. These plants were still bright green, but they were smaller and with fewer flowers and leaves*	**Reasoning (Justification):** *Plants require light to grow and develop. This is why the plant that received 24 hours of light grew more.*

Comments: The claim is still limited to focus on light, but the scientific explanation example now includes multiple pieces of evidence. Furthermore, the evidence includes both **quantitative measurements** (e.g., average height, number of flowers, and number of leaves) and **qualitative observations** (e.g., color of flowers and leaves). Obviously, the data collected in this case was more complicated and required greater analysis before the group could construct their initial claim.

Example 3

The Question:	
What do plants need to grow?	
Our Claim:	
Plants need water, carbon dioxide, and light to grow.	
Our Evidence: *On average, for the six plants that received constant light, carbon dioxide, and water, they grew 20 cm, had six yellow flowers, had fifteen leaves, and they were all bright green. On average, for the six plants that received 12 hours of light, limited carbon dioxide and water, they grew 8 cm, had two yellow flowers, and had four leaves. Also, two of the plants had zero flowers. These plants were still bright green, but they were smaller and with fewer flowers and leaves.*	**Reasoning (Justification):** *Photosynthesis is the process during which green plants produce sugar from water, carbon dioxide, and light energy. Producing sugar is essential for plant growth and development. That is why the plants that received a constant source of water, carbon dioxide, and light grew the most.*

Comments: This example becomes more complex in that the group has decided to investigate **multiple variables** that impact plant growth. This question requires a greater **understanding of the science concepts** related to plant growth and that water, carbon dioxide, and light are necessary for photosynthesis to occur. Not only does the reasoning become more complicated, but the claim that the group is justifying has also become more complex.

Like Example 2, this group uses **specific** quantitative and qualitative **evidence** in order to support the claim.

The Mystery of Mr. Xavier

You and your partner are private detectives who have been hired to investigate the death of the wealthy but eccentric Mr. Xavier, a man who was well known for his riches and for his reclusive nature. He avoided being around others because he was always filled with anxiety and startled easily. He also suffered from paranoia, and he would fire servants whom he had employed for a long time because he feared they were secretly plotting against him. He would also eat the same meal for dinner every night— two steaks cooked rare and two baked potatoes with sour cream.

Upon arriving at the tragic scene, you are told that the servants found Mr. Xavier dead in his home early this morning. The previous evening after the chef had prepared the usual dinner for Mr. Xavier, the servants had been dismissed early to avoid returning home during last night's terrible storm. When they returned in the morning, Mr. Xavier's body was found face down in the dining room.

Looking into the room, you start your investigation. The large window in the dining room has been shattered and appears to have been smashed open from the outside. The body exhibits laceration wounds and lies face down by the table, and there is a large red stain on the carpet that emanates from under the body. An open bottle of red wine and a partially eaten steak still remain on the table. A chair that has been tipped over is next to the body, and under the table is a knife with blood on it. Due to his paranoid nature, Mr. Xavier always had Kurt Wagner, the butler, lock all doors to the mansion at night. However, detectives found that the back door had in fact been left open. Detectives found that the chef, Robert Drake, had been the last employee to leave that night. When questioned, Mr. Drake stated that the doors are supposed to lock behind him when he leaves. In addition, a bottle of medication for high cholesterol was discovered in the medicine cabinet. Also, the carpet in the dining room was wet. With this information, come up with a single claim and supporting evidence that explains how Mr. Xavier died.

Your Name:

| The Question: |
| How did Mr. Xavier die? |

| Our Claim: |

| Our Evidence: | Reasoning (Justification): |