

Scientists and engineers develop evidence-based explanations and communicate findings, conclusions, and proposed solutions. This resource addresses the development and justification of scientific explanations and engineering design solutions as a means for engaging respectfully in argumentation using applied scientific explanations and empirical evidence.

Reasoning and argument are essential for identifying the strengths and weaknesses of a line of thought, the best explanation of a phenomenon, or the best solution to a problem.

Scientists and engineers-

- develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories,
- communicate explanations and solutions individually and collaboratively in a variety of settings and formats, and
- engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

Claim-Evidence-Reasoning (CER) is a typical discussion structure used by scientists and engineers to engage in collaborative discussions with peers (other scientists and engineers). The CER process enables scientists and engineers to provide well-organized, evidence-based explanations that include logical reasoning. While both scientists and engineers use the CER structure, they use it for different purposes. Scientists tend to focus on asking questions and analyzing patterns while engineers tend to focus on solving problems.

CER Purpose and Structure

CER is a structure used in science and engineering, but with a different focus.

Purpose of CER - Scientists

Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Scientists use their reasoning to convince the scientific community of the accuracy of their data and understanding of the world. Scientists collaborate to develop and defend their explanations using evidence based on a preponderance of data.

Purpose for CER - Engineers

Engineers collaborate with their peers through the design process, evaluating others' solutions and justifying their own using the design criteria and evidence. Engineers use their reasoning to persuade customers that their design is the best and most cost-effective.

Claims

A claim is a proposed answer to a scientific question or design problem.

Scientists

Scientists make an assertion that addresses the original question or problem. This statement often includes a conclusion about a scientific phenomenon that has occurred. The statement takes the form of a conclusion and addresses questions that are not easily answered with a simple yes or no.

Engineers

Engineers make a statement about a solution to a design problem. The statement takes the form of a conclusion related to the solution's function, cost-benefit relationship, and degree of effectiveness in relation to the problem.

Evidence

The evidence supports the accuracy of the claim and includes data points, observations, or a summary of data. Multiple sources are used to support the evidence.

Scientists

Scientists gather evidence and data relevant to the claim through scientific investigation. There must be enough evidence to support the accuracy of the claim. This evidence may be quantitative or qualitative.

Engineers

Engineers gather evidence and data relevant to the claim through the engineering design process. There must be enough evidence to support the accuracy of the claim statement. This evidence may be quantitative or qualitative.

Reasoning

The reasoning connects the claim and the evidence logically. This justification explains why the claim is reasonable.

Scientists

Scientists connect the claim with the evidence they gathered. They justify their reasoning through the support of evidence and the application of scientific principles.

Engineers

Engineers connect the claim with the evidence they gathered. They justify their reasoning through the support of evidence and the application of scientific/engineering principles. A persuasive tone is used to convince a customer that the design is the best and most cost effective.

Example CER Format:

Scientific Question or Engineering Design Problem:

A testable scientific question or engineering design problem

Claim:

A statement with a response to the question or problem.

Evidence:

The evidence is information, measurements, or observations in a scientific investigation. Evidence for a design product includes results from testing in the form of data, graphs, or diagrams that support the claim. Typically, three pieces of information are presented when communicating through CER.

Reasoning:

Justification or argument showing how the evidence and scientific/engineering principles support the claim.