



## Middle School Students and Science Writing: Supporting Claims with Evidence and Reasoning

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### Overview of Session



- Critique examples of student writing
- Discuss importance of scientific explanations and argumentation
- Use rubrics to assess students' writing
- Observe videoclips from science classrooms

### Context: 7th Grade Chemistry Unit



- Substances and Properties
  - Describe observable properties of fat and soap.
  - Determine the density, solubility, and melting point of fat and soap.
  - Key learning goal - Different substances have different properties
- Chemical Reactions
  - Investigate three different chemical reactions, boiling, and mixing.
  - Use molecular models to explore whether new substances are produced.
- Conservation of Mass
  - Investigate if mass changes in chemical reactions.
  - Use molecular models to explore why mass is conserved during chemical reactions.



### Activity: Critique Students' Writing



- Examine the two students' explanations
- Questions:
  - How would you assess these responses?
  - What are the strengths of each example?
  - What are the weaknesses of each example?

## What are Explanation and Argumentation?

- **Explanation**

- *make sense* of how or why a phenomenon occurred
- Examples:
  - Explain why the biodiversity decreased
  - Explain what has happened to the pitch of bird song in cities

- **Argumentation:**

- *Defend or support* knowledge claims through evidence, warrants and backing
- Examples:
  - Argue for your explanation for why the biodiversity decreased
  - Argue for your experimental design to study what is happening to the biodiversity



## Importance of Scientific Explanation and Argumentation

- Science is about explaining phenomena
- Stressed in the science education standards
- Students should generate and evaluate scientific evidence and explanations
- Change students' image of science
- Enhance students' understanding of the nature of science
- Foster deeper understanding of important science concepts



## National Science Standards

- Present a brief scientific explanation orally or in writing that includes a claim and the evidence and reasoning that supports the claim. (AAAS, 12D/M6\*\*)
- Notice and criticize the reasoning in arguments in which the claims are not consistent with the evidence given (AAAS, 12E/M5b\*)
- *Inquiry and the National Science Education Standards* (NRC, 2000)
  1. Engaging in scientifically-oriented questions
  2. Giving priority to evidence
  3. Formulating explanations from evidence
  4. Connecting explanations to scientific knowledge
  5. Communicating and justifying explanations.



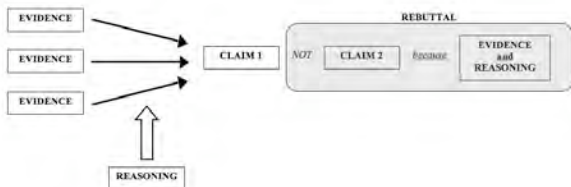
## CER Framework

*Adapted from Toulmin (1958)*

- **Claim**
  - a conclusion about a problem
- **Evidence**
  - scientific data that is *appropriate* and *sufficient* to support the claim
- **Reasoning**
  - a justification that shows why the data counts as evidence to support the claim and includes appropriate scientific principles
- **Rebuttal**
  - describes alternative explanations and provides counter evidence and reasoning for why the alternative is not appropriate.



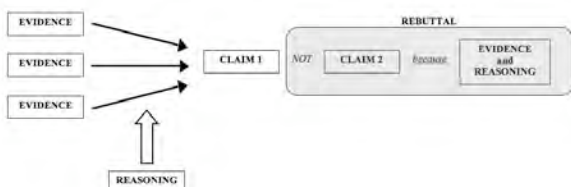
## CER Framework Adapted from Toulmin (1958)



## Chemistry Example

Liquids 1 and 4 are the same substance.  
(Claim) They both have a density of .93 g/cm<sup>3</sup>, have no color, and start to melt at -98 C. (Evidence) Density, color and melting point are all properties while mass is not a property. For substances to be the same, they must have the same properties. Since Liquids 1 and 4 have the same properties, they are the same substance. (Reasoning)

## CER Framework Adapted from Toulmin (1958)



## Activity: Assessing Students' Writing

- Examine student example and record responses to the questions below on the chart paper.
- Assess student explanation
  - Using the rubric, how would you assess this student's response in terms of - claim, evidence and reasoning?
- Provide feedback and strategies
  - What feedback would you provide this student? Why would that feedback be helpful?
  - What strategies might you use to help this student construct a stronger explanation?

## Base Rubric

	Claim	Evidence	Reasoning	Rebuttal
	<i>A statement or conclusion that answers the original question/problem.</i>	<i>Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.</i>	<i>A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.</i>	<i>Recognizes and describes alternative explanations, and provides counter evidence and reasoning for why the alternative explanation is not appropriate.</i>
0	Does not make a claim, or makes an inaccurate claim.	Does not provide evidence, or only provides inappropriate evidence (Evidence that does not support claim).	Does not provide reasoning, or only provides inappropriate reasoning.	Does not recognize that alternative explanation exists and does not provide a rebuttal or makes an inaccurate rebuttal.
VARIABLES	Makes an accurate but incomplete claim.	Provides appropriate, but insufficient evidence to support claim. May include some inappropriate evidence.	Provides reasoning that connects the evidence to the claim. May include some scientific principles or justification for why the evidence supports the claim, but not sufficient.	Recognizes alternative explanations and provides appropriate but insufficient counter evidence and reasoning in making a rebuttal.
FORM 1 to 5	Makes an accurate and complete claim.	Provides appropriate and sufficient evidence to support claim.	Provides reasoning that connects the evidence to the claim. Includes appropriate and sufficient scientific principles to explain why the evidence supports the claim.	Recognizes alternative explanations and provides appropriate and sufficient counter evidence and reasoning when making rebuttals.

## Activity: Assessing Students' Writing

- Examine student example and record responses to the questions below on the chart paper.
- Assess student explanation
  - Using the rubric, how would you assess this student's response in terms of - claim, evidence and reasoning?
- Provide feedback and strategies
  - What feedback would you provide this student? Why would that feedback be helpful?
  - What strategies might you use to help this student construct a stronger explanation?

## Providing Students Feedback

- What to Comment on:
  - Components of the explanation - claim, evidence, and reasoning
  - Science content of explanation
  - Holistic quality of explanation
- How to Comment:
  - Explicit and clear feedback
  - Point out strengths and weaknesses
  - Provide suggestions on how to improve
  - Ask questions to promote deeper thinking

## Teaching Strategies

1. Discuss the framework →
2. Connect to everyday examples →
3. Provide a rationale →
4. Connect to other content areas →
5. Model and critique examples →
6. Provide students with feedback →
7. Have students engage in peer critique →

## Conclusion

- Make the framework explicit (claim, evidence and reasoning)
- Use rubrics to evaluate student writing
- Provide students with feedback
- Incorporate multiple teaching strategies in your classroom instruction



## Contact Information

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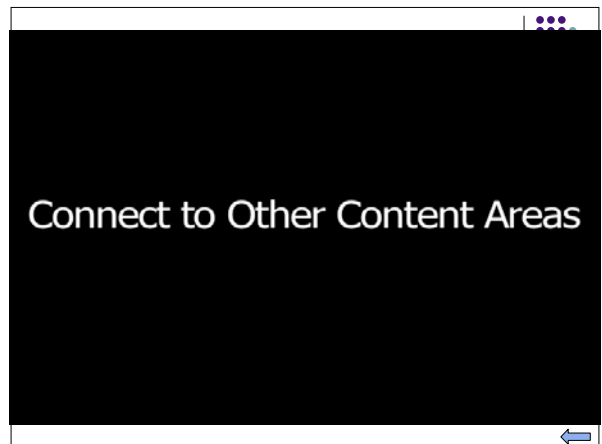


Hyperlinked Slides



Discuss the Scientific  
Explanation Framework





Model and Critique  
Examples

Providing Students  
With Feedback

Have Students Engage  
in Peer Critique