# Arguing to Learn - Candle Investigation

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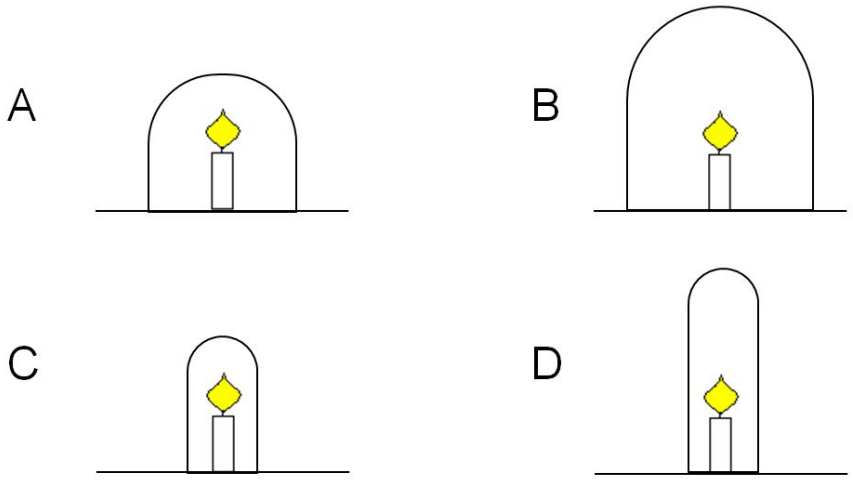
# School Context and Lesson Tryout

- DSS Co-ed EMI School
- Lesson tryout in S2 Science
- Topic: Candle Investigation

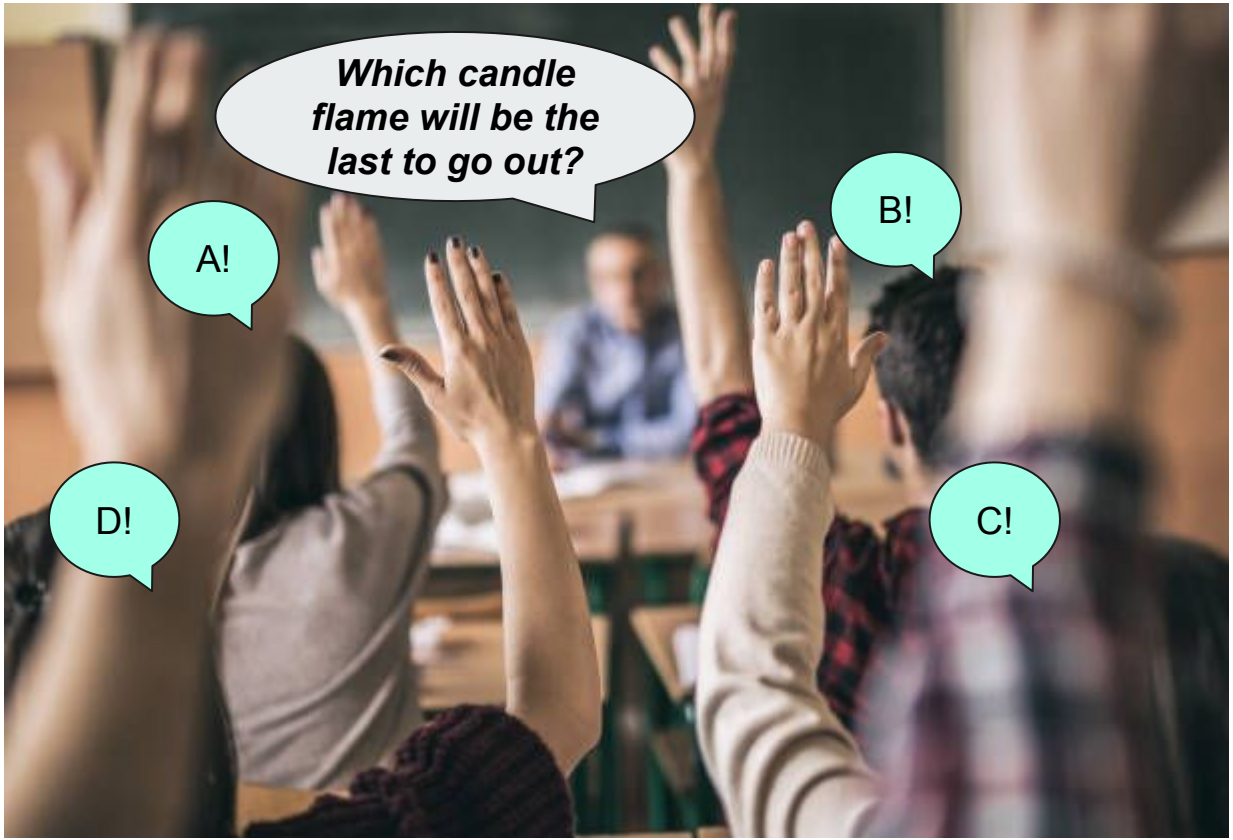
# Part 1:
# Promoting reasoning in science dialogue

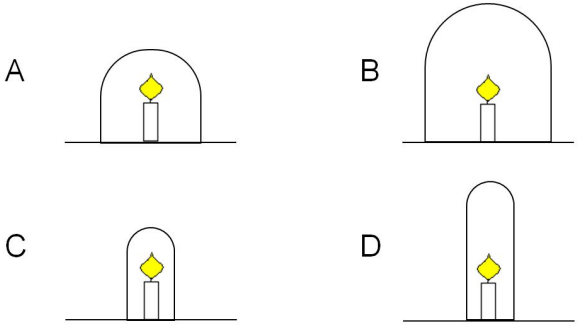
# Entry ticket

The pictures below show four identical burning candles.
Each is covered by a glass container of a different size.
Which candle flame will be the **last** to go out?




Reference:
TIMSS 2007 Science Items



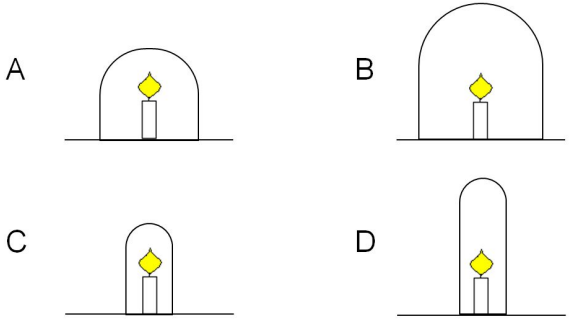

Are students' **claims** supported?

What scientific **evidence** is involved during students' decision making?

Can students **justify** their answers with evidence?

# Transcript 1

**Asking students to provide reasons for their claim**




T: Everyone thinks that it's B? OK… why? Raise your hand.

S2: Larger capacity for oxygen.

T: Larger capacity for oxygen…can you elaborate more about capacity?

**Encouraging students to further explain**

S2: The container of the larger size contains more oxygen.

T: OK, can we stop at here? So larger container… and can we have S3 elaborate more on…

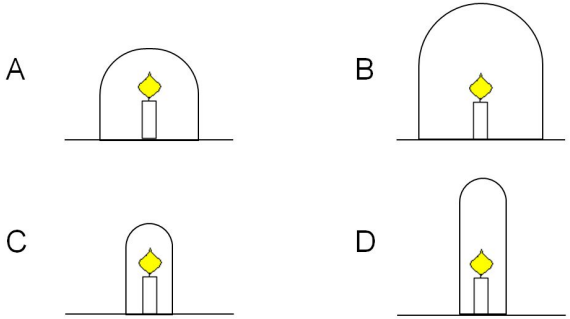
**Inviting students to explain other's idea**

S3: Coz like there is a fire triangle…

T: Fire triangle.. so

S3: Yeah… but then so there has to be fuel, oxygen…. and heat… then it has like a similar fuel, and similar heat, and then there is more air so that means B is more… B can burn long.

# Transcript 1




T: Everyone thinks that it's B? OK… why? Raise your hand.

S2: **Larger capacity for oxygen**.

T: Larger capacity for oxygen…can you elaborate more about capacity?

S2: The container of the larger size contains more oxygen.

T: OK, can we stop at here? So larger container… and can we have S3 elaborate more on…

S3: Coz like there is a **fire triangle**…

T: Fire triangle.. so

S3: Yeah… but then so **there has to be fuel, oxygen…. and heat**… then it has like a **similar fuel, and similar heat**, and then there is **more air** so that means B is more… **B can burn long**.

| Claim | Evidence | Reasoning |
|---|---|---|
| **B will be the last to go out** | **B has a larger capacity**<br>**Fire triangle: fuel, oxygen and heat** | **A, B, C, and D have similar fuel and heat, but B has larger capacity and thus more oxygen, so it will be the last to go out** |

# Remarks

| Claim | Evidence | Reasoning |
| --- | --- | --- |
| B will be the last to go out | B has a larger capacity for oxygen<br>Fire triangle: fuel, oxygen and heat | A, B, C, and D have similar fuel and heat, but B has more air (oxygen), so it will be the last to go out |

- Students generally are able to try supporting their claim with guidance
- Evidence may not be relevant
- Justification may not be convincing

# Part 2:
# Introducing the CER framework

# Claim, Evidence, Reasoning (CER)

- **Claim**
  - A statement that expresses the answer or conclusion to a question or a problem.
- **Evidence**
  - Scientific data that support the claim.
  - Data are information such as observation or measurements from controlled experiments or secondary data.
  - It needs to be sufficient and appropriate.
- **Reasoning**
  - Justifications that link the evidence to the claim.

# Warm-up activity: introducing CER

The table below describe some properties between fat and soap:

| | Colour | Hardness | Solubility | Melting Point | Density |
|---|---|---|---|---|---|
| ***Fat*** | Slightly yellow | Soft | Water – no<br>Oil – yes | ~ 37 °C | 0.92 g/ $cm^3$ |
| ***Soap*** | Milky white | Hard | Water – yes<br>Oil – no | Higher than 100 °C | 0.84 g/ $cm^3$ |

Write a **scientific explanation** stating whether fat and soap are the same substance or different substances.

# Transcript 2

| | Colour | Hardness | Solubility | Melting Point | Density |
|---|---|---|---|---|---|
| ***Fat*** | Slightly yellow | Soft | Water – no<br>Oil – yes | ~ 37 °C | 0.92 g/ $cm^3$ |
| ***Soap*** | Milky white | Hard | Water – yes<br>Oil – no | Higher than 100 °C | 0.84 g/ $cm^3$ |

Claim

S4: I think they are different substances because for colour, hardness, solubility, melting point, and density… they are all different. And some of them… for example, melting point, they are having very big difference.

Reasoning

T: OK, so your claim is that they are different substances. As I am trying to adopt this framework. What about S5, did you hear what S4 just said?

S5: Em… she said…

T: You heard what S4 just said right? So can you try to ***highlight the evidence or reasoning*** provided by S4?

S5: Her evidence… is the table.

Evidence

**What are the C, E, and R from S4?**

# Transcript 2

| | Colour | Hardness | Solubility | Melting Point | Density |
|---|---|---|---|---|---|
| ***Fat*** | Slightly yellow | Soft | Water – no<br>Oil – yes | ~ 37 °C | 0.92 g/ $cm^3$ |
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T: The table is the evidence… how? ***Why is it the evidence?***

S5: ***The table shows the color… and how hard…….***

T: OK, that means the color, hardness, solubility…this table… all the information is the evidence. ***So, what is her reasoning?***

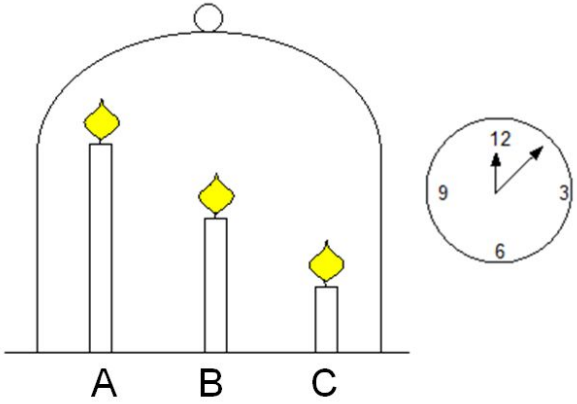
S5: Her reasoning…? ***Those information… color… hardness… are different.***

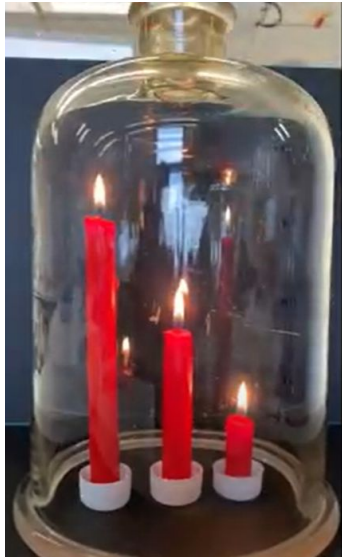
**May ask students to construct explanations based on CER/ identify CER from others**

# Part 3:
# Arguing with the CER framework

# Main task: Candle Investigation

## Which candle(s) will go out first?



**POE (Predict, Observe, and Explain)**

**+**

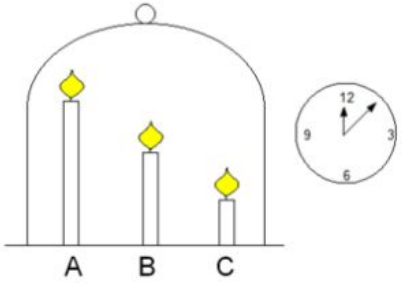
**CER (Claim, Evidence, and Reasoning)**

# Evidence cards

| | | |
|---|---|---|
| ① Burning requires fuel. | ② Burning requires oxygen. | ③ Burning consumes oxygen and produces carbon dioxide. |
| ④ Carbon dioxide is denser than air. | ⑤ Carbon dioxide puts out fire. | ⑥ Hot gas floats and cold gas sinks. |
| ⑦ Burning of candle produces water. | ⑧ Burning gives out heat. | ⑨ Burning requires high temperature. |

**Task 1: Candle Investigation I (evidence cards)**

Which candle(s) will go out first?




| | | |
|---|---|---|
| ① Burning requires fuel. | ② Burning requires oxygen. | ③ Burning consumes oxygen and produces carbon dioxide. |
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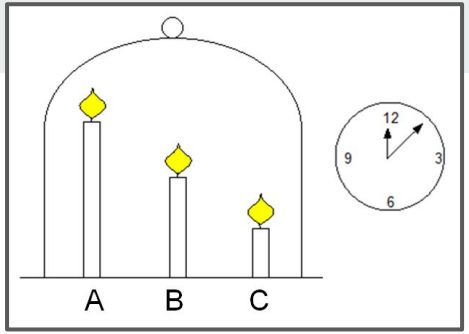
| ⑦ Burning of candle produces water. | ⑧ Burning gives out heat. | ⑨ Burning requires high temperature. |

| Group | Claim | Evidence (ONE to THREE only) - just write the number(s) to save time | Reasoning |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

# Student work

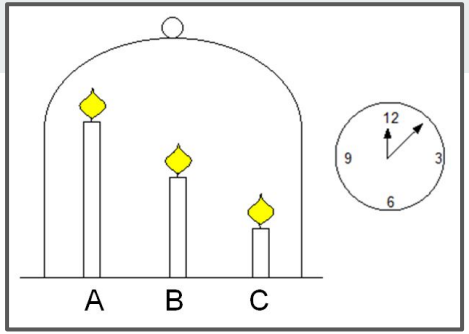



**Reasonable C, E, and R**

| Group | Claim | Evidence (ONE to THREE only) - just write the number(s) to save time | Reasoning |
|---|---|---|---|
| 1 | Candle C will go out first. | 1,3<br>① Burning requires fuel.<br>③ Burning consumes oxygen and produces carbon dioxide. | 1. As there is the same amount of oxygen and heat, fuel is the only element in the fire triangle that will affect the speed of burning. The more fuel that the candle has, the longer it will last. Candle C has less wax (which means less fuel) it would go out first.<br>2. Since Candle C is shorter compared to others, it would have less wax to burn and therefore go out the quickest. |

**No consideration in products of burning and density of gases**

# Student work




**Correctly predicted the results with appropriate evidence**

| Group | Claim | Evidence (ONE to THREE only) - just write the number(s) to save time | Reasoning |
|---|---|---|---|
| 5 | Candle A will go out first | 3, 5, 6 | because the hot carbon dioxide is increasing at the higher part of the jar which makes it put out the fire according to their height, starting from the tallest to the shortest. |

| ③ | ⑤ | ⑥ |
|---|---|---|
| Burning consumes oxygen and produces carbon dioxide. | Carbon dioxide puts out fire. | Hot gas floats and cold gas sinks. |

**No explicit explanation about how evidence 6 supports the claim**

# Arguing to learn

Claim — Evidence — Reasoning

- **Selection of evidence:**
  - Relevance?
  - Sufficient?
  - How strong is the evidence?
- Use of evidence in **reasoning**
- Use of evidence for **rebuttal**

| | | |
|---|---|---|
| ① Burning requires fuel. | ② Burning requires oxygen. | ③ Burning consumes oxygen and produces carbon dioxide. |
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| ⑦ Burning of candle produces water. | ⑧ Burning gives out heat. | ⑨ Burning requires high temperature. |

# Summary

- CER can be explicitly taught by providing examples for students to ***identify*** **Claim, Evidence and Reasoning** in an argument
- Encourage students to ***construct, evaluate, and critique*** arguments with CER
- Provide opportunities for students to apply ***higher order thinking skills*** and appreciate the ***nature of science*** through scientific argumentation
- Enhance students' skills of answering explanation type questions in ***assessments***

# Thank you!

Please feel free to find me at:

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