Argumentation and Learning

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The ambiguity of the terms "Argumentation" and "Learning"

The two terms have multiple meanings.

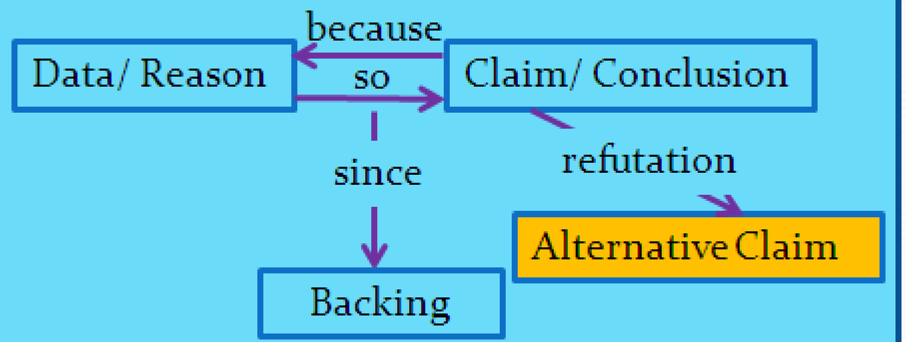
Can you think of meanings of "learning" in educational contexts?

Some of the meanings of the term "Argumentation"

"Argumentation is a verbal and social activity of reason aimed at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rational judge" (Van Eemeren et al, 1996, p.5).

The argument as a knowledge structure

The **argument** includes a claim or a conclusion relying on data or reasons :



"The aim of argumentation is not to deduce consequences from given premises; it is rather to elicit or increase the adherence of the members of an audience to theses that are presented for their consent" (Perelman & Olbrechts-Tyteca, 1958/1969)

“Arguing to Learn” and “Learning to argue”

Andriessen and Baker (2003) made a fundamental distinction:

“Arguing to Learn” is an activity in which participants aim at (or are told to) learn about an issue by arguing about it

“Learning to Argue” is an activity aimed at learning the rules of the argumentative game

A myriad of research possibilities

- Co-elaborating an argument, Trying to Convince each other about own viewpoints, Arguing together to comprehend a difficult issue or to Solve a Problem, Discussing to decide about a moral dilemma, are some of the interesting activities that belong to "Argumentation and Learning"

But is this myriad of possibilities worth the effort?

- Argumentation may comply with the dialogical vision
- Argumentation may comply with the collaborative vision
- Argumentation may comply with the vision of critical reasoning

Worthwhile

How is it possible to study "learning to argue"?

Studying “arguing to learn”: a basic methodological challenge

Pre-test

↓

Invitation to argue

↓

Dialogue (argumentative or not)

↓

Post-test

An example of post-hoc study showing the benefits of argumentation

Conceptual change about decimal numbers:

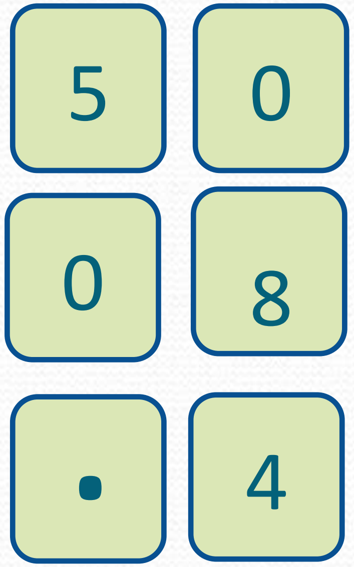
The six-cards task was specifically designed to encourage argumentation in dyads. Six cards containing the digits 0, 0, 5, 8, 4, and a decimal point were presented to the student or students. The goal was to use all cards to construct:

- 1. The biggest possible number
- 2. The smallest possible number
- 3. The number closest to one
- 4. The number closest to one half

Dyads had a calculator at disposal

Schwarz, B. B., Neuman, Y. & Biezuner, S. (2000). Two "wrongs" may make a right...If they argue together! *Cognition & Instruction*, 18(4), 461-494.

An example of post-hoc study showing the benefits of argumentation



Ve35: The numbers after the period go smaller. 458 is smaller than 854 and because of that my number is smaller.

Si36: If you take a pie and you divide it into 458 parts, every part will be larger than if you divide by 854. You have 458 parts and I have 854 parts, so I have more parts than you do. So mine are smaller than yours are.

Ve37: I don't know. [She takes the calculator. She multiplies 0.458 by 10 and obtains 4.58. She multiplies 0.0854 by 10 and obtains 0.854.]

Ve38: Yours is less but I don't understand! Why?

Si39: I have 854 thousandths and you have 4,580 thousandths. So mine is smaller because the two are thousandths.

An example of controlled study showing the benefits of argumentation

- Asterhan, C. S. C. & Schwarz, B. B. (2007). The effects of monological and dialogical argumentation on concept learning in evolutionary theory. *Journal of Educational Psychology*, 99(3), 626-639.
- Asterhan, C. S. C. & Schwarz, B. B. (2009). Argumentation and explanation in conceptual change: Indications from protocol analyses of peer-to-peer dialogue. *Cognitive Science*, 33, 374-400.

Study 1: Dyads

app. 1.5 hrs

1) Individual pre-test

2) Instructional movie

Control
(n=19 dyads)

3) Dyadic collaboration

Argumentati
(n=19 dyad

4) Individual immediate post-test

5) Individual delayed post-test
(one week)

Experimental condition: eliciting peer argumentation

1) Prior to interaction:

- verbal instructions to engage in critical, dialectical dialogue
- procedural prompts (e.g., Can you explain why a certain solution is better?)

2) During interaction:

Example of dialogue excerpt (four turns) from hypothetical dyad:

solution – request for clarification – elaborated solution - challenge

Model of argumentative dialogue

A: Then the ducks had to change their feet so that they could swim. The area was flooded with water, and because of the new environment webbed feet developed.

B: What do you mean “developed”? How did that happen?

A: Hmmmm. In the beginning they did not know how to swim. But slowly they learned to do it and that caused some sort of development in their feet. I mean, webs developed between their fingers. And that’s how it was passed on to the next generation.

B: Well, if that were true, then Olympic swimmers should also develop webbed feet, since they also swim all day long!

Assessing evolutionary understanding

Example of a test item:

Ducks have webbed feet. Thousands of years ago, the ancestors of the current ducks lived mostly in dry lands and their feet were similar to those of current pigeons or chickens. It is also known that as a result of global warming and consequent sharp increases in the amounts of rain, the living areas of these proto-ducks became mostly flooded. Given these data, how would evolutionary theory explain the change that occurred in the duck's feet (to their current shape of webbed feet)?

Coding evolutionary understanding

- Quality of conceptual understanding – assess underlying explanatory schemas (Ohlsson, 1996):

  10 qualitatively different schemas, each assigned to one of 6 different hierarchical categories (grade 0-5)

  - *Conceptual understanding* (average grade on specific test occasion)
  - *Conceptual change* (dichotomous: yes/no)

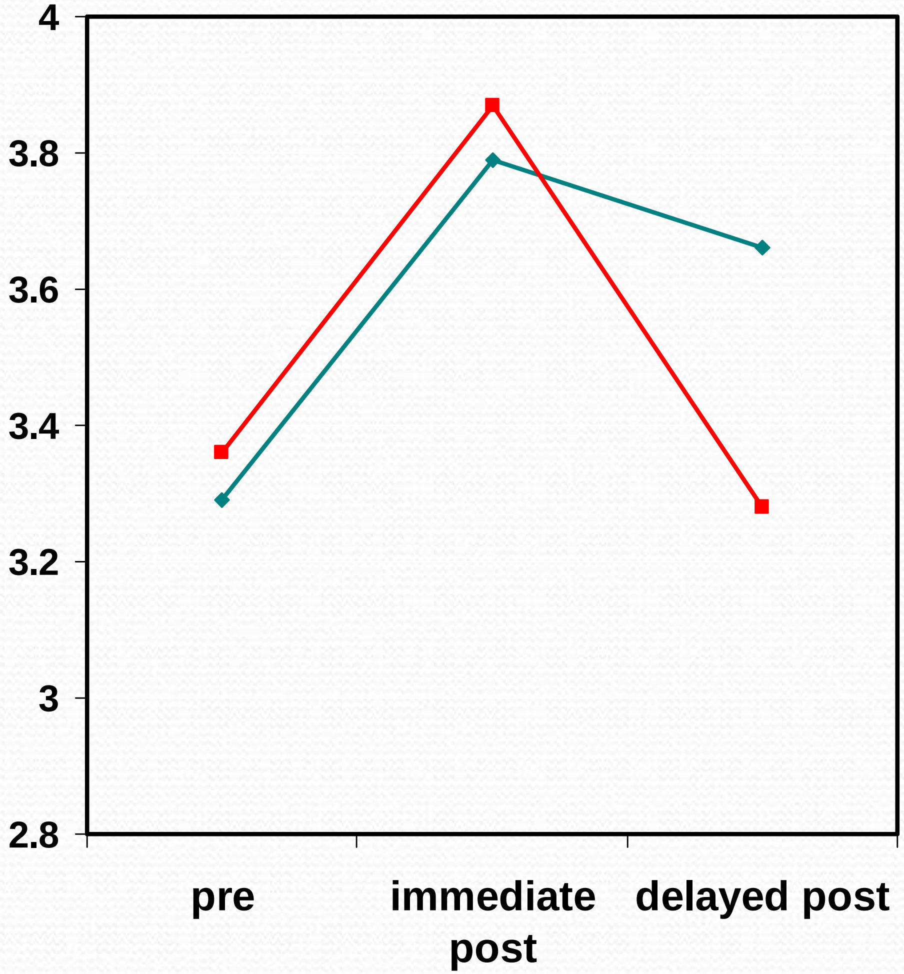
- Number of discrete Darwinian principles that students explicitly applied (none, partially correct, correct)

Statistical analyses

- "Problem" of interdependency: Individual assessment but collaborative intervention phase. What should be the appropriate unit of analysis??
- Statistical solution: All analyses on continuous variables were performed while controlling for pretest performance and nested effects (individual within dyad)
- Control variables: dyads in experimental and control conditions did not differ on:
  - extent of collaboration,
  - mentioning correct solution in course of interaction
  - discussion length.

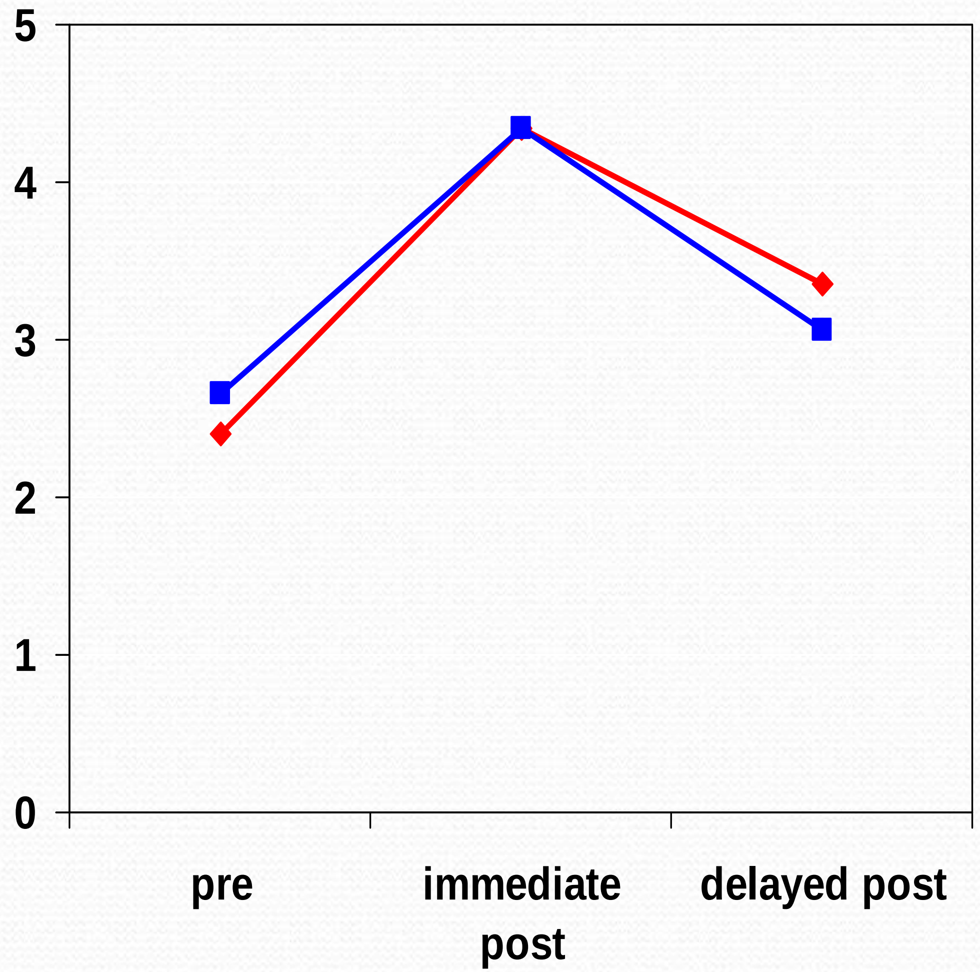
Results study 1: Quality of explanations

- Overall learning gains: experimental > control (η^2=.073)
- Patterns of learning: Preserved gains vs. temporary gains
- Conceptual change: advantage for experimental condition



Results: Discrete Darwinist principles

- No differences between conditions
- Only immediate gains



Does argumentation lead to superior processing?

- Different patterns of learning
- Correct answer mentioned – not related with learning
- No gains on piecemeal knowledge (principle score), but only on quality of conceptual understanding (explanatory schemas)

Arguing to learn: the importance of the norms of the domain

- Arguing in science is considered as one of the most important activities to be fostered in classrooms (Driver, Newton, & Osborne, 2000). It is generally integrated in inquiry-based activities
- Arguing in mathematics is also considered as one of the most important activities to be fostered in classrooms (Arzarello, 2008; Boero, 2008; Inglis & Ramos, 2009). It should precede proving
- Argumentation in history is now fostered after reading and evaluating multiple texts (Goldberg, Schwarz & Porat, 2011)

Argumentative Design

- Research has shown that productive argumentation is very difficult to emerge but that its emergence leads to deep gains
- Importance of design for:
- Arranging initial cognitions
- Providing proper tools timely (multiple texts, hypothesis testing devices, feedback, etc.)
- Proper instructions (scripts, Fischer, Stegmann, & Wecker, 2013; Weinberger, Ertl, Fischer, & Mandl, 2005). before group work
- Structuring peer argumentation during argumentation

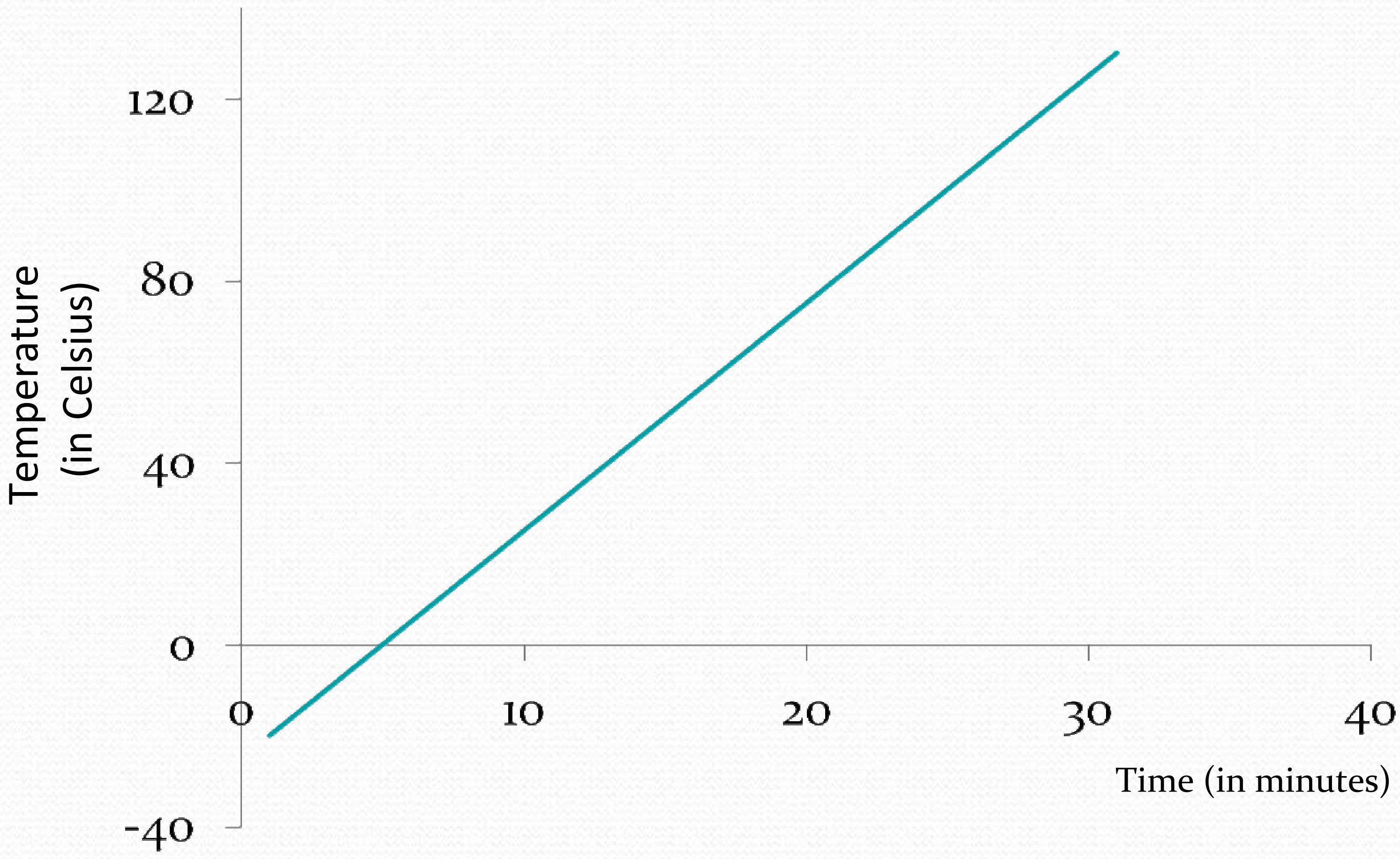
Andriessen, J. E. B. & Schwarz, B. B. (2009). Argumentative Design. In N. Muller-Mirza and A.-N. Perret-Clermont (Eds.), *Argumentation and Education – Theoretical Foundations and Practices* (pp. 145-174). Springer Verlag

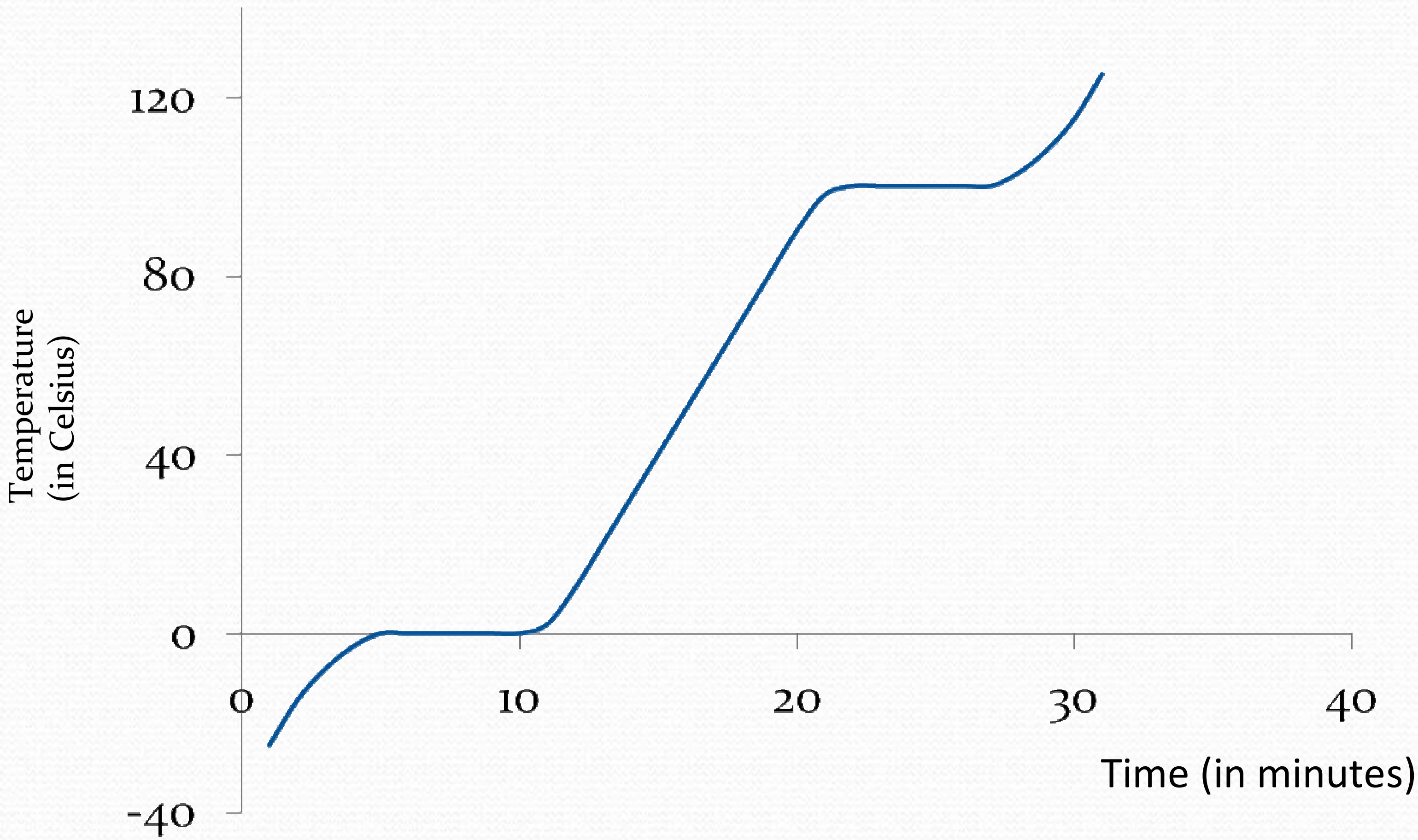
An example of task design in science education

A block of ice is uniformly heated in a closed container

How does the graph of the water (in whatever state it is) look like?

Chin, C. & Osborne, J. (2010). Supporting Argumentation Through Students' Questions: Case Studies in Science Classrooms. *Journal of the Learning Sciences*, 19(2), 230-284


Temperature
(in Celsius)
120
80
40
0
-40
0
10
20
30
40
Time (in minutes)


Temperature (in Celsius)
120
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0
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0
10
20
30
40
Time (in minutes)

Different kinds of designs lead to different outcomes

- When asking students to choose one of the graphs, then to discuss in small groups their divergent answers, no learning was detected
- When giving a list of additional facts, no learning followed small group argumentation
- When students were encouraged to list questions about the graphs, small group argumentation was found productive

List of additional facts

- Ice will melt when it is heated and turns into water
- In solids there are bonds between the particles that hold them together in fixed shape
- When you heat a substance the supply of heat energy is usually constant
- Energy is needed to break bonds between particles
- Ice melts at 0o C and boils at 100o C
- Whilst energy is being used to break bonds between particles then there will be no temperature change
- When substances are heated the particles in them absorb heat energy and move about more quickly

Use the following questions as a guide as you work through this activity. You do not have to ask or answer every question. Use only those that will help you to figure out your answer.

Observing	**What do I notice here?**	What changes are there (from the beginning, through the transitions, to the end)?
Comparing	**What are the similarities and differences between A and B?**	How are A and B similar?
Analysing Relationship between variables	**What are the variables involved here? What pattern or trend do I see here?**	What is the relationship between the variables?

Scaffolding scientific questioning

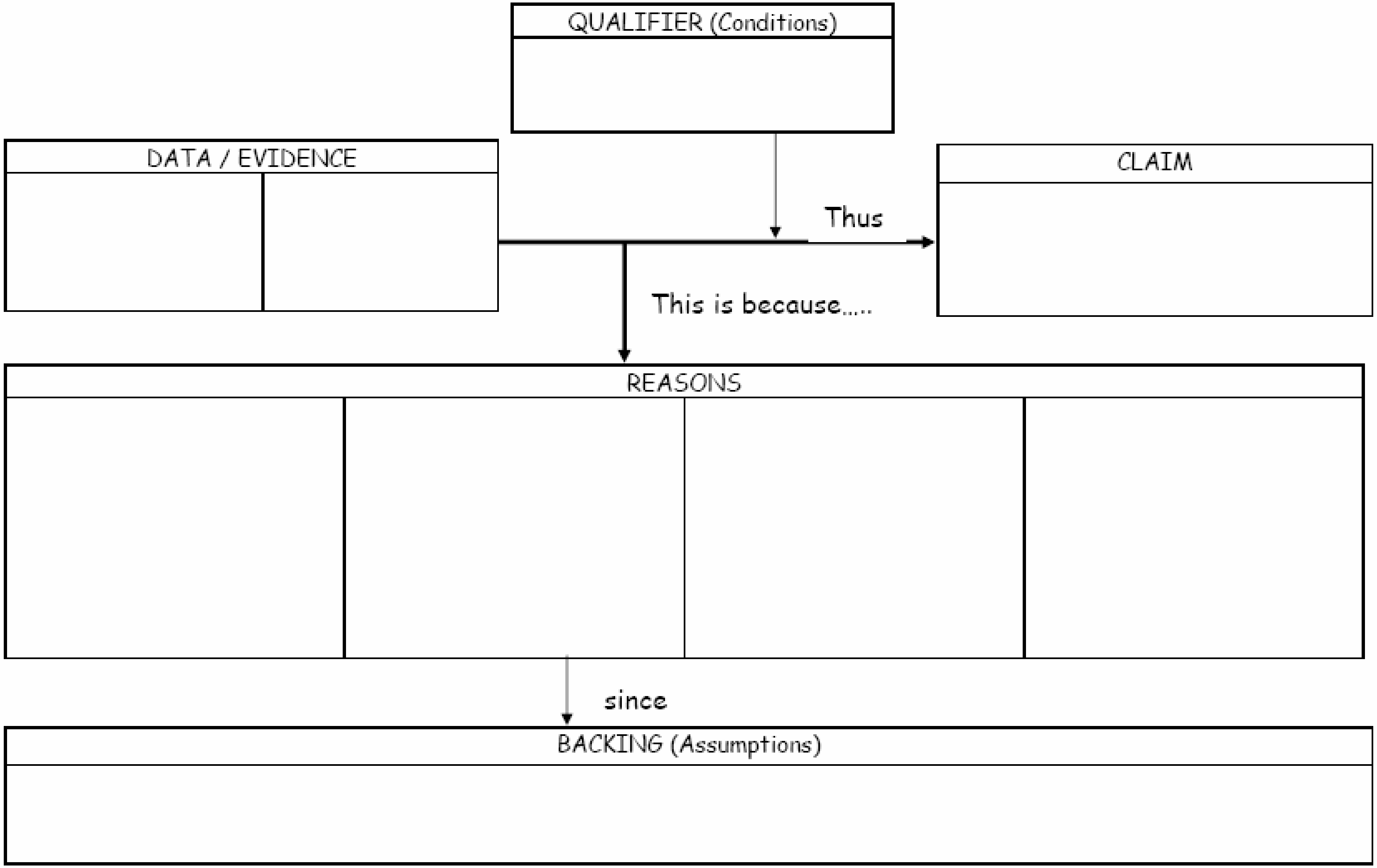
Raising questions	**What questions do I have about this?**	Is there anything that I am puzzled about?
Predicting	**What would happen if .....?**	
Explaining	**What is my explanation for how this happens?**	What are some possible reasons for .....?
Justifying	**What is the evidence to support my view?**	
Evaluating	**Which is the better graph? Why?** **Are there any exceptions or conditions under which this would not be true?**	Which evidence statement is relevant to my argument?

Scaffolding the construction of a scientific argument

Which graph is most likely to show how the temperature of water changes as it heats up?

Our claim / belief	We think that the graph most likely to show how the temperature of water changes as it heats up is graph A / B (circle one) …..
Data / Evidence	Our evidence for this is …..
Reason	This evidence supports our idea because ….. We do not think that graph A / B (circle one) is correct because …..
Counter-argument	Someone might argue against our idea by saying that …..
Rebuttal	If someone does not agree with us, we would convince him / her by …

Further Scaffolding of the Construction of a Scientific argument according to the Toulmin model



Ways to evaluate the quality of Arguments

Type of argument	Code	Description
1	AC	A simple *claim* without justification or grounds versus another claim or counterclaim.
2	AG+	One or more claim(s) with justification or *grounds* (comprising data, warrant, and/or qualifier and backing) but no rebuttal.
3	AG++	One or more claim(s) with more *detailed* justification or grounds (comprising data, warrant, and/or qualifier and backing) but no rebuttal.
4A	AG+RA	One or more claim(s) with justification or grounds, and with a *rebuttal* that addresses a weakness of the opposing argument and/or provides further support for one's earlier argument.
4B	AG+RS	One or more claim(s) with justification or grounds, and with a *selfrebuttal* that considers the limitation or weakness of one's own argument.

With this multiple scaffolding some groups of students could participate in productive argumentation

R: I agree with you in this part… when you take it [ice] out of the fridge, it's below 0°C…. *I want to know why one period in graph B, right, the temperature is just constant….*

X: At the 100°C point?….

J: At the boiling point…. Perhaps, the boiling is in progress.

R: Yeah, the boiling is taking place….

X: *But I'd need to know if the water is placed in a … pot with a cover on it?*

R: With or without cover.

X: Yeah, open or without cover. Because with the cover, then heat will not escape. Heat will enter the pot, into the water. But then when the heat wants to escape, it wouldn't escape so easily. So the heat must be converted into some other form. So the water may increase to a higher temperature.

With this multiple scaffolding some groups of students could participate in productive argumentation

R: Okay, what do you think, Jiahao?....

X: Jiahao, *are you still supporting A or are you supporting B? Or neither A nor B?*

J: I am at the point of changing my position…

X: To?

J: B, but not so fast.

R: Okay. Yeah, me too, because I'm kind of convinced but not really, really in a sense convinced. Because, as the paper states, energy is being used to break bonds between particles. Then there will be no temperature change. But the problem is the temperature is increasing (referring to the slope showing temperature increase).

J: That's because perhaps it has finished breaking its bonds between the particles.

R: Uhm, so you agree with B. So all of us kind of agree with B.

J: Uhm, I'm not really agreeing with B.

With this multiple scaffolding some groups of students could participate in productive argumentation

X: On the piece of paper titled Evidence statements, the fourth line, it says that energy is needed to break bonds between particles. So… at the start of the experiment, it was ice. So the heat was used to break the ice into liquid form first. So there was no heat used to increase the temperature but most of it was used to change the form. So it must stay constant for the period when it was changing into liquid.

R: Okay, that was kind of precise.

X: And I think that when it comes to the 100°C point, it stays constant too because it's changing from liquid form to gaseous form.

With this multiple scaffolding some groups of students could participate in productive argumentation

R: So you think that it will stay constant for a while so that in a sense, there is time for the liquid to change to gas.

X: Yeah. It needs the heat energy to change from liquid to gaseous [form].

J: Thus, the temperature rises. *Is that what you are saying?*

X: Uh, yes. No. After it changes to gaseous state, then it rises.

J: *Why does it rise? Just because it's in [the] gaseous state?*

X: (thinking hard and verbalizing slowly and thoughtfully) Because the heat energy is used to change the state of the liquid. So after it changes its state, then it [temperature] will shoot up. The heat energy must be used [...] must be changed to some form somehow. So in my opinion, I think that the energy supplied, after it changes from liquid state to gaseous state, would be used to increase the temperature.

Hot issues in Argumentation and Learning

- The role of the teacher in facilitating argumentation for learning
- CSCL tools for facilitating argumentation for learning
- CSCL tools for facilitating moderation of argumentation
- The role of epistemic beliefs in argumentation
- The role of motivation (achievement goals) in argumentation for learning
- Gender studies in argumentation for learning
- …