Explanations, explanations, explanations

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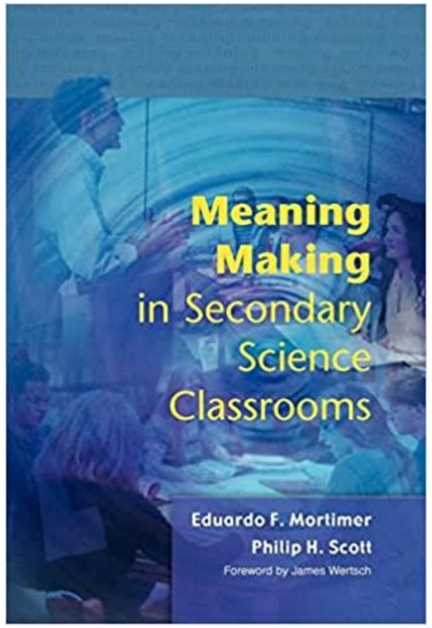
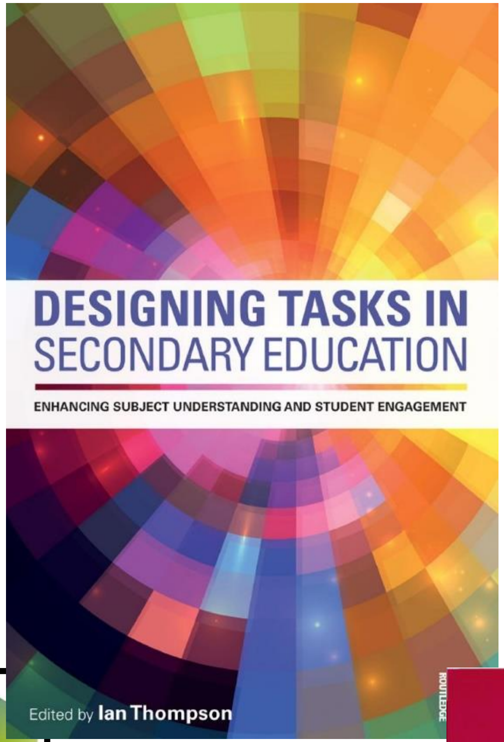
Guess this dem

- Methane rocket
- Whoosh bottle
- Sodium and chlorine
- Aluminium and bromine
- Dehydration of sucrose with concentrated $KMnO_4$
- Howling jelly baby
- Chip pan fire
- Cannon fire
- Methane bubbles
- Thermite reaction
- Cobalt chloride complexes
- $KMnO_4$ and propane-1,2,3-triol
- Flame tests
- Milk powder


Meaning Making
in Secondary Science Classrooms
Eduardo F. Mortimer
Philip H. Scott
Foreword by James Wertsch


DESIGNING TASKS IN SECONDARY EDUCATION
ENHANCING SUBJECT UNDERSTANDING AND STUDENT ENGAGEMENT
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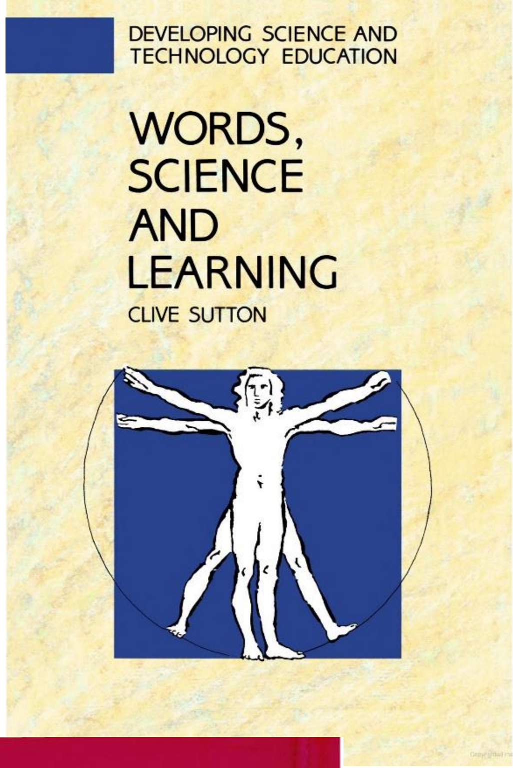
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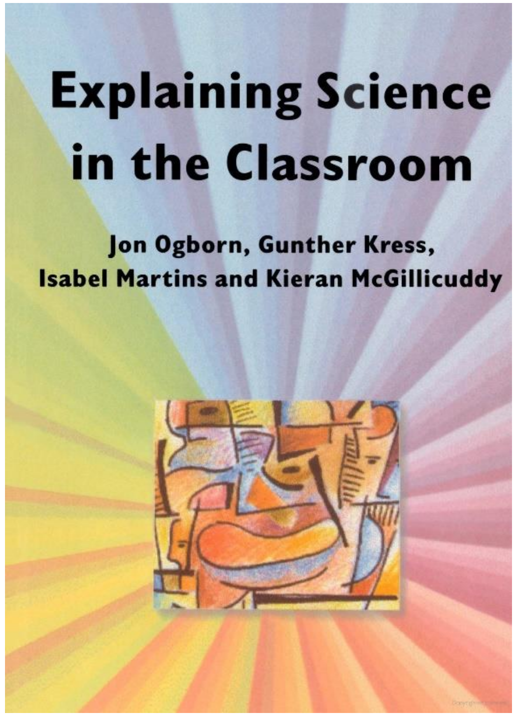
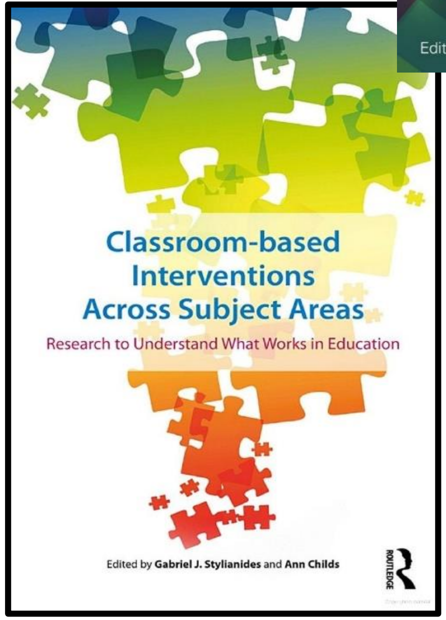
WORDS, SCIENCE AND LEARNING
CLIVE SUTTON


Explaining Science in the Classroom
Jon Ogborn, Gunther Kress, Isabel Martins and Kieran McGillicuddy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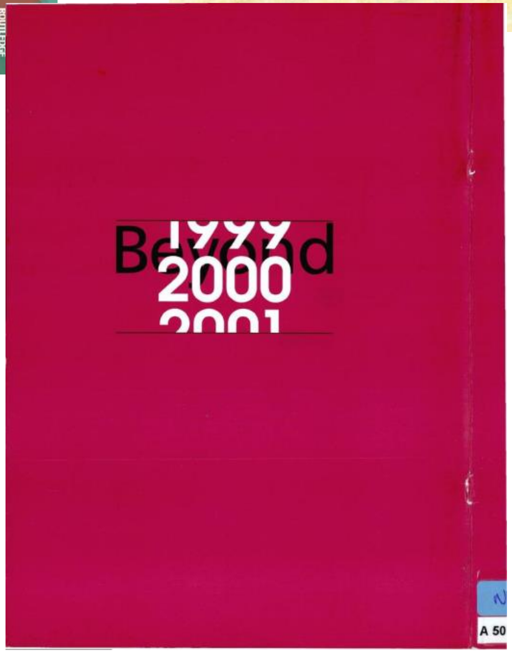
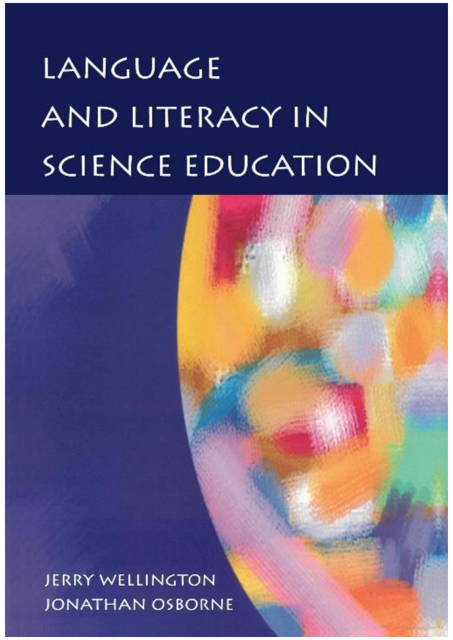
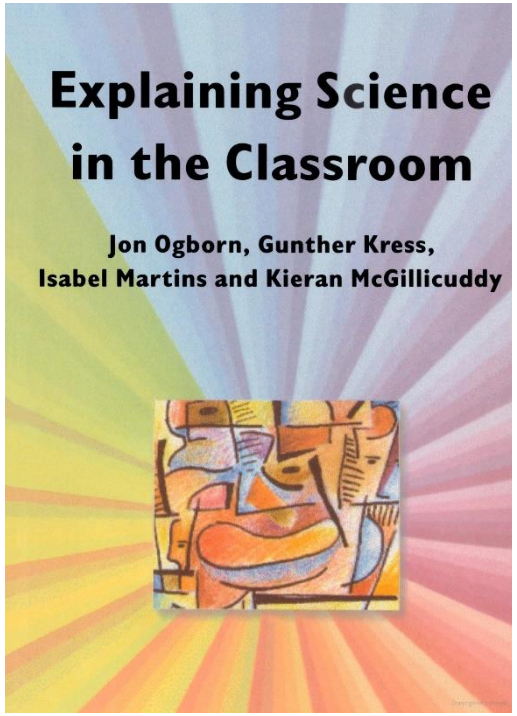

Beyond
2000


LANGUAGE AND LITERACY IN SCIENCE EDUCATION
JERRY WELLINGTON
JONATHAN OSBORNE

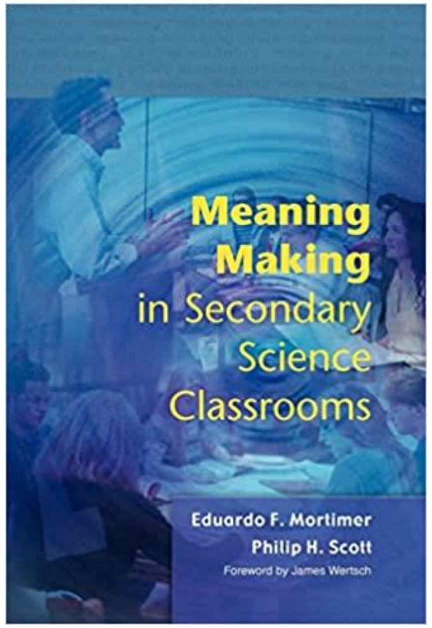
How does the fizz get into fizzy drinks?

Why are some metals more reactive than others?

What happens to salt or sugar when they dissolve in water?

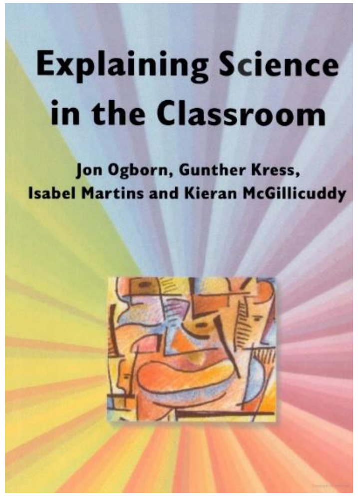


Explanation: involves importing some form of theoretical model or mechanism to account for a specific phenomenon. (p. 30)



Explanations as scientific stories - once upon a time

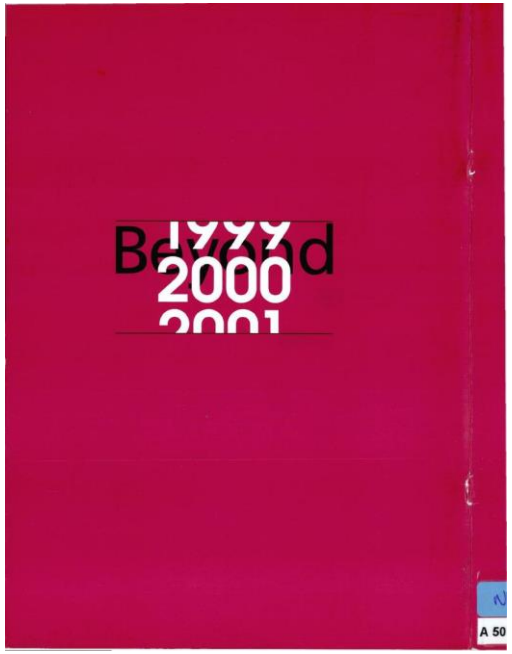
- If I ask it is raining and you tell me that the water is falling from the sky, I have been told only that it is raining.
- But a story about a depression coming across the Atlantic and bringing wet air with it begins to do the job. Such an explanation tells us how something to other comes about . This makes a scientific explanation very much like a story, even though it may not be told like a story. (p.9)

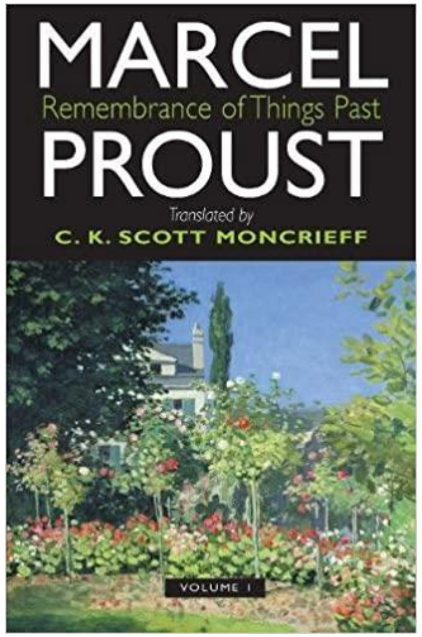


BIG stories

Scientific knowledge can best be presented in the curriculum as a number of key ‘explanatory stories’.

- THE PARTICLE MODEL OF CHEMICAL REACTIONS
- THE EARTH AND BEYOND

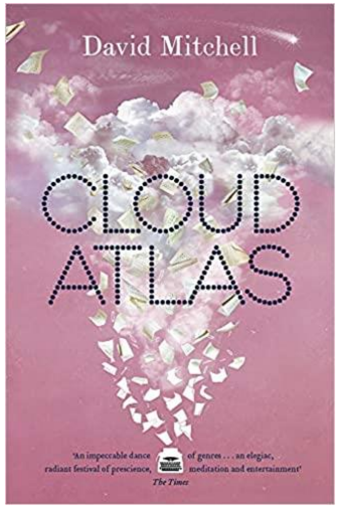




Short(er) stories

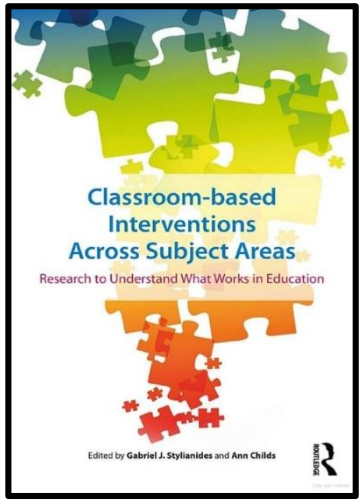
Ogborn et al. define an explanation as a story that 'tells how something or other comes about' (p. 9) and give examples of what might constitute the boundaries of an explanation, for instance, how a river became polluted; the origin of coal; the transmission of disease; the mechanism of heredity, how television works (p. 9)

Stories within stories (Nested or embedded stories)



One teacher's explanation of the differences in types of bonding between particles, extended across four lessons. However, this overarching explanation also had smaller explanations embedded within it; for example, the focus of lesson 3 involved explaining why sand and water, both having covalent bonds between atoms, have such different physical properties

Who should ‘tell’ the story?



- Teacher and student led
- Alexander Haydon – Who is doing the questioning?
- Every other Jewish mother in Brooklyn would ask her child after school ‘what did yiouy learn today?’ But not my mother ‘Izzy, she would say did you ask a good question today?’ (Isodore Rabi (1989-1988) Nobel prize winner in Physics)
- Those who ask questions – teachers, texts, tests, - are nto seeking knowedlge; those who seek knowledge – students – do not ask questions’. (Dillon, 1988, p. 197)

Challenging explanations in Chemistry

- Over to you
- KS3, 4 and 5…..
- 1 minute

Coherent internal accounts

- Hillier, J. M. (2013). How does that work? Developing pedagogical content knowledge from subject knowledge. *Teacher Education and Practice*, *26*(2).
- Egg and conical flask
- Rocket balloons
- Burning pencil
- Melting ice

Two written explanations

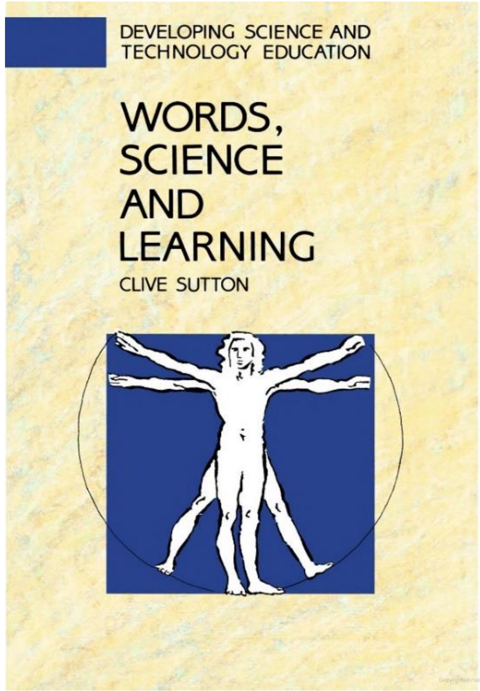
- One chemist and one biologist

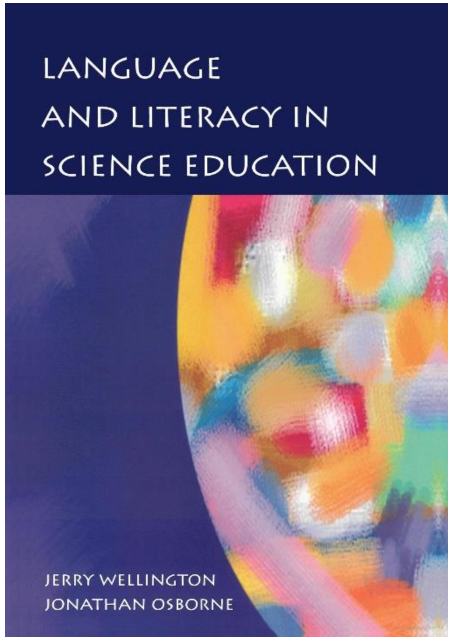
Description of process	*Explanation of process*
Hot water is placed in a conical flask. A peeled egg is placed on the top of the flask. Over the space of a few minutes, the egg is slowly pushed into the conical flask. Nice clear and concise description.	Initially when the hot water is placed in the conical flask, a lot of water is evaporating and transitioning into water vapour (gas) particles which have a lot of kinetic energy. These particles will collide with other air particles in the conical flask, transferring energy and causing a net increase in the energy of gas particles in the flask. This causes an increase in pressure inside the conical flask as the gas particles are moving with greater speed so are exerting an overall greater force on the conical flask walls when they collide with the walls. There is also now a greater number density of gas particles in the air compared with outside the flask. Air particles will therefore start to leave the flask, moving from an area of high pressure to lower pressure outside the flask. They leave the flask by exerting an upwards force on the egg (which can move enough to let some gas escape). Yes, a really detailed and thorough explanation, although the gas leaves before the egg is placed onto the flask – the argument that the egg can move doesn't really work for the later argument. When the water starts to cool, water vapour particles start to condense and transition back into water. Some evaporation is still taking place, but the net effect is a reduction in the number of water vapour particles. Therefore, the pressure inside the flask starts to decrease. Yes, there is another reason it decreases as well. Now, pressure is lower inside the flask then outside it. Gas particles outside the flask therefore try to enter the flask, but the egg is a barrier. The force exerted by the particles outside the flask on the egg causes the egg to move inside the flask. Yes, the air outside pushes the egg in.
Key words to be defined Pressure Evaporation Condensation Water vapour	

- Crucially, the interviews revealed that the preservice teachers had realized that: ‘if you write it down yourself you might realize that you can’t explain it . . . unless you try and put it into words either on paper or spoken then you might not realize that what’s in your head is not necessarily that ordered.’ (p.332)

Levels of difficulty

- **Level 1 naming words** such as oesophagus, fibula, meniscus and vertebra





- **Level 2 process words** such as evaporation, distillation, condensation, photosynthesis and evolution.
- Level 2a Within this group they also point out that some processes can be observed and demonstrated directly such as distillation.
- Level 2b However other process words such as evolution ‘belong to a higher level within this category’ because they are not directly observable e.g. photosynthesis, evolution .

- **Level 3 concept words** such as energy, force, work, salt and fruit.
- *These words cannot be understood in isolation. They are a part of a network of other words, all related together, often in a 'vertical structure', i.e. the understanding of one word (such as power) depends on prior understandings of other words (such as work and energy). Without prior understandings, the structure collapses".* (Wellington and Osborne, 2001, p.21)
-

3. non-science specific items

- However an equal challenge in science is teachers’ and textbooks’ use of more general academic language (non-science specific items)
- More challenging for EAL learners

What are these non-science specific items?

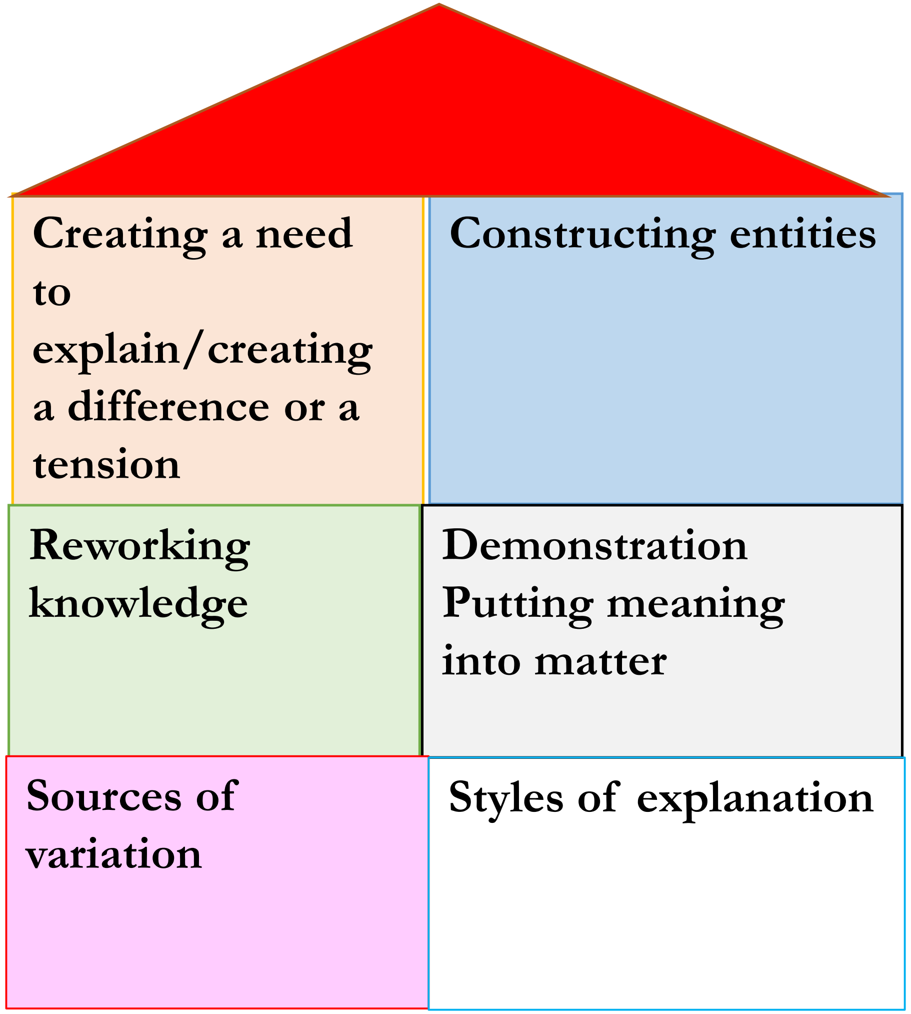
- They are words that are littered in science speech and textbooks like:
- Figure
- Property
- Substance
- Decay
- Explain
- Describe
- Characteristic
- Synthesise
- Absorb

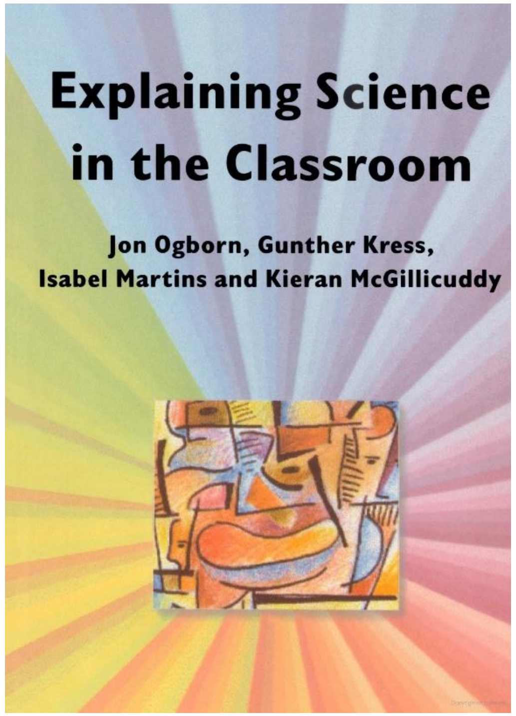
Noticing…….

- Carbon is present in the atmosphere as carbon dioxide.
- Carbon is present in the atmosphere as carbon dioxide.
- Carbon (level 1) is present in the atmosphere (level 1) as carbon dioxide (level 1).
- Carbon is present in the atmosphere as carbon dioxide

Initially when the hot water is placed in the conical flask, a lot of water is evaporating (2a) and transitioning into water vapour (gas) particles which have a lot of kinetic energy (3). These particles will collide with other air particles in the conical flask, transferring energy and causing a net increase in the energy (3) of gas particles in the flask. This causes an increase in pressure (3) inside the conical flask as the gas particles are moving with greater speed (3) so are exerting an overall greater force (3) on the conical flask walls when they collide with the walls.

The architecture of an explanation





Concept	*State the concept you are explaining and which Key Stage the explanation is for.* *Clear statement of the science at the 'correct level'* *(Coherent Internal account)*
Real life context	Creating a need to explain
Why is this challenging?	*Student preconceptions/misconceptions(including references)* *What do experienced teachers say?*
Explanation	*What am I assuming they know* *What will you actually do to explain the concept? How will you take account o student misconceptions?* *Suggestions from experienced teachers*
Activities to support explanation	
Points to consider	*Advantages and limitations of any model, analogy, practical etc.*