RiLS evaporation sequence

Water unit sequence (Grade 5/6)

Lesson 1: Water in the school environment.	Group work to list, on a map, areas where water exists and in what form. Brainstorm – where is it, how do you know?
Lesson 2: How can you show there is water in things?	Activities to provide evidence that water exists in various nominated places - soil, leaves, food, air.
Lesson 3: Introducing the particle representation.	Context of an evaporating pool of water to discuss what is happening leads to a range of ideas about the particle idea and a set of representations (dot drawings, plastic bead , annotated sequenced drawings of what happens at the surface as particles come away). Eucalyptus oil / perfume activity. Role play
Lesson 4: Explaining evaporation and condensation.	Disappearing handprint activity (in groups). Comparison of rate of evaporation of dishes of water in different places.
Lesson 5: Drying a cloth	Students are given standardised cloths dipped in standard amounts of water and challenged to dry them quickly (Group work).
Lesson 6: Computer simulation	Students simulate the evaporation of water from their cloth using computer animations.

Where is the water in the school?

Session 1:Teacher 1 [T1]opens up classroom discussions - towards a more detailed view of states of matter.

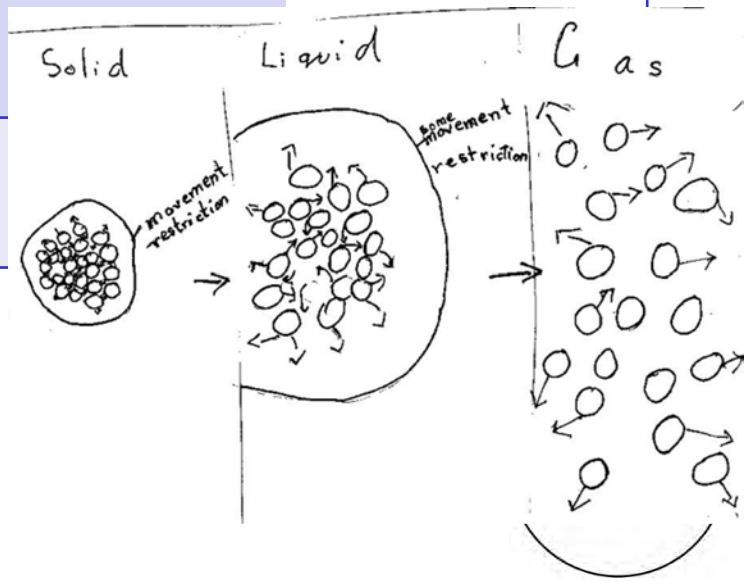
Active exploration through representation

T1*:* I want you to think [raises right hand and points finger to the head] how you are going to record here?[lowers hand and points to the map].You can do arrows if that helps you, you can list the places colour in, and/or write down where that water is.

Only 10 / 42 students thought there is water in air.

Evaporation Lesson 3: Introducing the molecular model

Representation	Teacher move	Student action
1. Role play	You are all water molecules. I want you to imagine you are water molecules, in the solid state, I want you to move to show me what you would look like.	
		Students discuss movement. 6M: No, each one sort of moves – [pushes the other student and moves to and fro]
Teacher uses jiggling body to emphasise movement.	They [students] are moving, is that correct? Do molecules in a solid state move? T1: Yes they move.	
2. Use of role play to have students simulate solid, liquid, gas	Exchange where T2 leads question-response discussion as students model a liquid compared to solid and gas. Gas! Show me	
3. Drawing challenge: show solids liquids, gases.	You have bodily moved, very well … how would you indicate that in a diagram?	



Representation	Teacher move	Student action
4. Teacher uses beads to model a focus on individual molecule responding to an energy sources – vibrates them – some spill.	T1: Come back again to that gas molecule, … when we had that heat source, that energy coming in is this what happens?	
	A student comes to the container, picks up a bead and moves his hand in a haphazard motion above the head.	
	T2 challenges this by demonstrating dispersal by shaking beads out –models randomness of distribution T2: Which molecules are the first ones to go?	
	Sts: Top ones. St: Ones that had started moving faster. St: More heated ones Sts: Ones that get more energy	
Bead demonstration	T1: In your diagram, there may be need to show a three dimensional diagram or a series of diagrams, think about not just two-dimensional. T1: Okay let us give these molecules, beads, a human form [picks up a bead and points to it]. Here is George, he is here vibrating in water as a solid, then there is more energy he moves more in a liquid state, and then here is Molly …	
5. Drawing challenge T1 models storied drawing on board	Tell me a story about one water molecule, about what happens to it. Let's do it in four frames. Remember, label, say why is he here, what does he actually need?	

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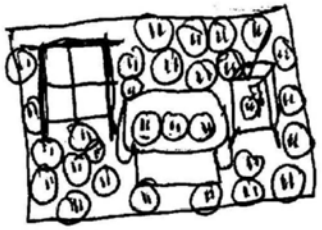
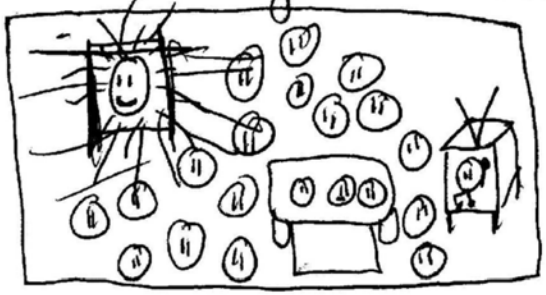
Diagram !!

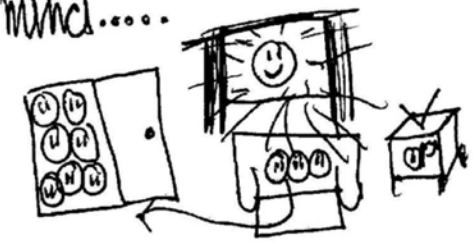
One day Blob the water molecule was sitting at home watching TV with his freinds.



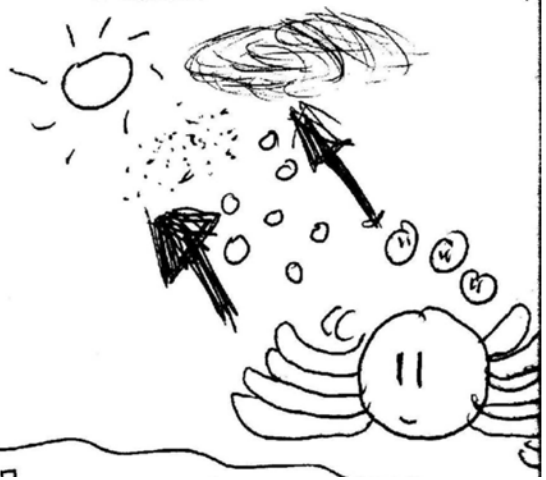
Then suddenly ~~of heaten~~ a stream of ~~sug-n~~ sunlight came through the window.



Sadly, all of Blobs friends had to go. But Blob didnit mind.....



Because he came too!



Sequence of representations

Each representation offers particular affordances in focusing attention on aspects of the evaporative process

Each student representation offered an opportunity for the teacher to support students by challenging and negotiating meaning

Video of puddle evaporating, verbal challenge

↓

Role play of molecules as solid, liquid, gas

↓

Drawing challenge – solid, liquid, gas

↓

Bead 3D model, process of evaporation

↓

Cartoon representation of the life of an individual molecule

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Teacher challenge, negotiation of representations

T1: So you are making a connection here that if there is air then there are water molecules, interesting. Anyone thought it was a solid. Can you explain your thinking here?

T1: So can you represent that? Can you show me both, and show me what is different? What would be the change, how would you represent that?

When you were rubbing out your cloth definitely was getting drier, but you couldn't see the water . So maybe somebody can show me what was wrong with the model I showed you.

Sts (about bead model of molecules): They are going everywhere.
T2: How have you shown that? Because when I go around and have a look most of your diagrams are having lines going up [raises both hands above head, with palms facing each other.] …

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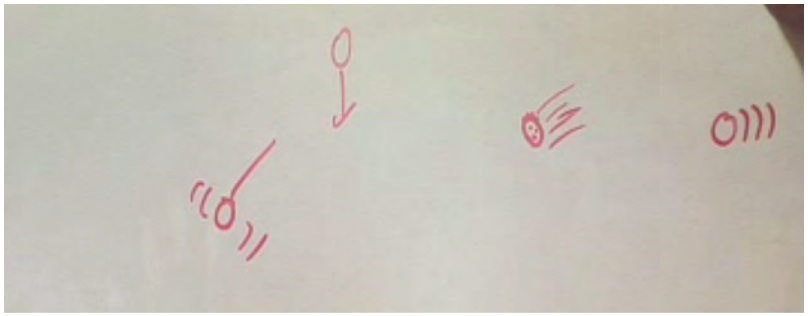
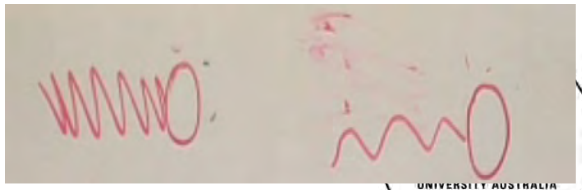
Students understanding the nature of representations

I was just focusing on what they do, not representing other things like shape and size, they are very, very tiny. …

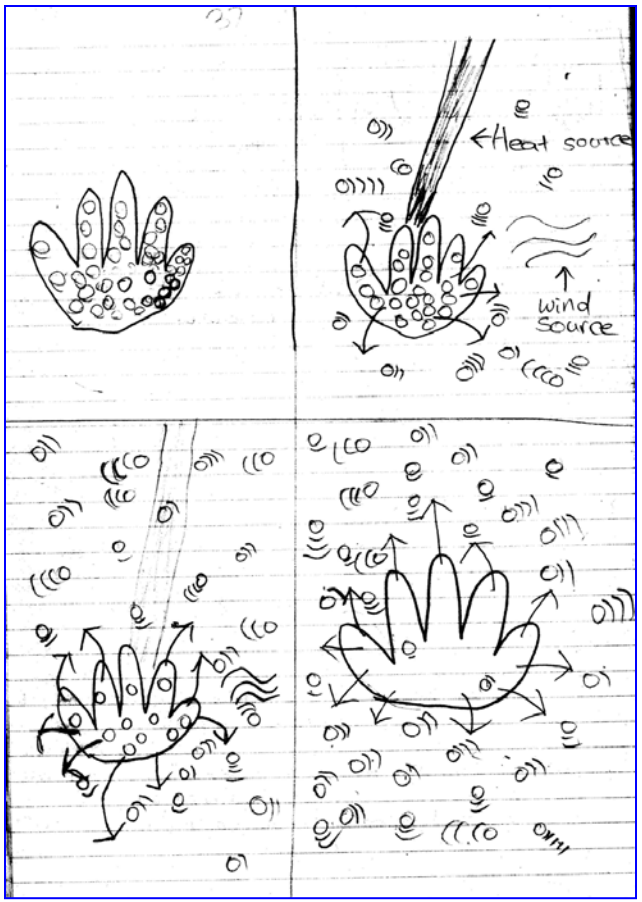
I: How do representations help you?
J: Instead of just explaining it with words or a paragraph of writing, it actually shows what's happening. It improves my understanding. It's like a giant microscope looking at what is actually happening.

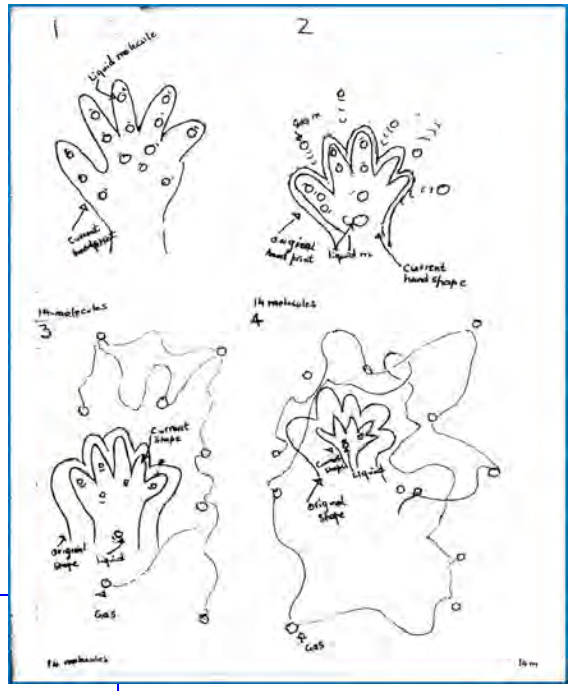
S: The heat source from the sun will go down to the paper … and then the heat source evaporates water into the air as gas water particles which will move much more rapidly than the water particles on the paper. To show them moving differently, if there is one small stroke then it's not moving as fast. There's a couple more strokes then they move pretty fast.

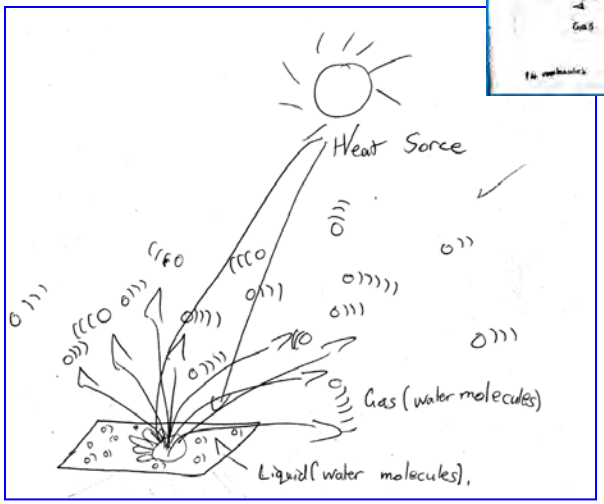




Variation in student representation: The ‘disappearing handprint’







SCIENCE EDUCATION

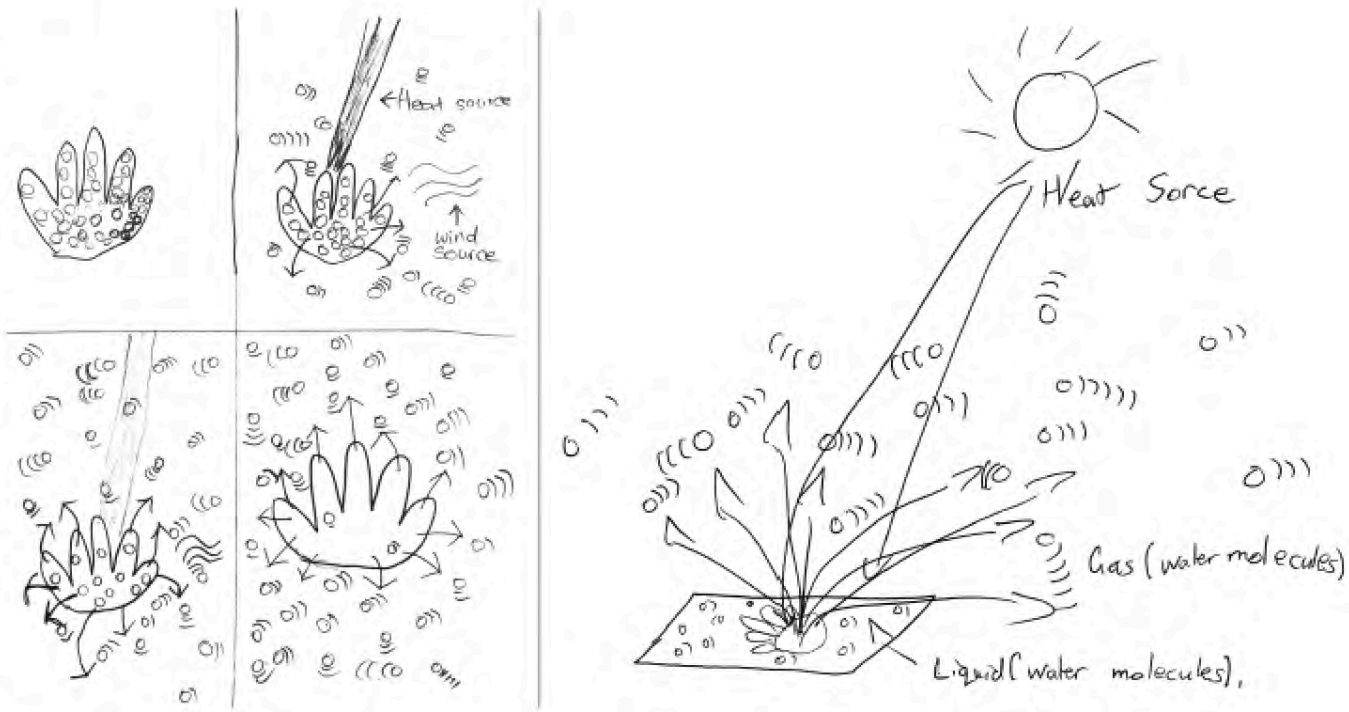
Drawing to Learn in Science

Emerging research suggests drawing should be explicitly recognized as a key element in science education.

Shaaron Ainsworth[1]*, Vaughan Prain[2], Russell Tytler[3]

Should science learners be challenged to draw more? Certainly making visualizations is integral to scientific thinking. Scientists do not use words only but rely on diagrams, graphs, videos, photographs and other images to make discoveries, explain findings, and excite public interest. From the notebooks of Faraday and Maxwell (*1*) to current professional practices of chemists (*2*), scientists imagine new relations, test ideas, and elaborate knowledge through visual representations (*3–5*).

However, in the science classroom, learners mainly focus on interpreting others' visualizations; when drawing does occur, it is rare that learners are systematically encouraged to create their own visual forms to develop and show under-

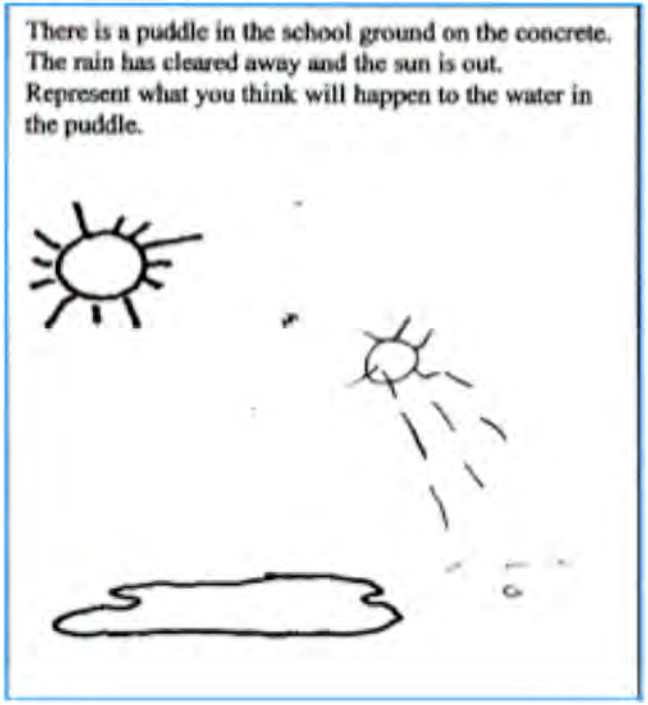


Revealing understanding. Drawings by two 11 year olds (left and right) of an evaporating handprint show representational choices that guide and communicate individual understandings.

tional topics reduce them to passive roles

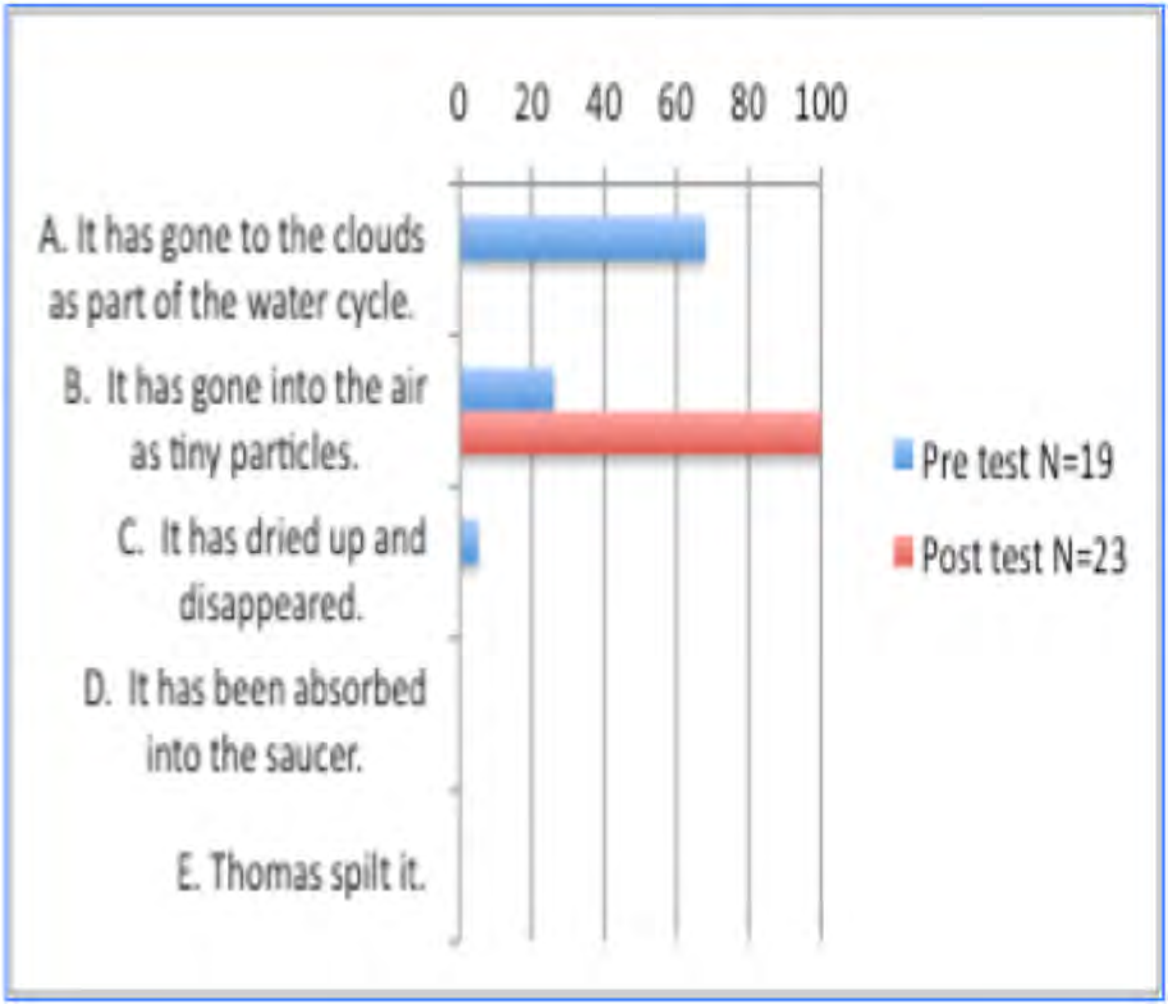
Ainsworth, S., Prain, V., & Tytler, R. (2011). Drawing to learn in science. Science, 333 (26 August), 1096-1097.

Pre- and post- test example



Pre- and post- test multiple choice

A saucer of water dries up. What has happened to the water?



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Post test drawings

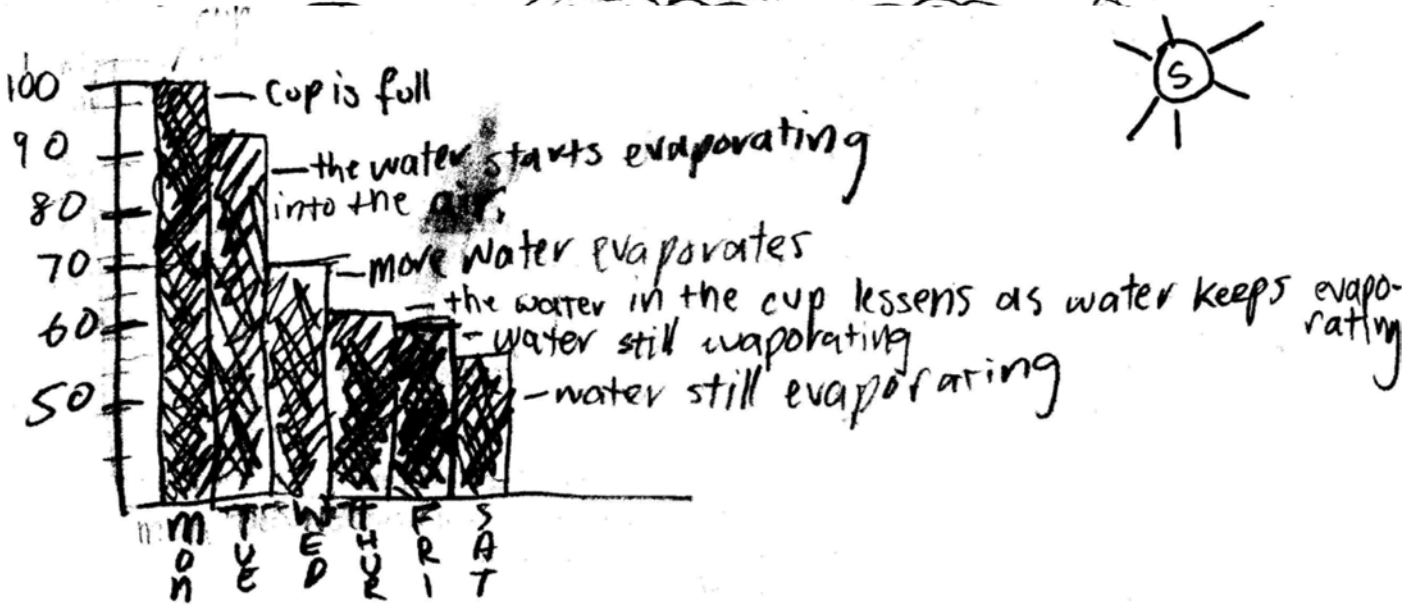
Water Stories - Q.2 Explain with words and other representations (eg. drawings, graphs, arrows) what is happening in the stories below.

S-5Q

On Monday, October 10th 2008, Charlie poured 100ml of water into a wide mouth measuring jar and left it on his desk. He measured the level of water on 6 consecutive days and found them to be:

Monday: 100ml Tuesday : 94 ml Wednesday :70ml Thursday: 62ml Friday :60 ml Saturday :55ml

2a. Use a representation /representations to show how the level of water changes from Monday to Saturday.



2b. Why do you think the water level drops?

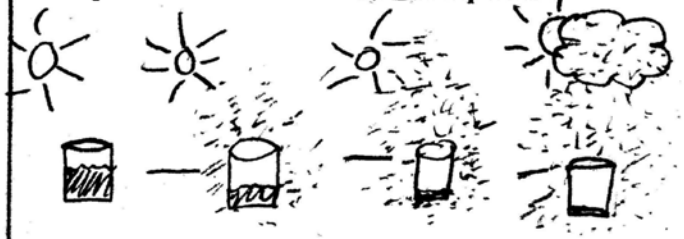
Because the water particles are evaporating into the air.

Q3:Clouds are made of tiny droplets of water, said the teacher. Where do you think the water in the tiny droplets of water in the clouds comes from?

S-6H

3. Use words and other representations (e.g. drawings, graphs, arrows) to represent what is happening in the stories below.

3a. ***"Clouds are made of tiny droplets of water"*, said M. . Then she added:**
" Where do you think the water in the tiny droplets of water in the clouds comes from?"
Use representations to answer M s question.



The water doesn't always come from a cup, it can be any water from any source. Like a puddle on the ground - the hot sun soaks it up (evaporation) and it goes back to the clouds

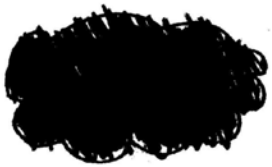
3b. Mr. added: ***I have a challenge for you. Use representations to show how little drops of water form clouds.***

1 Water droplets in the sky.

2 Some droplets start forming groups

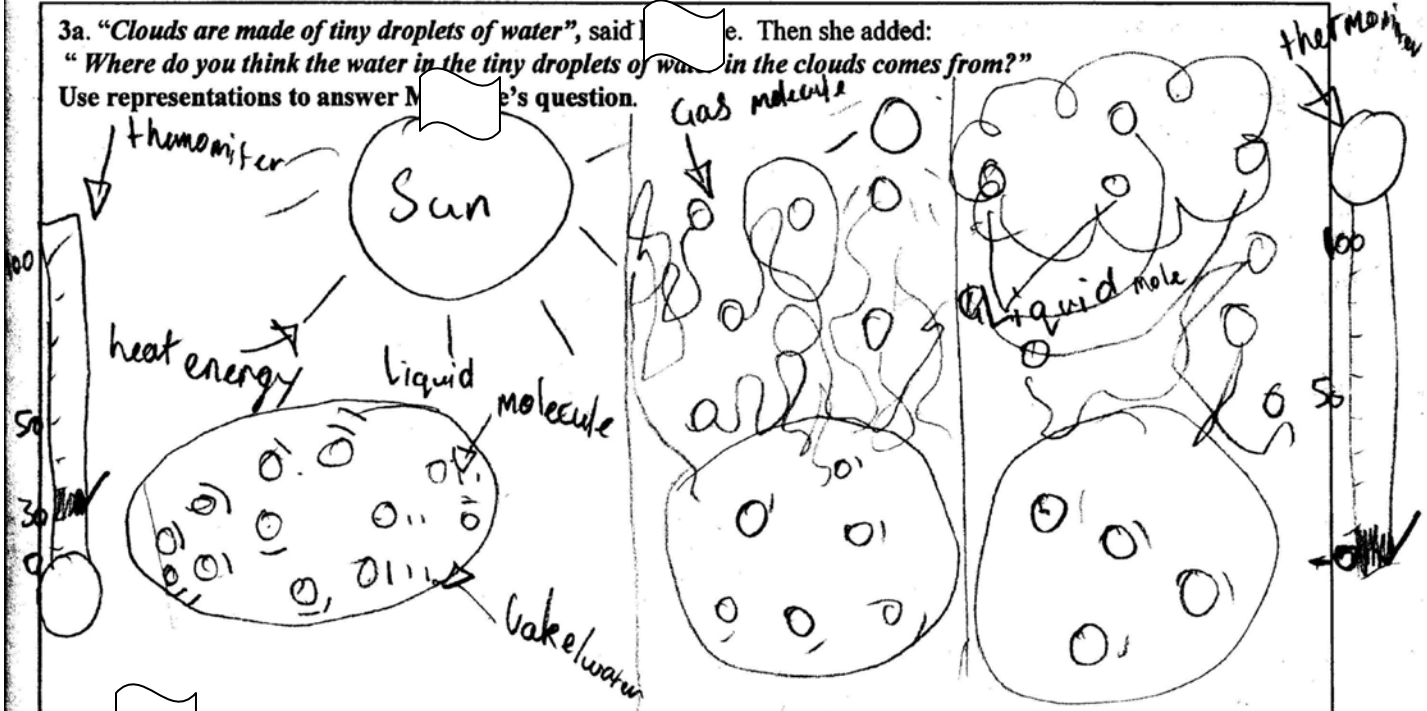
3 Larger groups are forming.

4 Droplets of water are so close together, they become one.

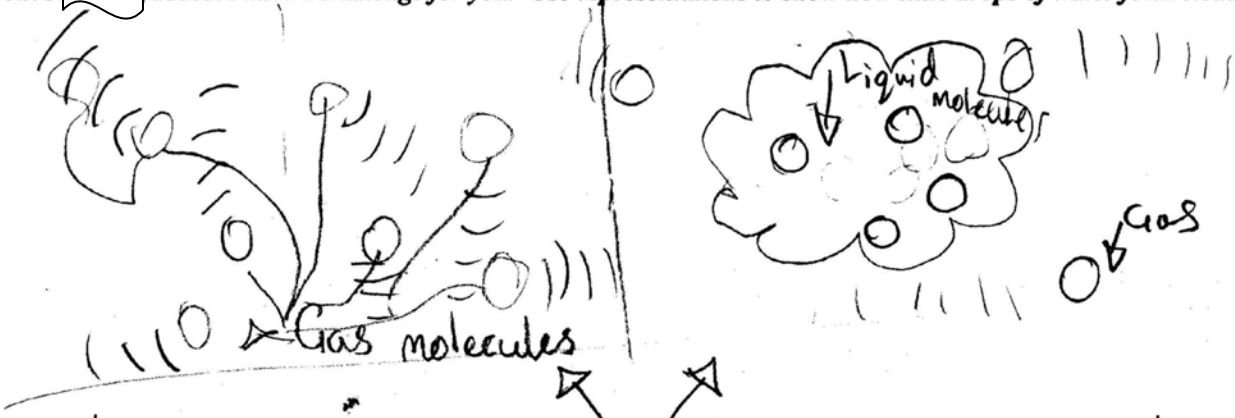


S-6G

3a. *"Clouds are made of tiny droplets of water"*, said [illegible]e. Then she added:
" Where do you think the water in the tiny droplets of wa[illegible] in the clouds comes from?"
Use representations to answer M[illegible]e's question.



3b. M[illegible] added: *I have a challenge for you. Use representations to show how little drops of water form clouds.*



The molecules in the diagrams above are gas and liquid in the first picture the molecules are evaporated and are moving. In the the 2nd one they are high in the sky and forming clouds together.

Implications

- The classical conceptual change principle of ‘explore before explain’ is followed for this sequence however particle ideas are thought of as tools to interpret evaporative phenomena rather than a resolved concept to be described
- The explicit representational discussions allow insights into student.
- Each representation is partial, so that aspects of the particle representations may be ‘unscientific’ or ambiguous, yet they open up understandings of aspects of the scientific perspective as resources for further development
- This version of student learning presents ideas and understandings as perpetually ‘in process’

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