

COMMON MISCONCEPTIONS

Time for a change!

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PSTT College Fellow and Regional Mentor, Tom Holloway, addresses common misconceptions surrounding states of matter



What children need to know:

- observe that some materials change state when they are heated or cooled.
- know that some materials will dissolve in liquid to form a solution and describe how to recover a substance from a solution.
- identify the part played by evaporation and condensation in the water cycle.
- demonstrate that dissolving, mixing and changes of state are reversible changes.

Common misconceptions – often children will think:

- Steam is visible.
- Steam and condensation are the same.
- Evaporation only occurs when water is boiling.
- Clouds are made of gas.
- Boiling/evaporation are irreversible changes.
- When a solid dissolves in water it does not contribute to the mass of the solution.
- Liquids that evaporate/boil disappear forever.
- A fizzy-drinks can or glass container becomes wet because liquid from the inside seeps through to the outside.
- When a substance has dissolved it has 'disappeared'.
- Substances (like sugar) 'melt' in water.

I find that 'changes of state' is one of the most fascinating areas of the science curriculum to teach. I love how closely connected it is to the children's everyday lives and experiences. There is a magical aspect to it too. Salt, when it dissolves, and water when it evaporates both appear to disappear. It is very rewarding to help children unlock the science behind the 'magic'. Unsurprisingly, children have many misconceptions about this area of science. In the following article, I aim to unpick some of these misconceptions and suggest ways that they can be addressed.

Is it melting or dissolving?

Children often confuse the terms 'melting' and 'dissolving'. This may be because when certain types of food (such as a sugar cube) are put into hot water it can

Figure 1. Ice cubes and sugar cubes appear to break down in a similar way when hot water is poured over them.



appear to breakdown in much the same way that an ice cube does. Children need to understand that melting only involves one material (changing from a solid to a liquid) while dissolving involves two materials (one spreading amongst the other). To help children understand this, get them to act out the two processes.

Figure 2. Particles in a solid are arranged uniformly and tightly packed. In a liquid, the particles are still closely but less uniformly arranged and move around each other (flow).



For melting, they start as particles in a material in a solid state (e.g. an ice-cube in a pan on an oven). They are arranged close to each other in rows. When heat is applied (the 'oven' is switched on) they should move around each other more freely, but touching each other, to simulate the change into a liquid brought about by melting. It can be useful to show the children a representation of the particles (Figure 2).

Figure 3. The solute particles spread out amongst the solvent particles.

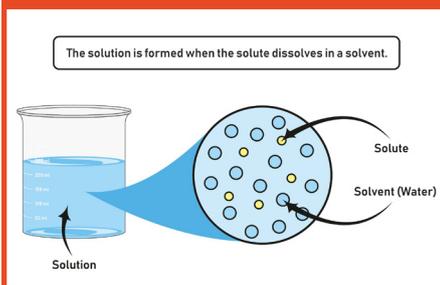


Figure 4. Children experience evaporation and condensation often in their everyday lives – often without realising it.



For dissolving, some children play the particles in the material that is dissolving (the solute – e.g. sugar) while others the particles in the liquid (the solvent – e.g. water). The solute 'particles' spread out amongst the solvent 'particles' to make a solution (Figure 3). This activity is also a great way of addressing the common misconception that when a solid, like sugar, dissolves it has disappeared. The 'solute particles' can 'hide behind' the 'solvent particles' so they can no longer be seen. Other ways this misconception can be addressed are by:

- *Observing colourful sweets dissolving rather than salt/sugar. The solute spreading out amongst the solvent can be clearly seen.*
- *Dissolving 5g of salt in 100ml of water and getting the children to measure the mass of the solution before and after.*

Evaporation and condensation

Children observe evaporation and condensation frequently in their everyday lives but are often confused about what is happening.

What's in a name?

As with many science topics, the common use of language is often a source of much of this confusion. We talk about puddles 'drying up' which gives the impression that water is absorbed (by the ground). We complain that the windows of our cars have 'steamed up' or observe that you can see 'steam' coming out of our mouths on a cold morning or from a kettle as it boils, giving the impression that 'steam' is visible and confusing water vapour (invisible gas) with water droplets floating in the air. For children to gain a secure understanding of evaporation and condensation, it is important that these processes are correctly identified and named, for example:

- *The puddles have evaporated!*
- *The windows are covered by tiny water droplets.*
- *There is a cloud above the kettle.*

Challenging children to identify as many examples of evaporation and condensation as they can is a great way of connecting their conceptual knowledge with the real-world and assessing their level of understanding.

How did the water get there?

It is logical for children to think that when water evaporates it has disappeared – it is no longer in the puddle or bowl and can no longer be seen. To address this misconception, children need to observe evaporation and condensation first-hand. A great way of doing this is to make a simple 'still'. Fill a container with water and cover the top with clingfilm. Place the container in direct sunlight or on top of a radiator and leave for around a day. The clingfilm will trap the water vapour as it evaporates. Children will be able to observe water droplets forming on the inside of the clingfilm leading to the questions; how did the water get there? Where did it come from? A bowl full of water but without a clingfilm covering could also be placed alongside for comparison. This could be extended by observing what happens to fizzy-drinks cans when they are taken out of the fridge. Often children think that the water covering the can has seeped out from the inside so it is important to demonstrate that the can is waterproof.

This experiment provides an opportunity to address any misconceptions that evaporation can only occur when water is boiling. This can be further reinforced by discussing how puddles evaporate even though the temperature of the water is much lower than boiling point. It is also a great way of demonstrating that evaporation is a reversible change.

What have dinosaurs got to do with condensation?

Children often think that clouds are a gas. Once they have a secure understanding of evaporation/condensation they can learn that they are in fact made up of millions of droplets of water that have condensed around tiny specks of dust. This can be related to the activity above with the water condensing on the bottom of the clingfilm representing a cloud.

I love to explain to children that water has been evaporating and condensing on Earth for billions of years. Rain falling on their heads at playtime once fell on the heads of dinosaurs – it is a wonderful 'wow moment'.