Chemistry > Big idea CSU: Substance > Topic CSU2: Solubility

Key concept (age 11-14)
CSU2.1: Comparing solubility

What's the big idea?

A big idea in chemistry is that of substances and properties. All materials are made of a single chemical substance or a mixture of substances. Properties of substances may be explained using the big idea of particles and structure.

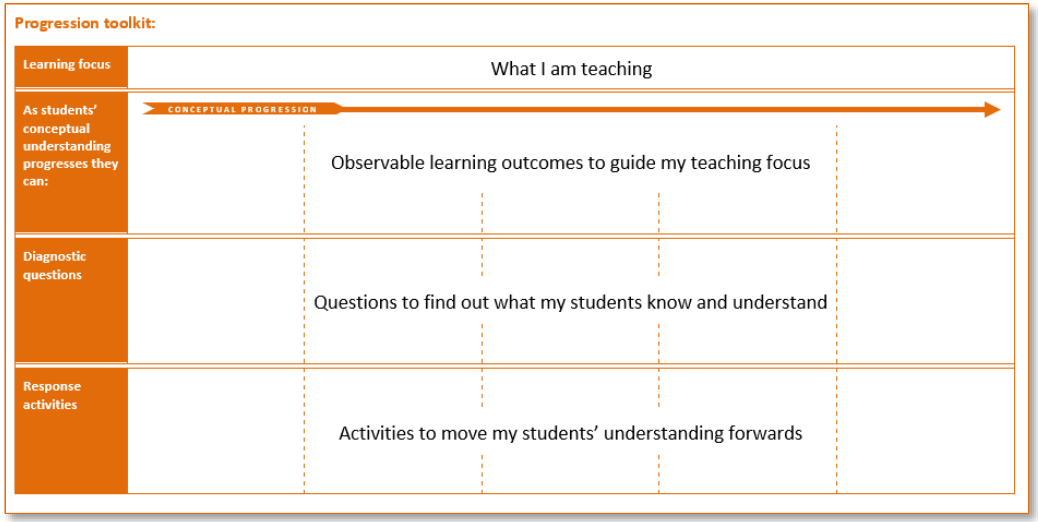
How does this key concept develop understanding of the big idea?

This key concept develops the big idea by introducing solubility as a distinct property of a substance.

The conceptual progression starts by checking understanding of solubility as being unaffected by stirring or addition of more solvent. It then supports the development of understanding of the effect of temperature on solubility in order to enable understanding of graphical representations of solubility versus temperature.

Using the progression toolkit to support student learning

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.



Progression toolkit: Comparing solubility

Learning focus	Solubility is a property of a substance that varies with temperature.				
As students' conceptual understanding progresses they can:	CONCEPTUAL PROGRESSION → Recognise that stirring does not affect the solubility of a substance. **P**	Recognise that increasing the volume of solvent does not increase the solubility of a substance.	Use data to predict observations of 100 cm^3 of solution where the mass of solute is above, below or equal to the solubility.	Predict observable changes following the cooling of a saturated solution.	Link points on a solubility graph to macroscopic observations.
Diagnostic questions	Stirring	Adding water	Warming up	Cooling down	Solubility graph
Response activities	Blue crystals (CPS2.1)	Undissolved salt	Copper sulfate data	Warming up and cooling down	Solubility curve

Key:

P Prior understanding from earlier stages of learning

What's the science story?

There is a maximum mass of a substance (solute) that will dissolve in any given volume of solvent. A solution in which no more solute will dissolve is called a saturated solution.

Solubility can change with temperature therefore the solubility of a particular substance is defined at a specific temperature. Graphical data on solubility can be used to predict macroscopic observations of solutions in terms of whether the solute will appear fully dissolved.

What does the research say?

Research (Çalýk, Ayas and Ebenezer, 2005) found that everyday experiences can influence student understanding of dissolving. Misunderstandings about what can affect the mass of a solute that dissolves have implications for understanding of solubility. For example, one research project (Adadan and Savasci, 2012) found that some students thought that mixing increased solubility. In fact, mixing increases how fast the solute dissolves but not how much. Another finding of the project was that some students considered an increase in the volume of water to result in an increase in solubility of a substance. This suggests confusion between the amount (mass) of solute that dissolves and its solubility. If the volume increases the mass of solute that dissolves will also increase but solubility remains the same.

Research (Uzuntiryaki and Geban, 2005) also found that some students had misunderstandings about the link between the mass of solute that dissolves and temperature. They considered, that once a solution had been warmed, and all the solute had dissolved, this solute would remain dissolved as the solution cooled. They appeared unaware that a solute could recrystallise.

A further research paper (Gültepe, 2016) reports findings relating to students' ability to interpret graphs in chemistry. In addition to requiring appropriate mathematical understanding the study found that a conceptual understanding of the related chemistry concepts was also important. Adadan and Savasci (2012) discuss the difficulties some students experience in moving between a graphical representation and other levels of representation (such as macroscopic). They link this to Johnstone's triangle (Johnstone, 1991) and suggest that a graph is a form of symbolic representation.

Guidance notes

To support students in answering the question, the solubility of salt is initially described in words as "The maximum mass of salt that can dissolve in $100cm^3$." Solubility is commonly expressed as grams of solute per 100g of water and this is used in subsequent questions and activities. It may help students to point out that 100g of water has a volume of $100cm^3$.

References

Adadan, E. and Savasci, F. (2012). An analysis of 16 to 17 year old students' understanding of solution chemistry concepts using a two-tier diagnostic instrument. *International Journal of Science Education,* 34(4)**,** 513 to 544.

Çalýk, M., Ayas, A. ş. a. and Ebenezer, J. V. (2005). A review of solution chemistry studies: Insights into students' conceptions. *Journal of Science Education and Technology,* 14(1)**,** 29-50.

Gültepe, N. (2016). Reflections on high school students' graphing skills and their conceptual understanding of drawing chemistry graphs. *Educational sciences: Theory and practice,* 16**,** 53-81.

Johnstone, A. H. (1991). Why is chemistry difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning,* 7**,** 75-83.

Uzuntiryaki, E. and Geban, O. (2005). Effect of conceptual change approach accompanied with concept mapping on understanding of solution concepts. *Instructional Science,* 33**,** 311-339.