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A Reply to "Reinterpretation of Students' Ideas when Reasoning about Particle Model Illustrations. A Response to "Using Animations in Identifying General Chemistry Students' Misconceptions and Evaluating their Knowledge Transfer Relating to Particle Position in Physical Changes" by Smith & Villarreal (2015)"

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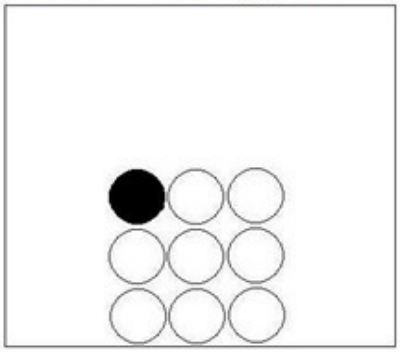
In Smith and Villarreal's recently published article in this journal (2015), several types of general chemistry students' misconceptions concerning the concept of particle position during physical changes were identified. One of the misconceptions identified was that given a solid sample of a substance, some students did not think that a selected particle would move far from its original position throughout the reversible physical changes of melting and dissolving. In a recent comment on this work (Langhebeim, 2015), it was suggested that the nature of the data collection instruments, which showed a "…particle model of nine particles that are confined within a relatively small area" (Langhebeim, 2015), may have contributed to this misconception. Langhebeim argued that the illustrations may have caused students to consider the particles' movement to be restricted, which may have resulted in students responding that a selected particle would not move far from its original position. Additionally, in the comment, Langhebeim reported on molecular dynamics simulations which showed that indeed, based on the data

collection instruments in Smith and Villarreal's work (2015), a selected particle would not move far from its original position over a short initial time period (shorter than the typical time period over which melting occurs).

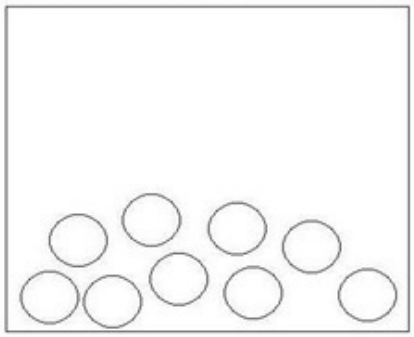
In developing our published study (Smith and Villarreal, 2015), we conducted pilot studies in which we tested and refined our data collection instruments. The original data collection instruments we used in our first pilot study are presented in Fig. 1 and Fig. 2.

Print Name_____

Imagine that you have a solid sample of nine molecules, with one of the molecules colored black, as shown on the following picture:

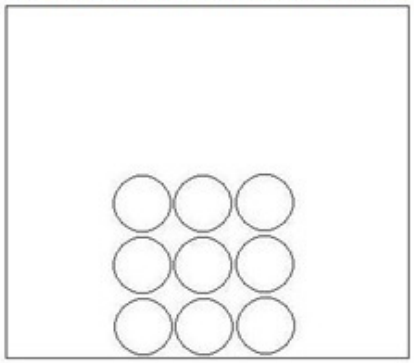


a) If the solid sample melts to a liquid, color in on the picture below where you think the molecule that was colored black in the original picture would be.



Explain why you chose the molecule that you colored in.

b) If the liquid in the previous picture freezes to a solid, color in on the picture below where you think the molecule that was colored black in the original picture would be.

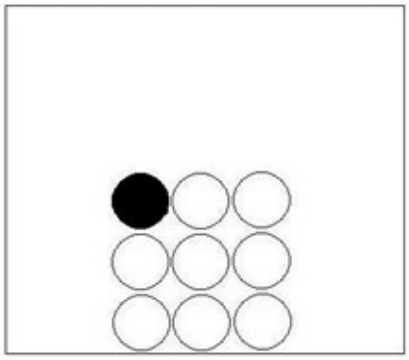


Explain why you chose the molecule that you colored in.

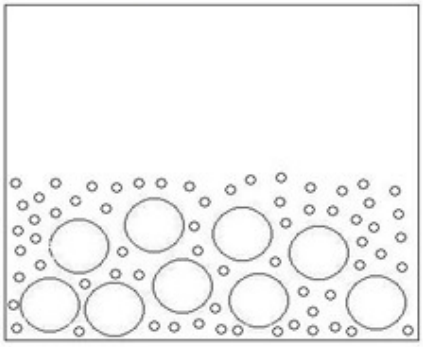
Fig. 1 The Original Pilot Study Melting Cycle Instrument.

Print Name_____

Imagine that you have a solid sample of nine molecules, with one of the molecules colored black, as shown on the following picture:

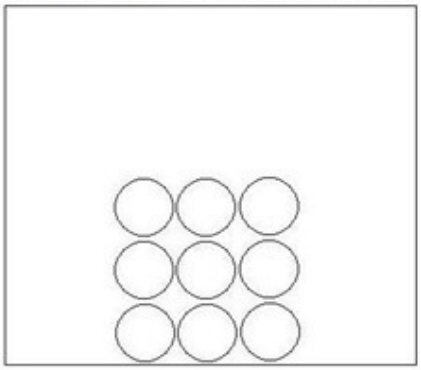


a) If the solid sample dissolves in water, color in on the picture below where you think the molecule that was colored black in the original picture would be.



Explain why you chose the molecule that you colored in.

b) If the water in the previous picture evaporates, color in on the picture below where you think the molecule that was colored black in the original picture would be.



Explain why you chose the molecule that you colored in.

Fig. 2 The Original Pilot Study Dissolving Cycle Instrument.

These data collection instruments were refined to their final form in our published study (Smith and Villarreal, 2015) and addressed several points. One of these points was that given the large area available to the particles in the instruments in Fig. 1 and Fig. 2, we did not find it likely that the particles would end up in the 3 x 3 grid arrangement portrayed in the final representation of each instrument. As such, the dimensions of the borders surrounding the particles in the representations were reduced so that the 3 x 3 grid arrangement of particles in the final representation of each instrument would appear more likely.

As seen from Fig. 1 and Fig. 2, the particles in the representations have a much greater area available to them compared to the data collection instruments in the published work (Smith and Villarreal, 2015). This pilot study did not have human subjects research approval from the Institutional Review Board, so we will not report specific results here. However, the nature of the students' misconceptions and the trends in the results of this pilot study were similar to the results reported in the published work. As such, we stand by the soundness of the interpretation of our results in the published work. We do, however, appreciate the value of the comment (Langhebeim, 2015) as it prompts further investigation of how factors such as consideration of time and the nature of the representations in the instruments might affect students' conceptions and responses.

References

Smith K. C. and Villarreal S., (2015), Using animations in identifying general chemistry students' misconceptions and evaluating their knowledge transfer relating to particle position in physical changes, *Chem. Educ. Res. Pract*,. **16**, 273-282.

Langhebeim, 2015