Choosing Classroom Resources: What Our Research Shows

A Guide for High School Science Teachers from Molecules & Minds at NYU's CREATE Lab

Consortium for Research and Evaluation of Advanced Technologies in Education

MOLECULES & MINDS

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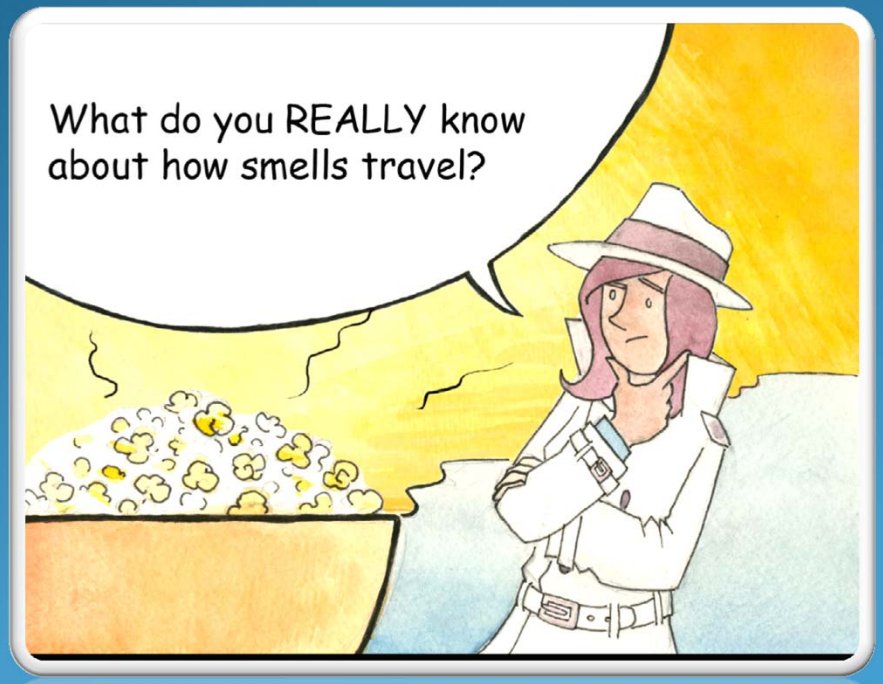
Some Key Questions



- Who are my learners?
- What is the learning context?
- What strategy will be most helpful?

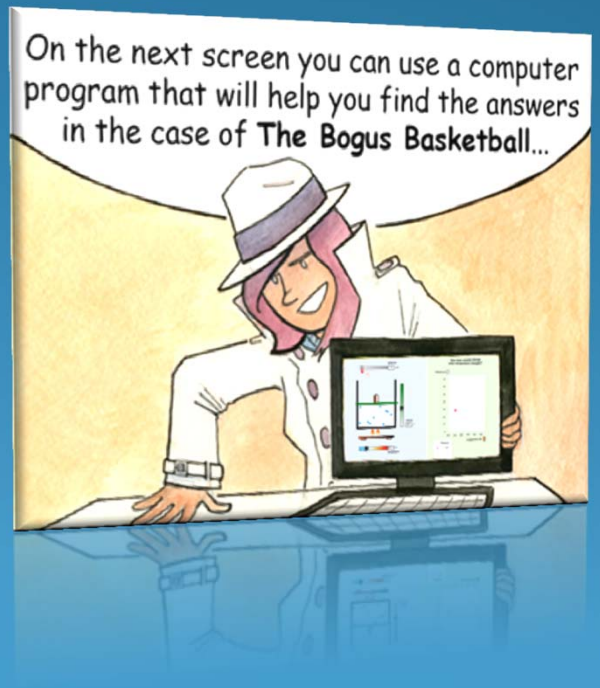
- We grappled with these questions as we designed the *Molecules and Minds* simulations

•As you make your own judgments about what resources to use, here are some things we learned through our research

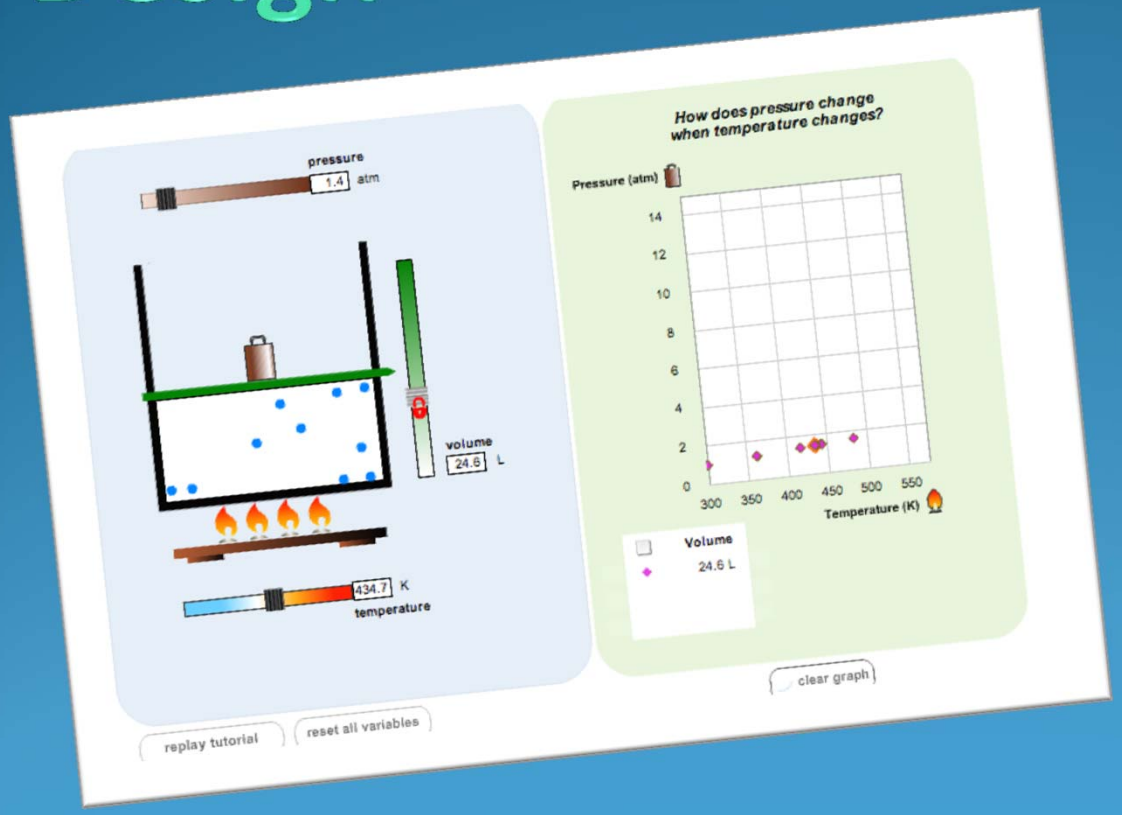
Levels of Representation

What does the resource look like?

- Simulations are more effective than pictures
- But what should they look like?
- We found that:



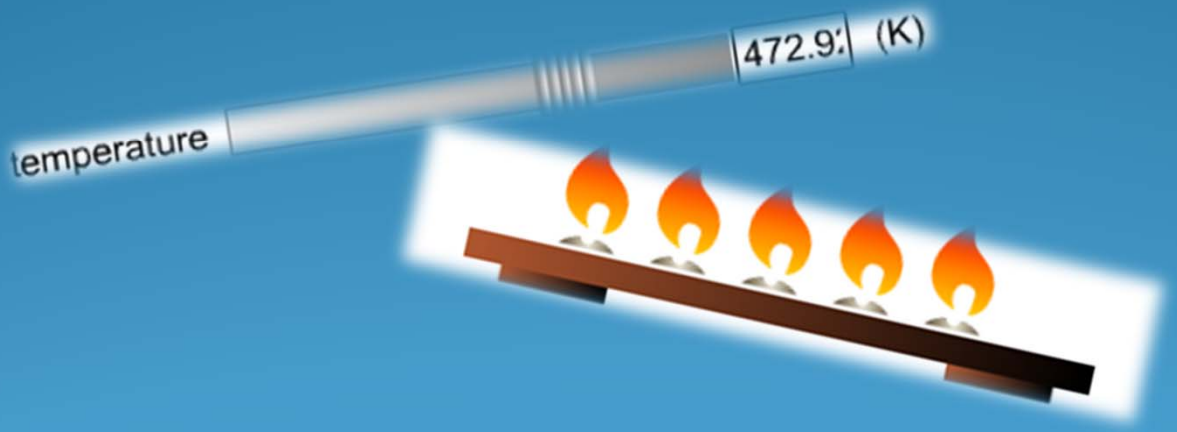
1. Big Ideas Need a Simple Design



- Why? Because bombarding the learner with unnecessary information inhibits learning.

- When you look for resources, think about clear and uncluttered!

How is the information represented?



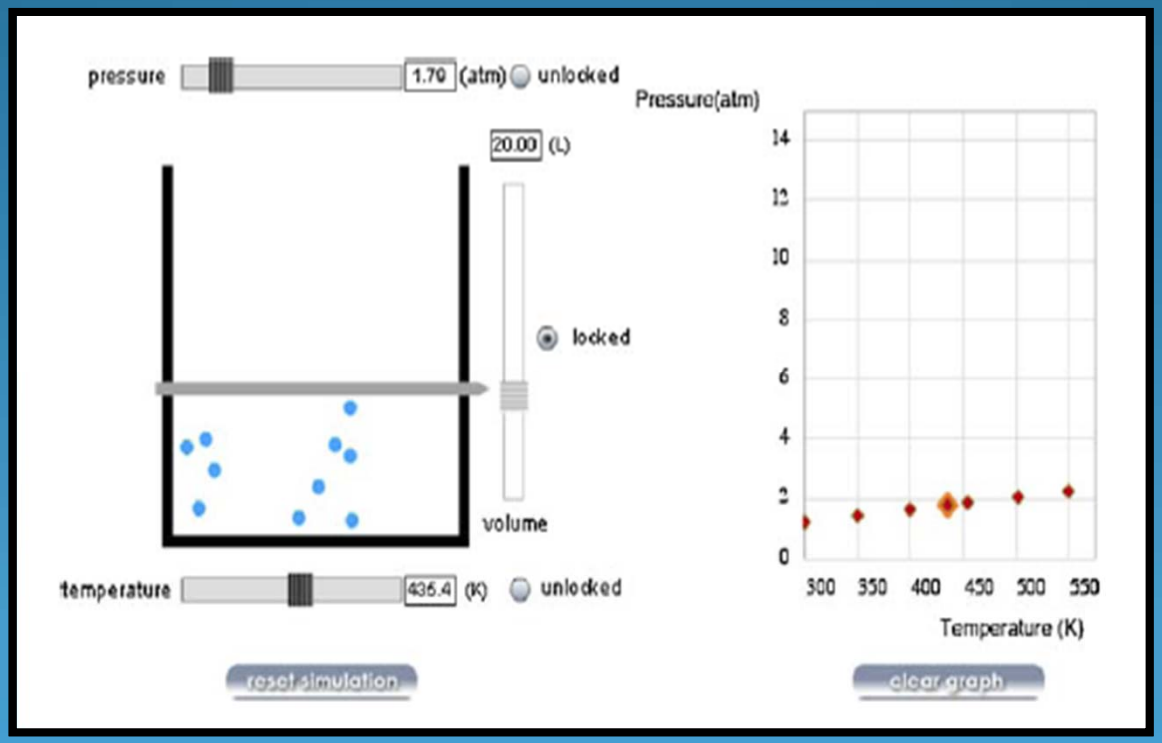
- We found that:

2. Icons Work Better than Symbols

- Why?
- Because icons have culturally accepted meanings.

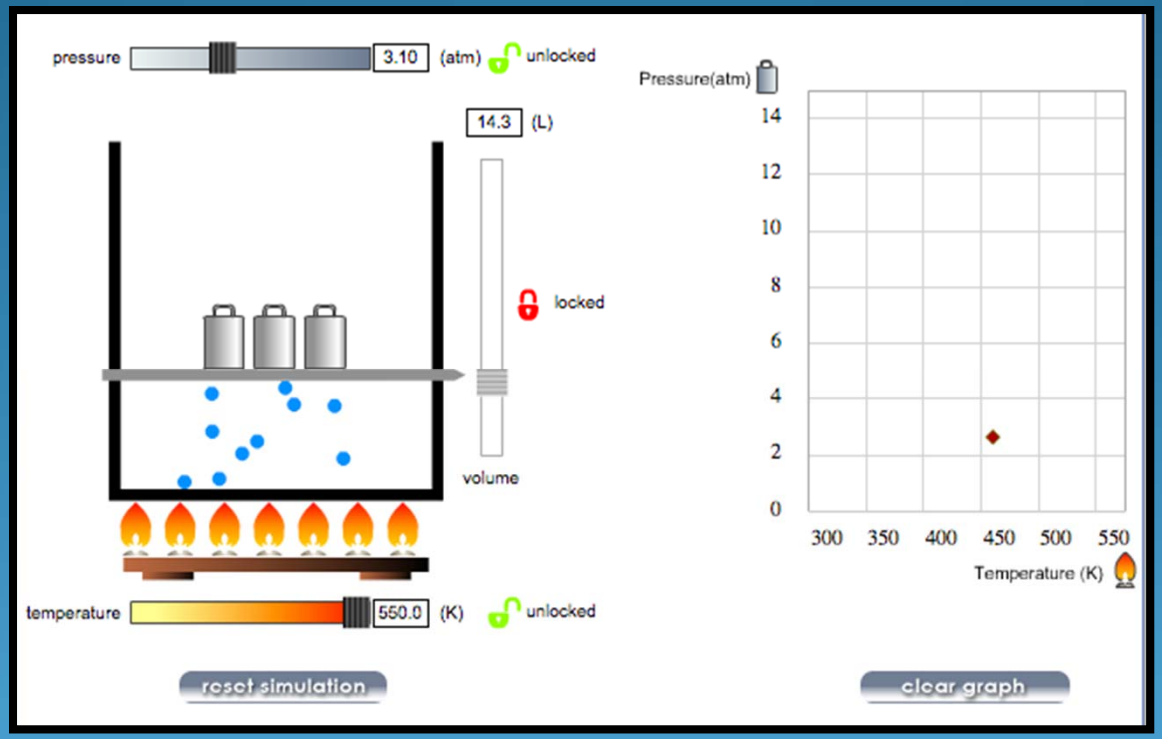
Symbolic

- Words are complex symbols that must be decoded



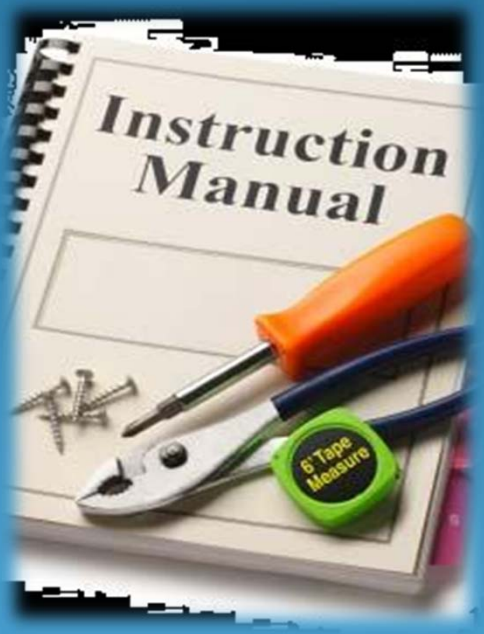
Iconic

- Icons are culturally understood representations



•When you look for resources, consider iconic representation!

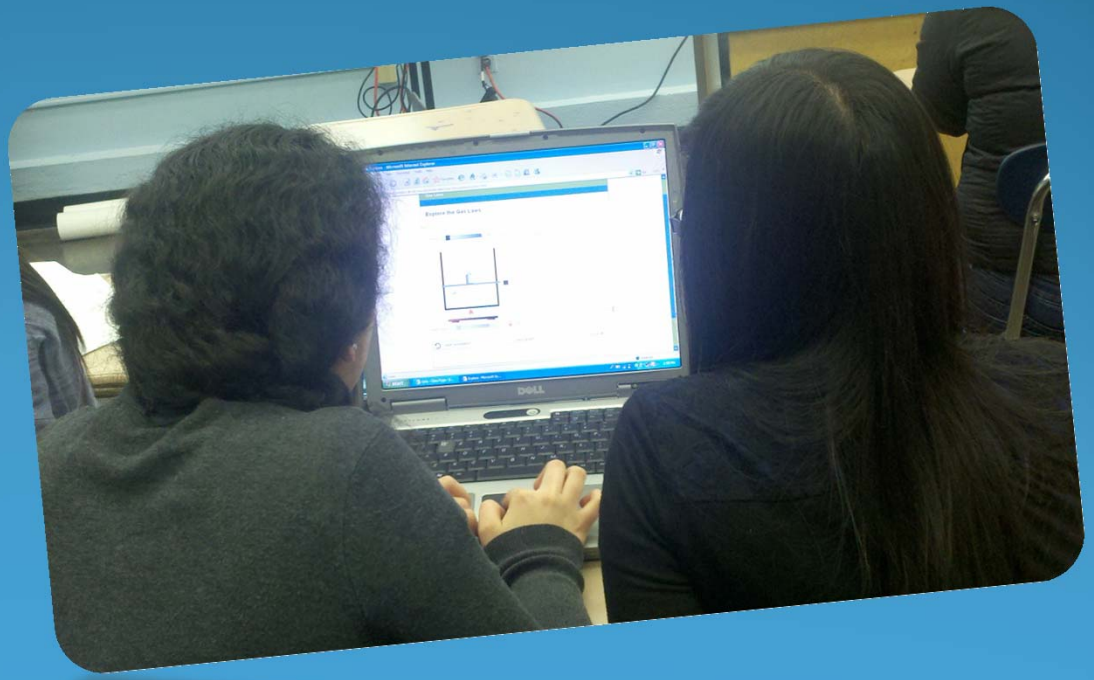
What learning strategies work best?



We found that:

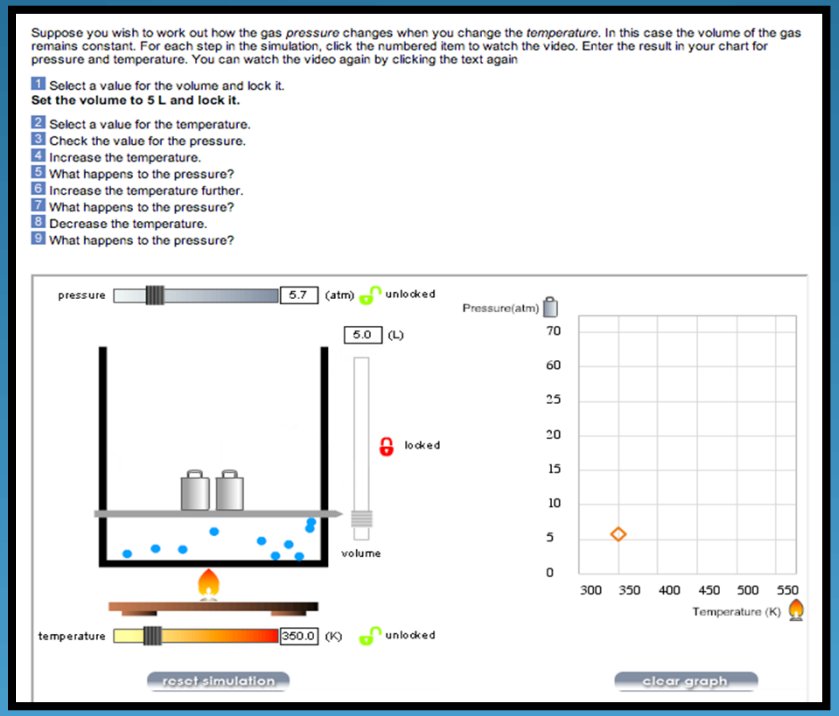
3. Freedom to Explore Supports Learning and Engagement

- Why? Because all learners value the opportunity to explore in a safe environment (even if they are not aware of it).



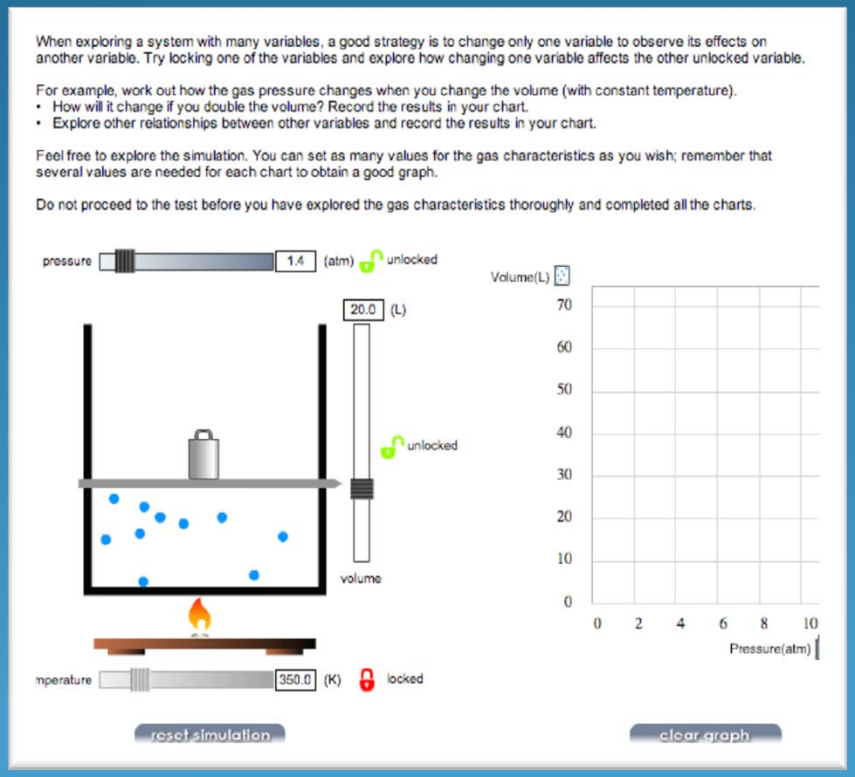
Worked-Out

- Learners follow step-by-step instructions



Exploratory

- Learners figure it out independently



- When you look for resources, consider exploratory learning!

What sequence of topics makes sense?

We found that:

4. The Order of Topics May Be Important for Learning

Why? Because learning complex theories will be more effective if the learner understands the underpinning concepts.

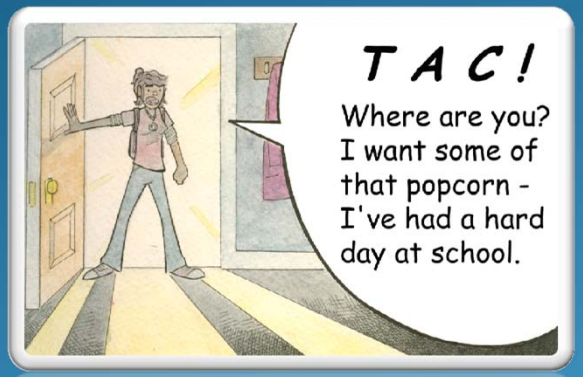
1. Diffusion	2. Kinetic Molecular Theory	3. Gas Laws	4. Phase Change
Particles in gases and liquids move randomly and quickly	Temperature affects the motion of particles	The behavior of gases is affected by pressure, volume, and temperature	Intermolecular forces
Motion is affected by particle size and temperature	The number of particles affects the motion of particles	If you want to make an argument for the relation between variables, one must be held constant in order to explore the affect of one upon the other	When particles exist as solids and liquids, there are forces of attraction between the particles that must be broken by heat.

- When you look for resources, does the order of topics make sense?

How is the material contextualized?

We found that:

5. A Problematizing narrative leads to better outcomes



Why? Problematizing narratives create a motivation to learn and help expand science learning from the classroom/lab into the outside world

When you look for resources, consider a problematizing narrative that connects science concepts with students' real-life experience

References

Big Ideas/Simple Designs:

Lee, H., Plass, J. L., & Homer, B. (2006). Optimizing cognitive load for learning from computer science simulations. *Journal of Educational Psychology, 98*, 902-913.

Icons/Symbols:

Plass, J.L., Homer, B.D., & Hayward, E. (2009). Design factors for educationally effective animations and simulations. *Journal of Computing in Higher Education, 21*(1), 31–61.

References

Exploration/Worked-Out

Homer, B., Plass, J.L., Milne, C., & Jordan, T. (2009). Icons and exploration: How interactions between learner characteristics and instructional design features affect learning in chemistry simulations. In S.C. Kong et al. (Eds.) *Proceedings of the 17th International Conference on Computers in Education [CDROM].* Hong Kong: Asia-Pacific Society for Computers in Education.

References

Order of Topics/Problematizing Narrative

Plass, J.L., Milne, C., Homer, B.D., Schwartz, R.N., Hayward, E.O., Jordan, T., Verkuilen, J., Ng, F., Wang, Y., & Barrientos, J. (2012). Investigating the effectiveness of computer simulations for chemistry learning. *Journal of Research in Science Teaching, 49*(3), 394-419.

Simulations Produce Better Learning:

Hoffler, T.N., & Leutner, D. (2007). Instruction animation vs. static pictures: A meta-analysis. *Learning and Instruction, 17*, 722-738.