Choosing Effective Multimedia Simulations for Chemistry Learning:
What Molecules & Minds Research Shows

Steven D. Yavner*, Catherine Milne*, Jan L. Plass*, Bruce Homer**, Trace Jordan*, Ruth N. Schwartz*

*NYU-Steinhardt **CUNY Graduate Center

Molecules & Minds Background

• Now in our 8th year of developing and refining chemistry simulations
• Supplements the teaching and learning of high school chemistry
• Designed to help learners understand observable, explanatory, and symbolic levels of representation
• Four topics: Diffusion, Kinetic Molecular Theory, Gas Laws, and Phase Change
• Simulations provide a model of what cannot be seen, and allow learners to manipulate variables and generate graphs
• Previous research showed that simulations can support effective learning (Plass et al., 2012)

Method

• Research conducted in urban and rural classrooms
• More than 2100 students
• Simulations refined through usability and efficacy studies
• Conclusions based on evaluation of posttests measuring knowledge and transfer
• Our studies indicated that the simulations fostered student learning of chemistry concepts (e.g., Homer & Plass, 2009; Homer, Plass, Milne, & Jordan, 2009; Plass et al., 2012).

Learning is Active (e.g. Bonwell & Eison, 1991)

Define a problem, make predictions, form hypotheses, observe & interpret data

Context is Everything (e.g. Brown, Collins, & Duguid, 2008)

Problematizing narratives show how science can explain everyday phenomena

Visualizations Support Learning & Inquiry (e.g. Reigeluth & Schwartz, 1989)

Illustrating what cannot be seen helps learners form their own representations

Theoretical Framework

Scaffolding Helps Learning (e.g. Vygotsky, 1978; Wood, Bruner, & Ross, 1976)

Narrative scaffolds help connect science to everyday life; visual scaffolds help connect the three levels of representation

Model-based Inquiry (e.g., Windschittl, Thompson, & Braaten, 2008)

Learner interaction with the simulations allows them to use their own manipulations for observations, predictions, & interpretations

Visualizations

1. A problematizing narrative leads to better outcomes

An eloquent teacher with ANYTHING about how gases behaved. Sounds silly... right? Well, maybe NOT so silly. Get ready to think about...

2. Big ideas need a simple design

Expanding science learning from the classroom/lab to the outside world increases motivation and engagement

3. Icons work better than symbols

Icons have culturally accepted meanings. Words are complex symbols that must be decoded

4. Freedom to explore supports learning and engagement

Limited direction and structure was more effective than step-by-step instruction in producing better learning outcomes and generating higher levels of motivation

5. The order of topics may be important for learning

Learners mastered complex theories more effectively when they understood the underpinning concepts

Conclusions

Simulations refined through usability and efficacy studies

Simulations fostered student learning of chemistry concepts

11th graders using the Molecules & Minds simulations

Simulations and curriculum material are available for free and unrestricted use at: www.create.nyu.edu/mm

Select References


