Doing Science Using Inquiry-based OER Simulations

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Realizing the Promise of Education Technology

- A nonprofit educational research and development organization based in Concord, Massachusetts.

- We create interactive materials that leverage the power of information technologies.

- Our goal is to improve learning opportunities for ALL students.

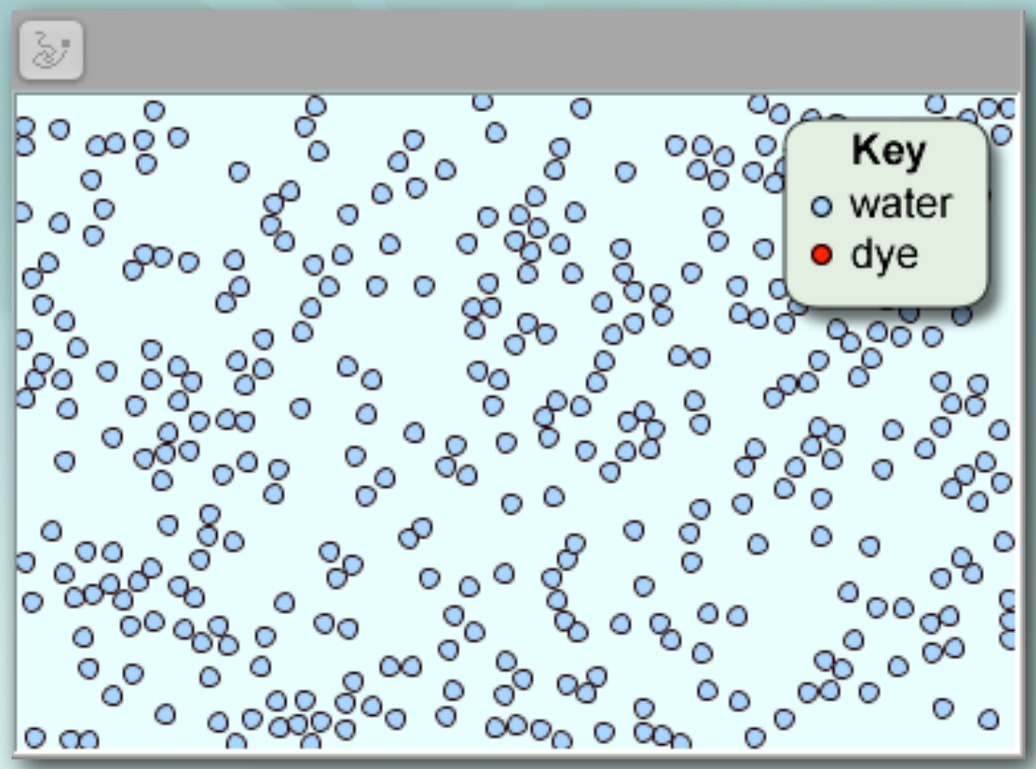
Scientific Practices

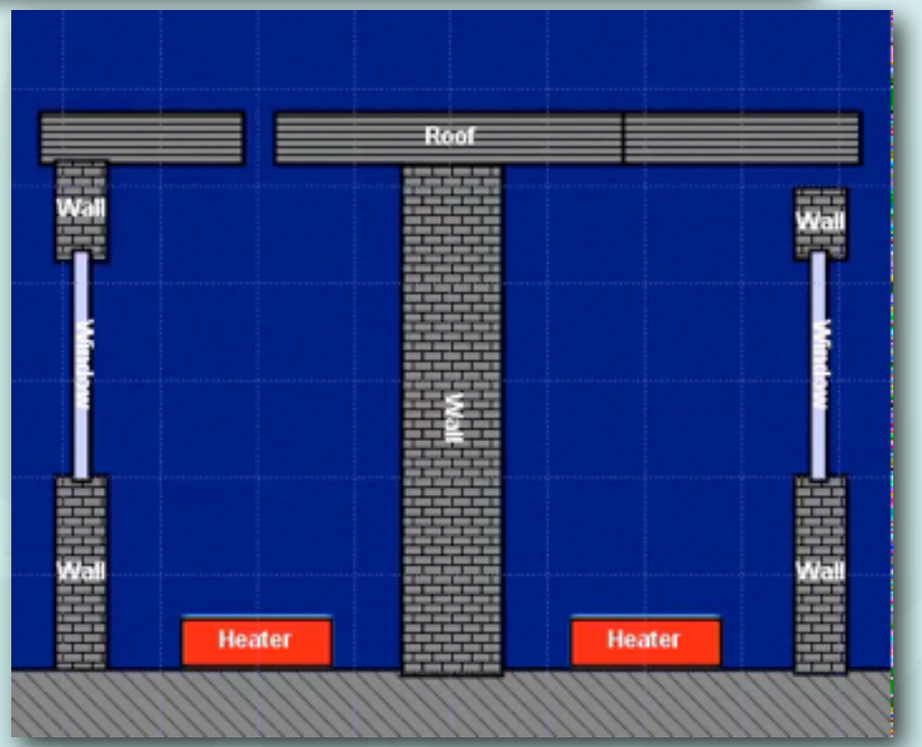
(From NRC Framework for Science Education)

- Asking questions / defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations / designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Models

Modes of Inquiry - Models





Use the animation controls below
to go on a guided tour of an aquapore.

At each stop on the tour
you can explore the model by
dragging the mouse to rotate the model
and shift-dragging to zoom the model.

Check out the questions below
to find out what kind of snapshots
you should take along the way.

*Note: With large biological molecules the hydrogen atoms are commonly not shown.

Jmol

Ideal Learning Environment

- Dynamic nature of many systems not easily conveyed with text and static images.

- Animations help, but don't allow students to construct knowledge. Student is passive learner.

- **Models which are computed in real-time allow users to probe the simulation by changing parameters. Student becomes an active learner.**

The Modeling Environment:

Molecular Workbench – a molecular dynamics tool.

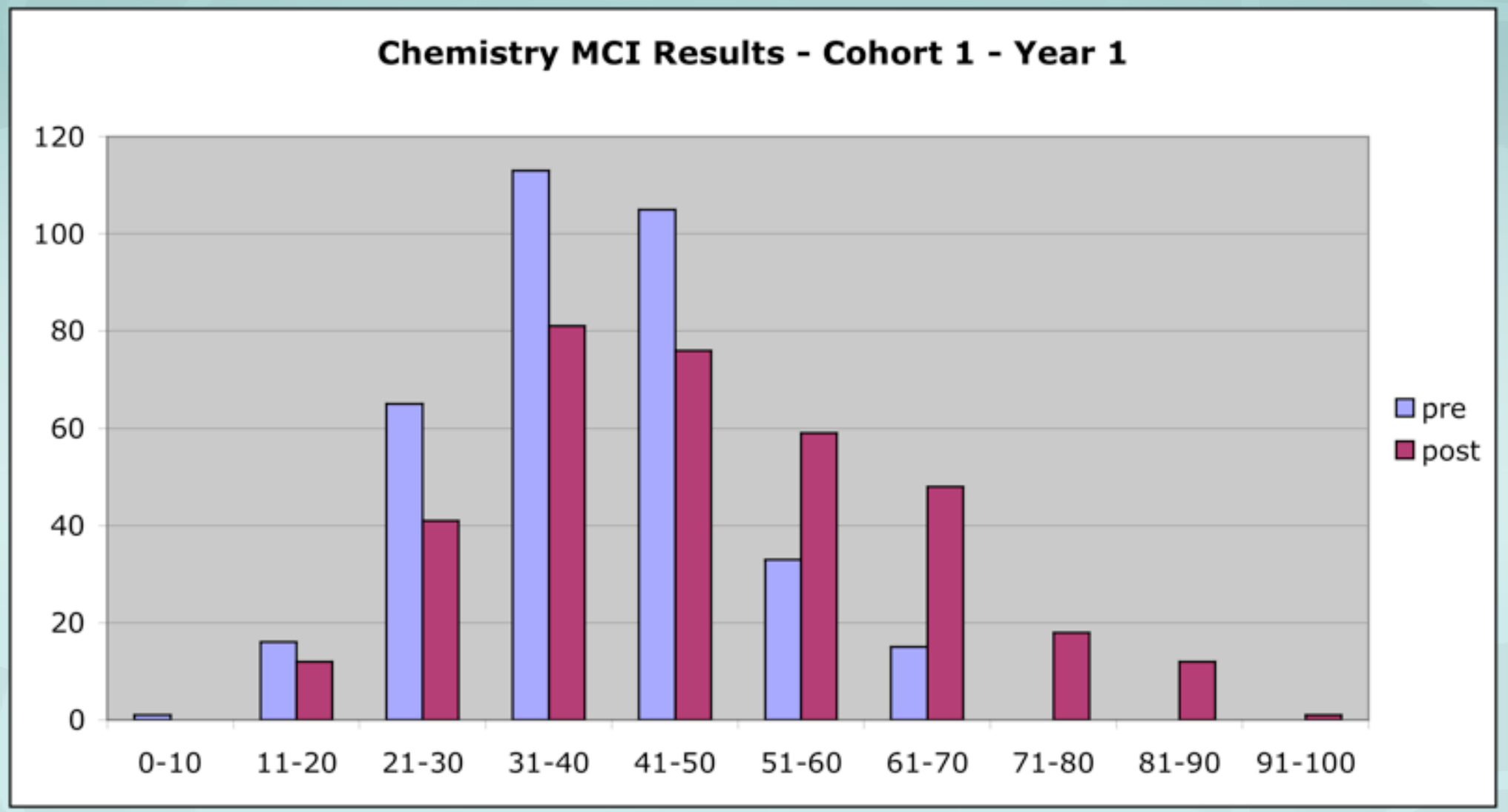
The Molecular Workbench – a molecular dynamics tool.

- Open-source cross-platform molecular dynamic engine.
- Calculates complex real-time interactions between atoms and molecules.
- User friendly interface for creating custom model-based activities.

Inquiry Is Key

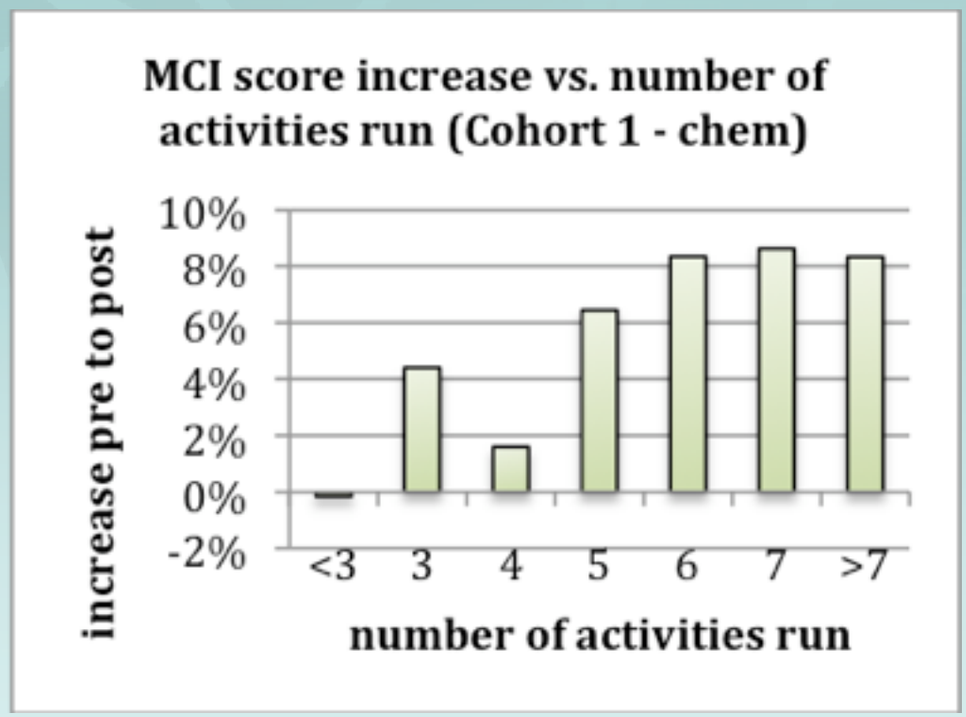
- Going deeper can simplify science
  - Most scientific phenomena can be explained by fundamental ideas of the atomic nature of matter, conservation of energy, Nature's tendency toward equilibrium.
  - Science through this lens is more connected - less individual facts to "memorize".
- Conceptual understanding is the goal.
- Utilize interactive models, to allow inquiry at the atomic level.
- Teachers are essential for inquiry approach to work.

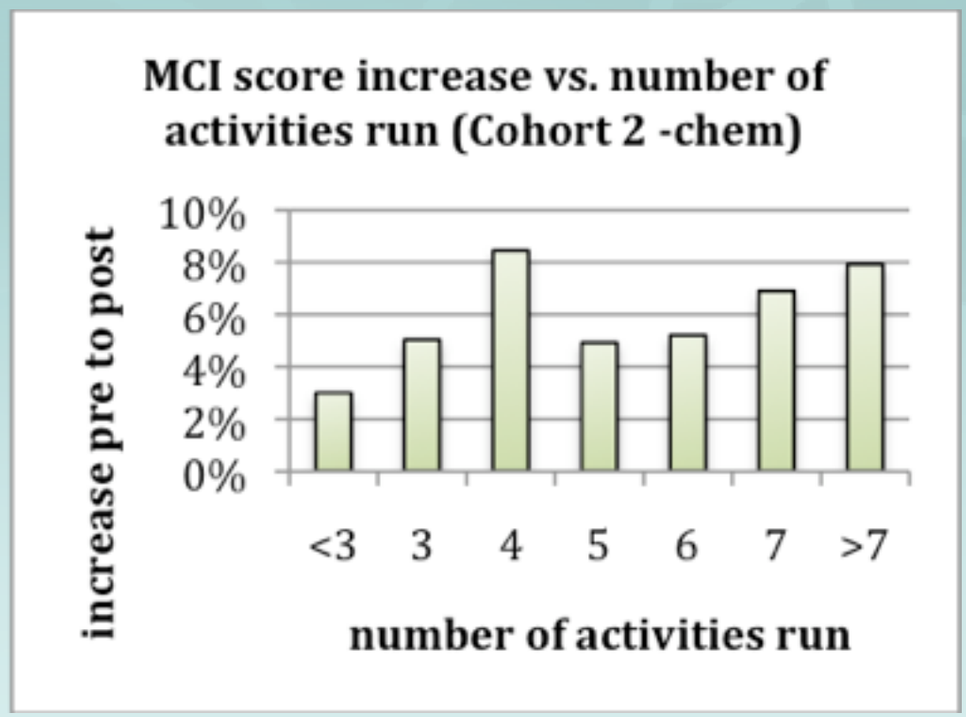
MCI Results
Cohort 1 - Chem

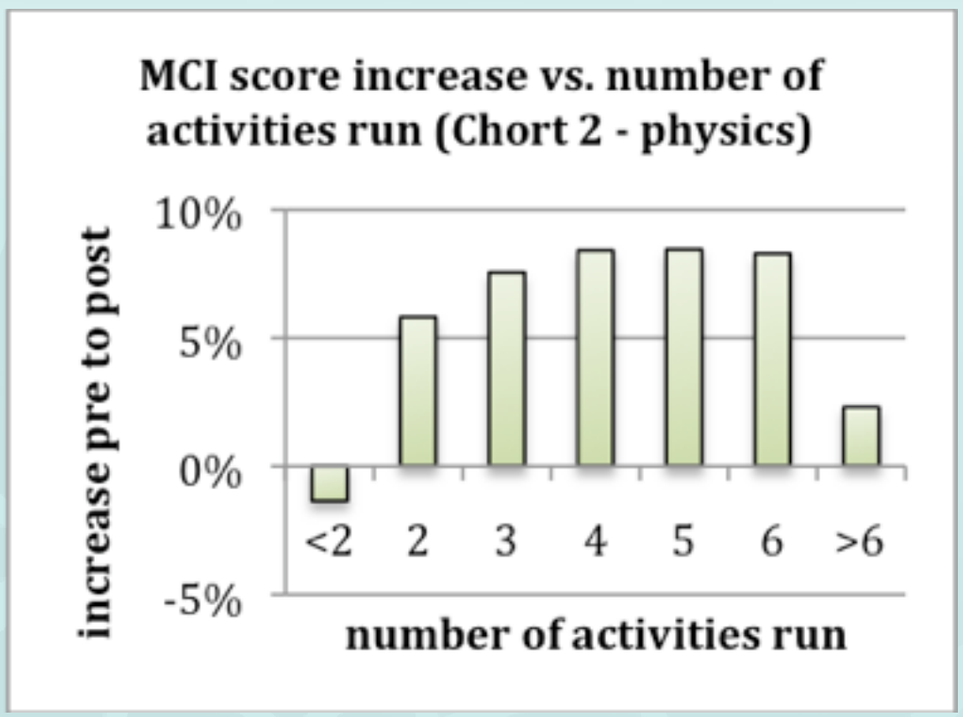


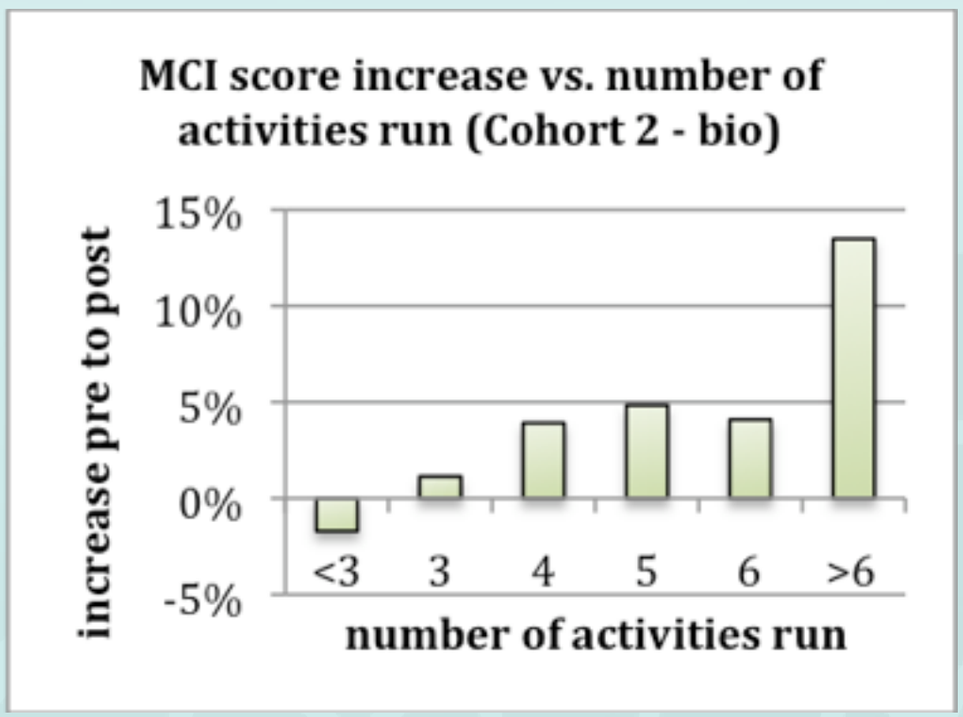
Group	Pre-test mean	Post-test mean	n	p-value based on paired t-test	Cohen's d	Effect size
Chemistry	39%	47%	348	7.8e-32	0.6	Moderate

Score increases related to number of SAM activities completed



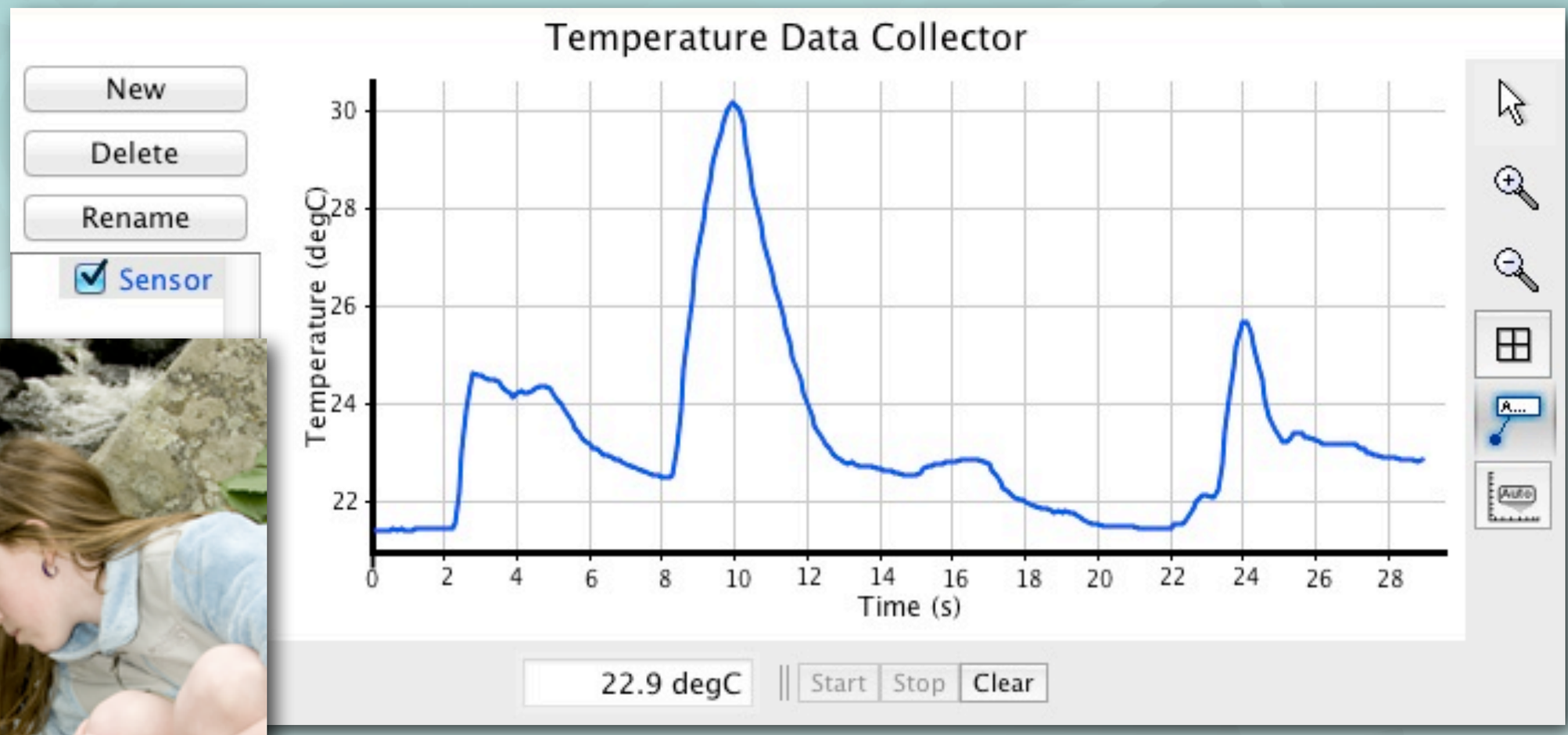






Probes and Graphs

Modes of Inquiry - Probes



Probes are Valuable Tools

- **displays immediately** data that one normally can't see with another device (sonar ranger displays velocity and acceleration)

- **collects data faster** than normal devices (sometimes over thousands of times per second)

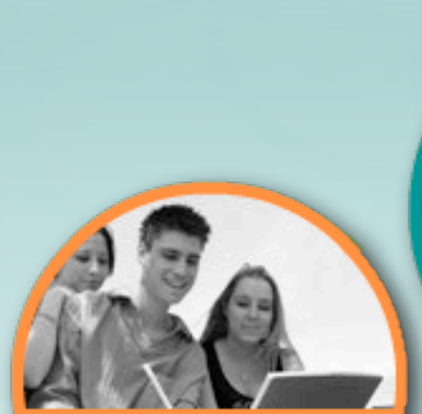
- records and displays **data collected over long periods** of time (some even up to a year)

- displays **simultaneously on the same graph** combines the collection from **multiple probes**

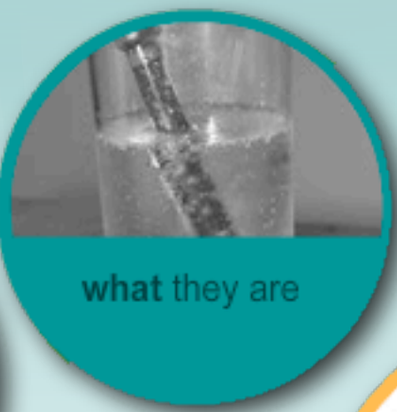
- uses the results of two or more different probes to provide a **derived display** (for example, electrical power being displayed from data collected from a voltage and current probe)

The Concord Consortium

ProbeSight



collaboration



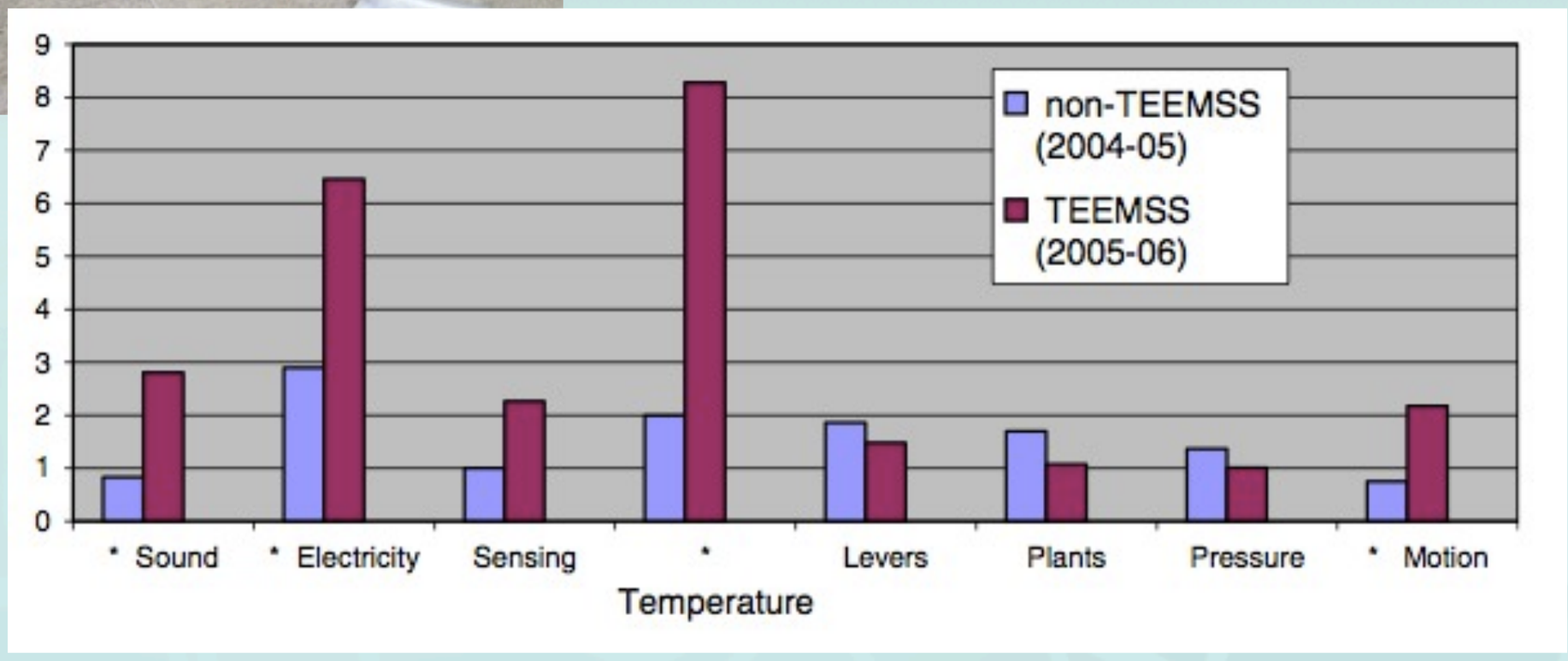
what they are

what's new

curriculum
ideas

supplier
index

The TEEMSS 2 curriculum was found to have potentially positive effects on general science achievement for elementary school students in grades 3–4.

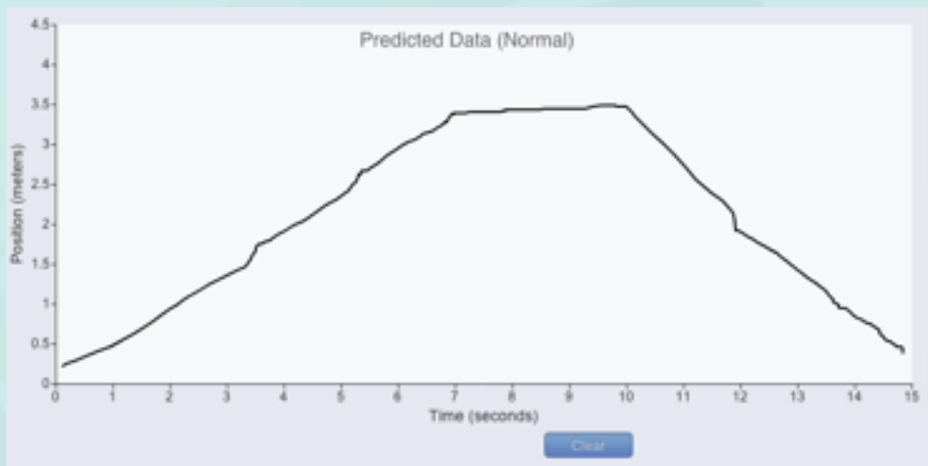


Listed as an effective curriculum in the prestigious What Works Clearinghouse.

Understanding Graphs

- Graphs are central to teaching and learning in many STEM courses and Common Core for Mathematics
- However, many students, at all ages, have difficulty *understanding* graphs and the concepts represented in graphs including scaling, slope and best fit.
- SmartGraphs is designed to help students understand graphs and the concepts they represent.
- Tools include pick a place, constructed or numeric responses, slope tool sequence,

  visual and textual scaffolding, etc.



SmartGraphs Results for Q2

Pre/Post Gains

	Experimental	**Control**	**Significance**
Total	5.07	4.30	p = .008
Multiple-Choice	1.16	1.07	p = .049
Open-Response	4.19	3.64	p = .043

n=1,686

Games

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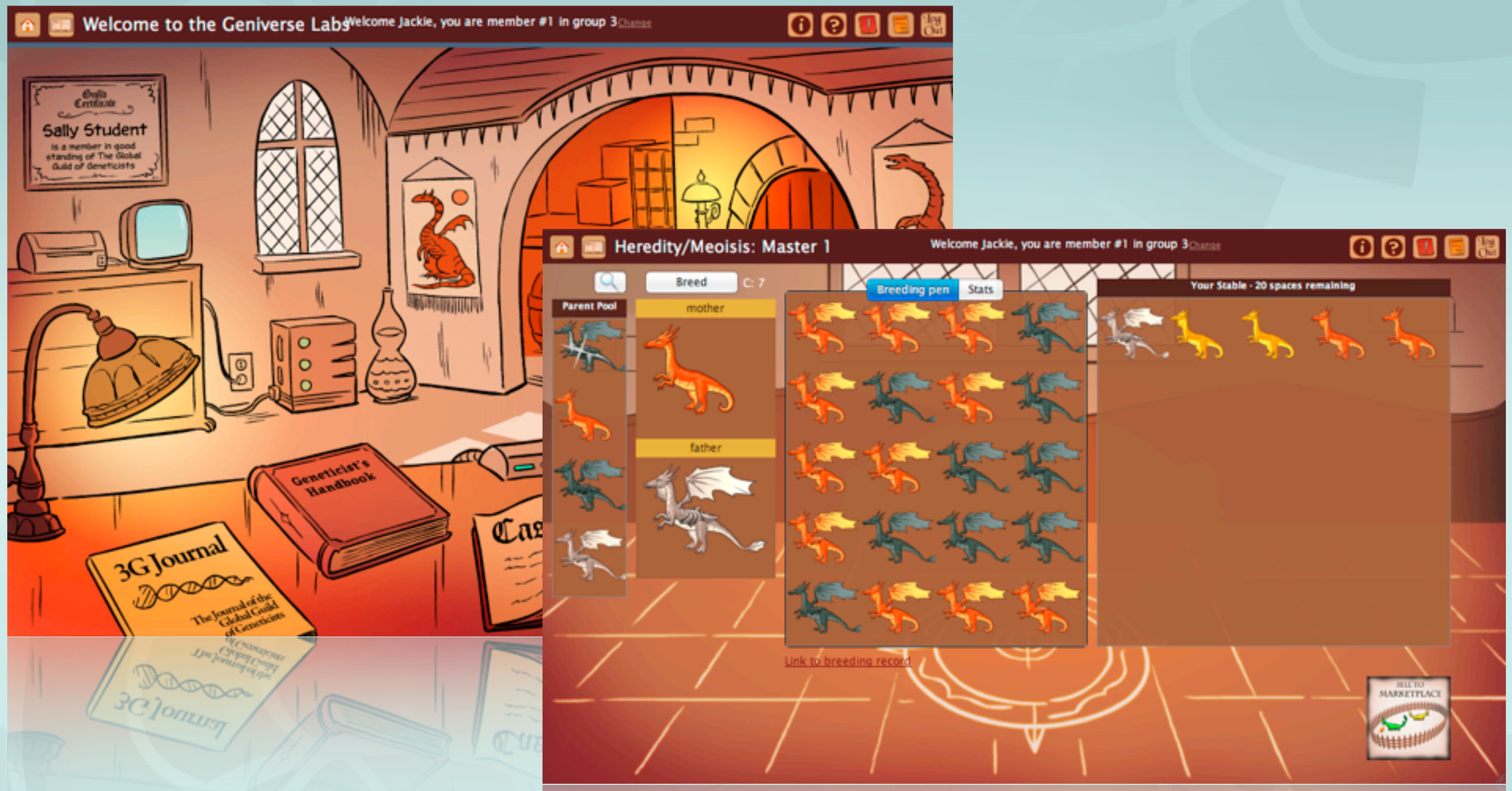
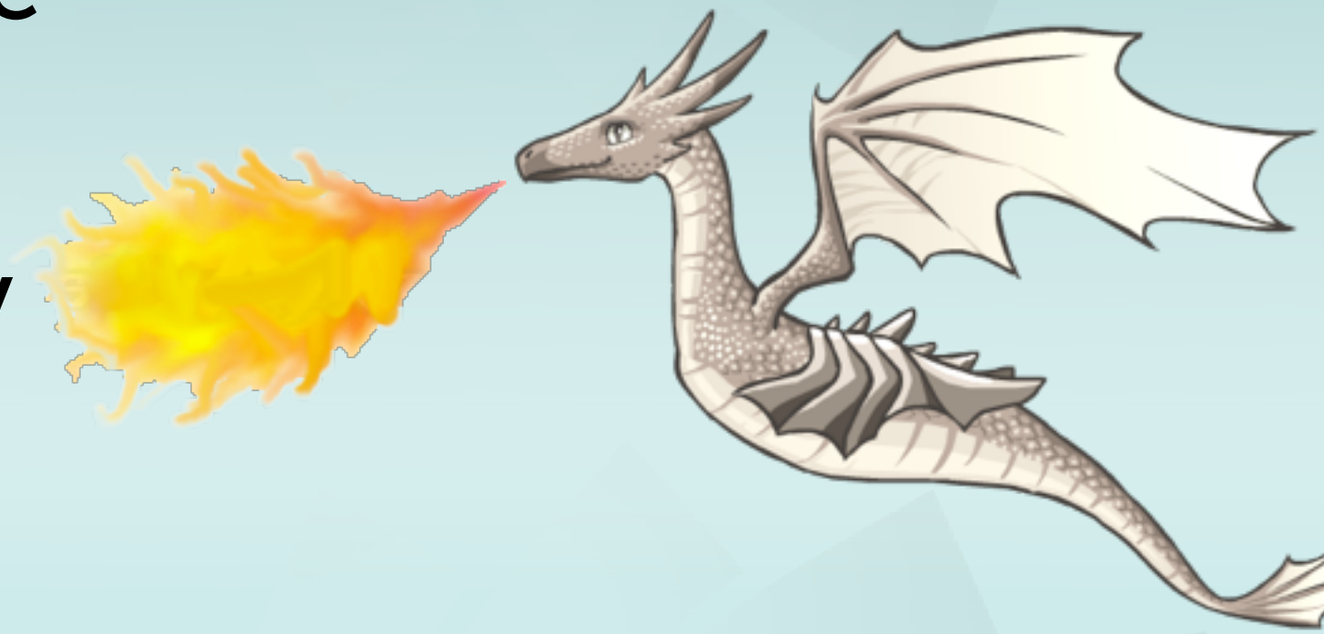
Geniverse



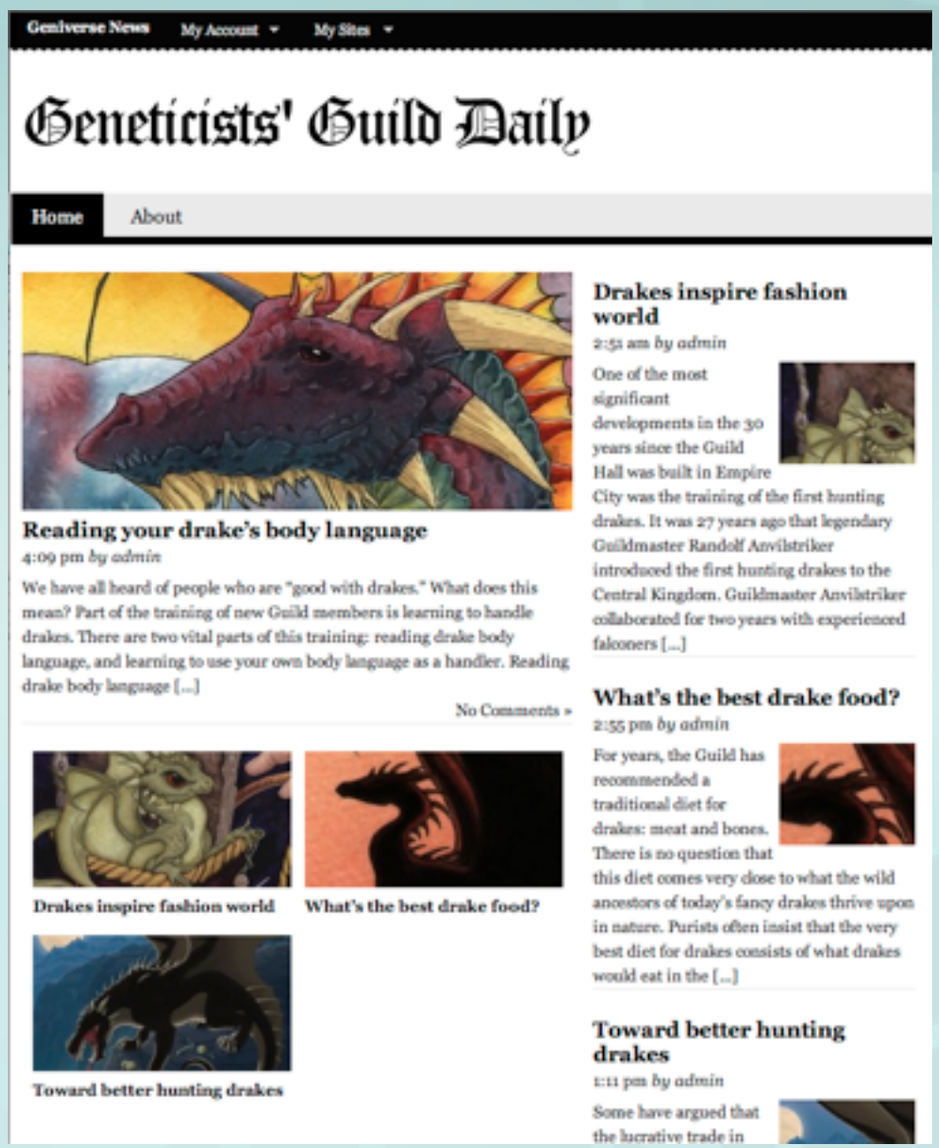
Science vs. Gameplay

- Accurate science
- Maintain fun elements of play
- Motivation
- Assessment



Student As Scientist

- Scientific process
- Focus on argumentation and reasoning
- Class, group, and student blogs

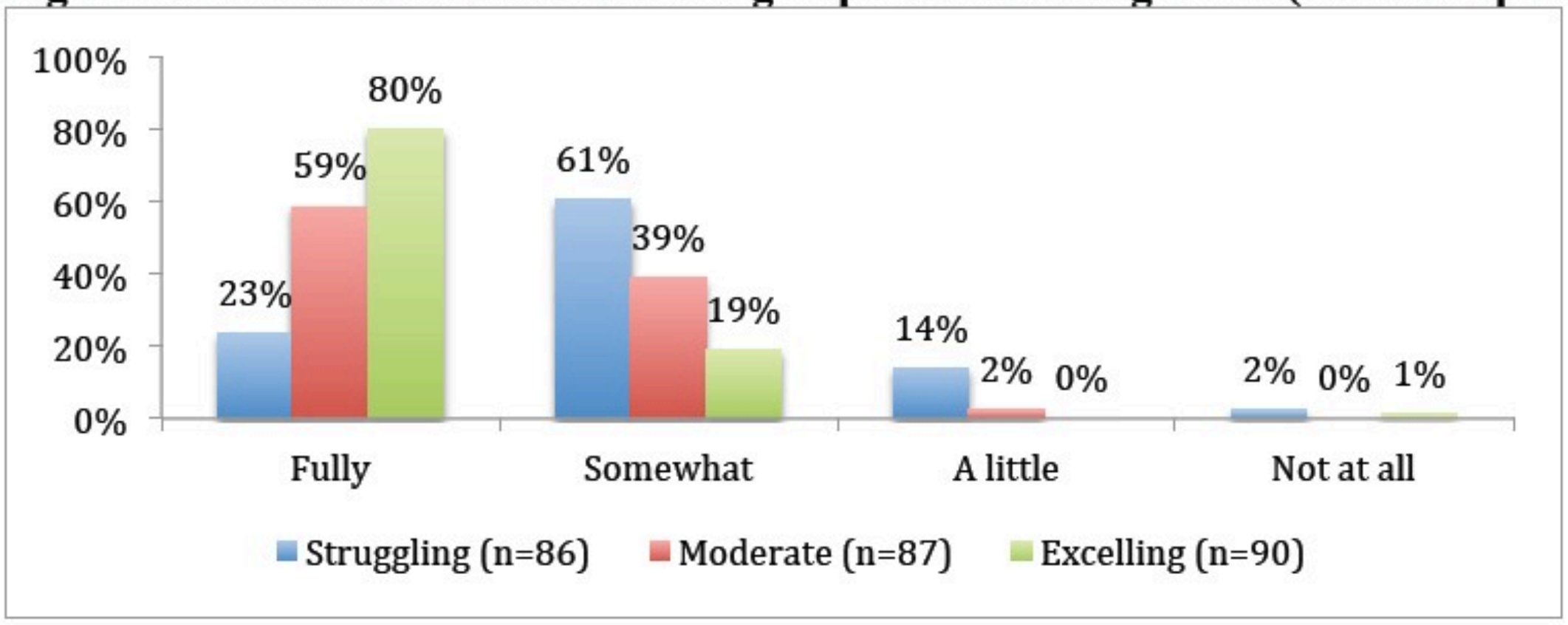


Geniverse Results

"They snuck into the next level because they wanted to keep playing. Also, students played the game at home, even though this was not required.

Students also went back to complete the same level again because they were 'mad' that the didn't get all three stars. The stars are a great idea."

Figure 4: Percent of Students Achieving Expected Learning Goals (teacher report)



Finding Models and Activities - Current and Past Projects

- Science of Atoms and Molecules (SAM/RI-ITEST)
- High Adventure Science
- Geniverse
- Evolution Readiness
- Electron Technologies
- Engineering Energy Efficiency
- Innovative Technology in Science Inquiry (ITSI-SU)
- SmartGraphs

Science of Atoms and Molecules

Finding Materials

- **Molecular Workbench Application and Database**
  http://mw.concord.org

- **NextGen MW - HTML5 version**
  http://mw.concord.org/nextgen/
  experimental site at: http://lab.concord.org

- **Various Project portals**
  http://www.concord.org/projects

Integration with Online Courses

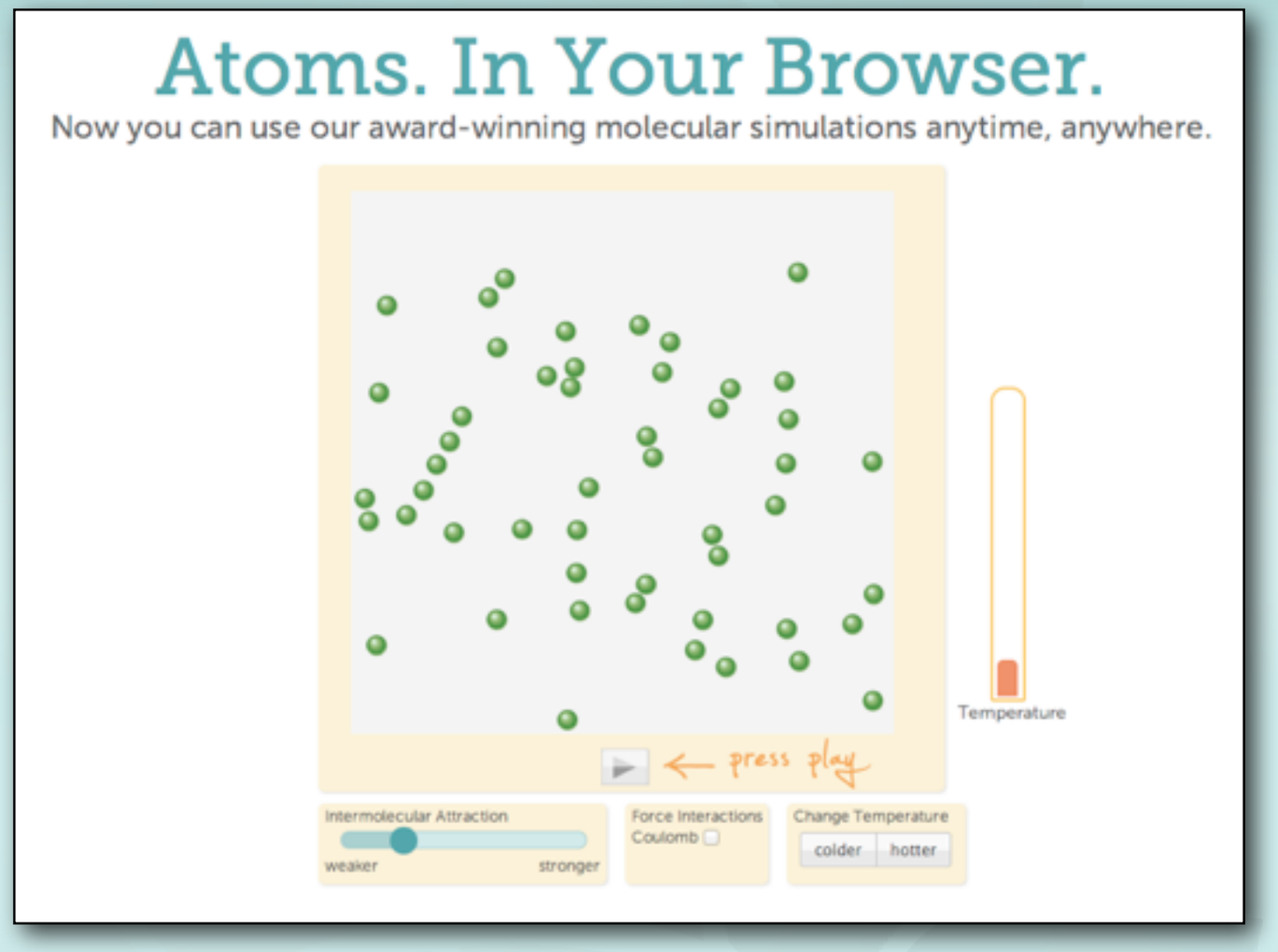
Current Integration Possibilities

- launch as "preview" mode (no registration)
  - common experience for discussion
  - can create your own questions to be asked within whatever system you use
  - if blended mode, could even hand out paper with questions
  - If running an MW authored activity, many have a "print" option which could print to PDF for online submission (or paper)

- register class for portal containing particular activity
  - will collect data electronically
  - teachers can generate customized reports

Current Integration Possibilities

- Embed Interactives in your own system
- Possible for NextGen MW found at http://lab.concord.org
- Or Classic MW applets most easily viewed at the MW showcase page http://mw.concord.org/showcase



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