



The Concord
Consortium

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.

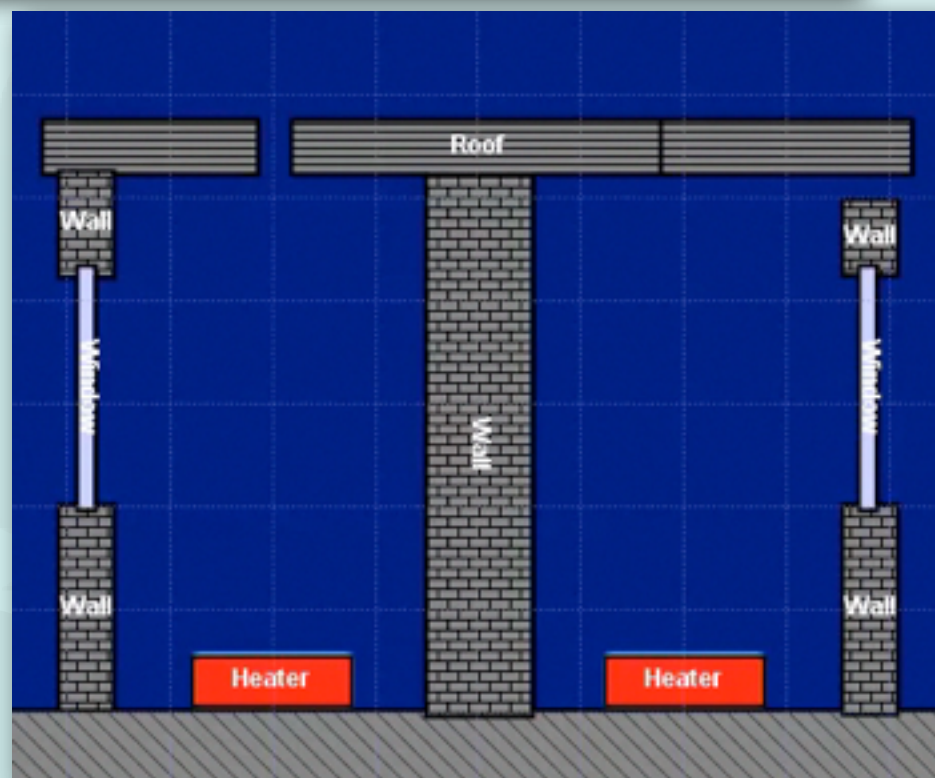
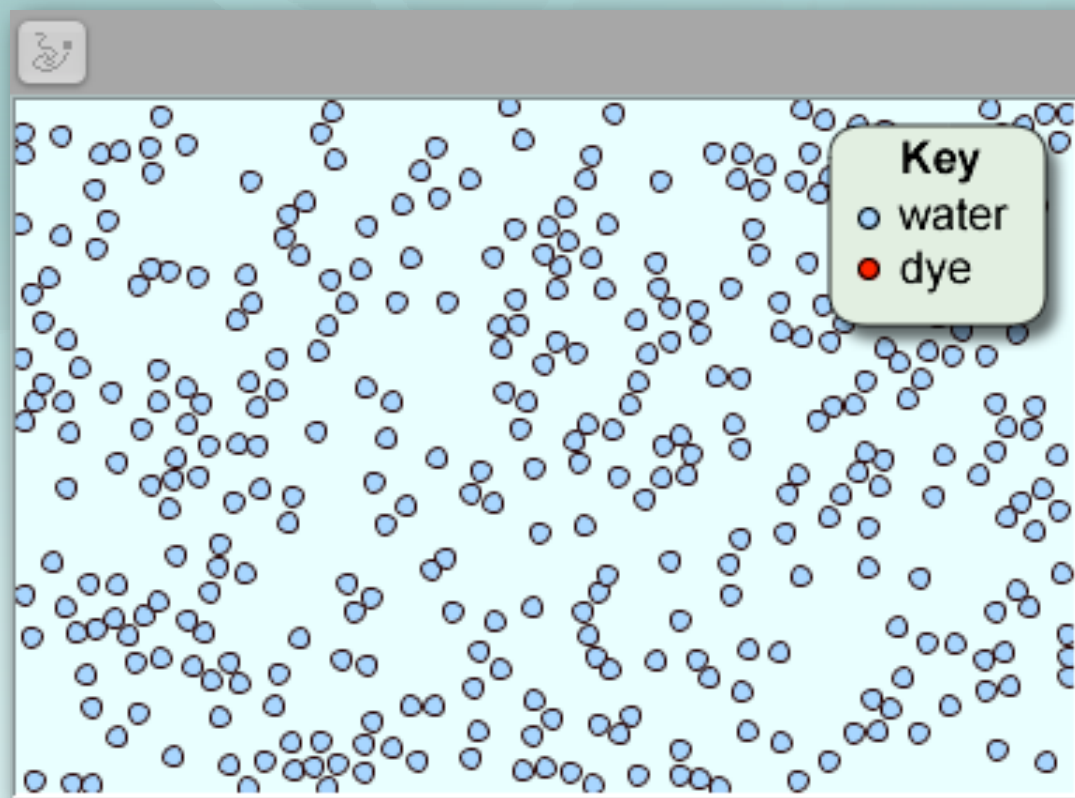
Scientific Practices

(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

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Jmol

you should take along the way.

to find out what kind of snapshots

- 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.



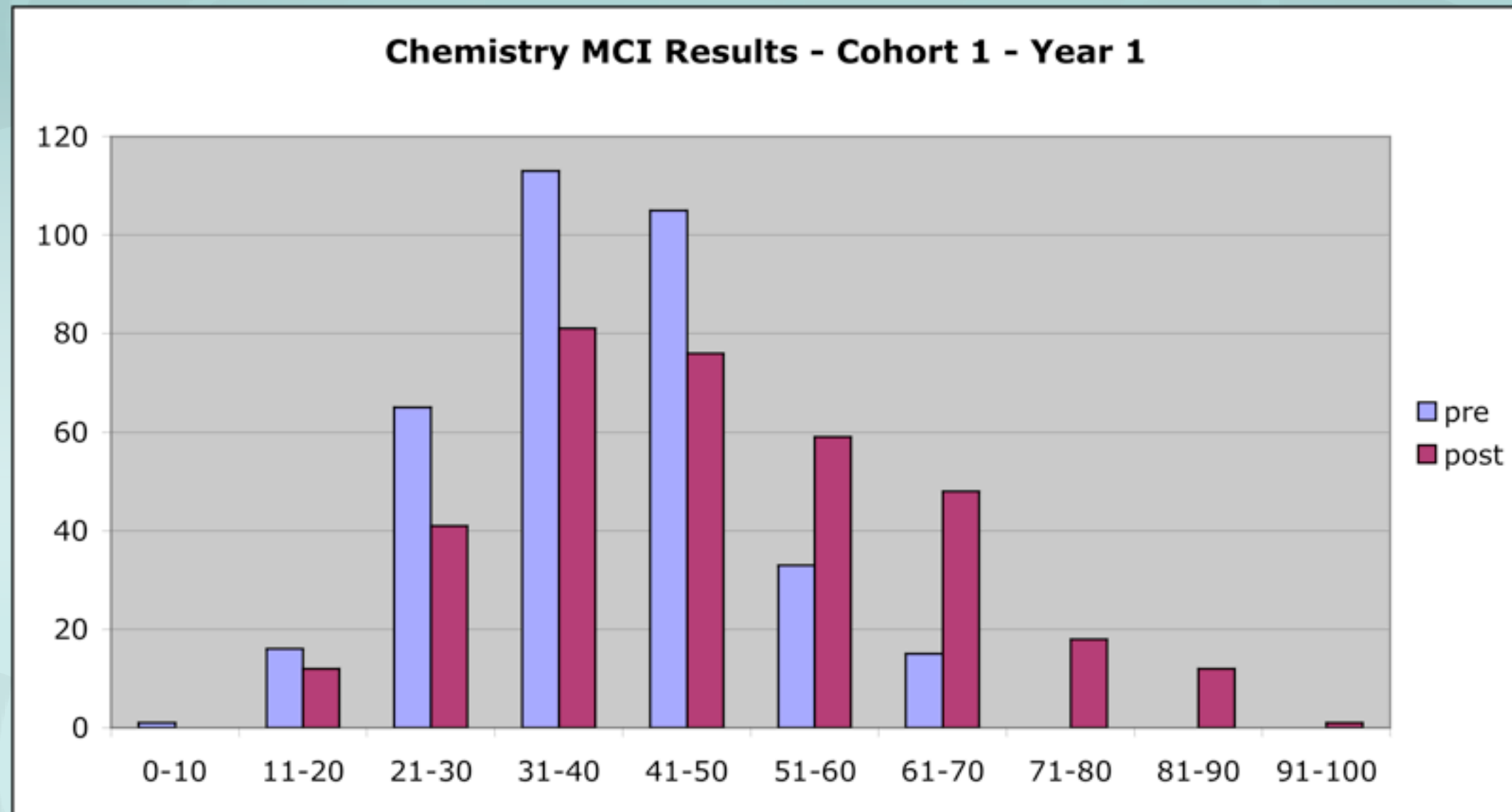
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Inquiry Is Key

- 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

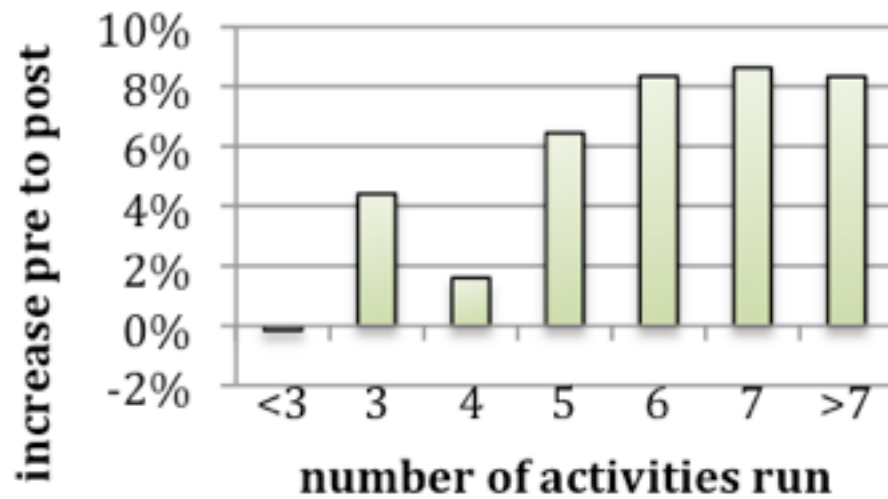
Cohort 1 - Chem



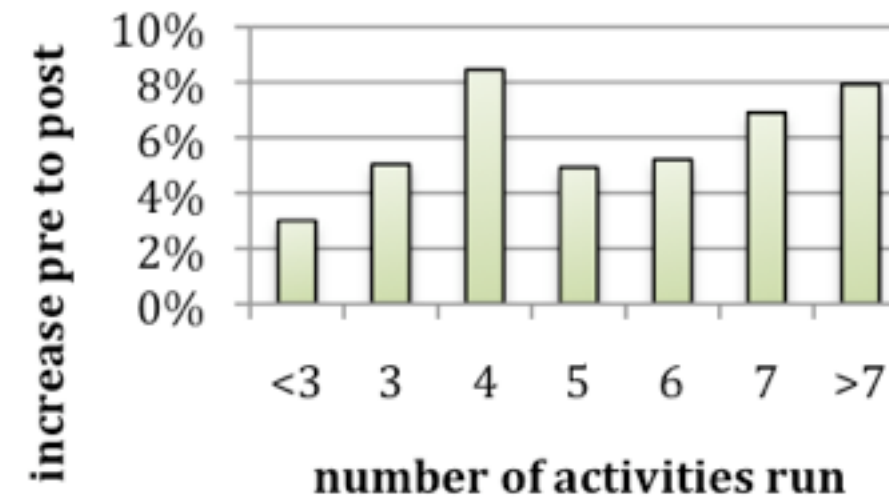
Group	Pre-test mean	Post-test mean	n	p-value based on paired t-test	Cohen's d	Effect size
Chemistry	39%	47%	348	7.8e-32	0.6	Moderate

Score increases related to number of SAM activities completed

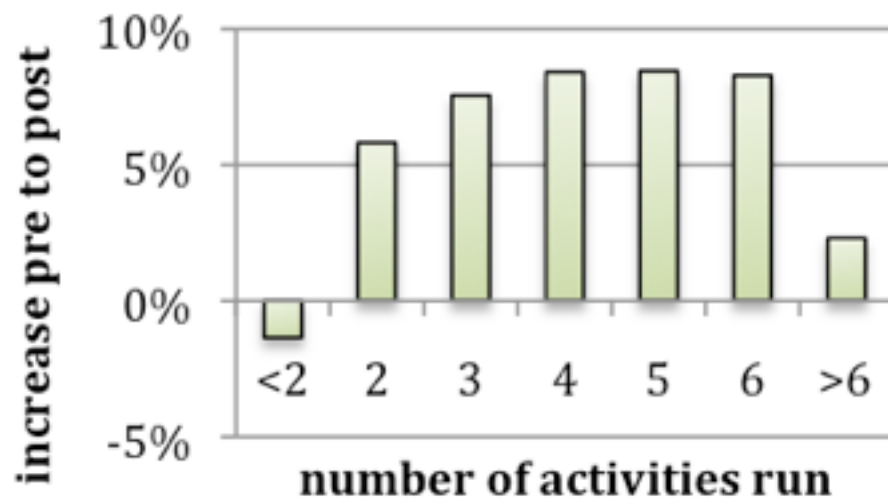
MCI score increase vs. number of activities run (Cohort 1 - chem)



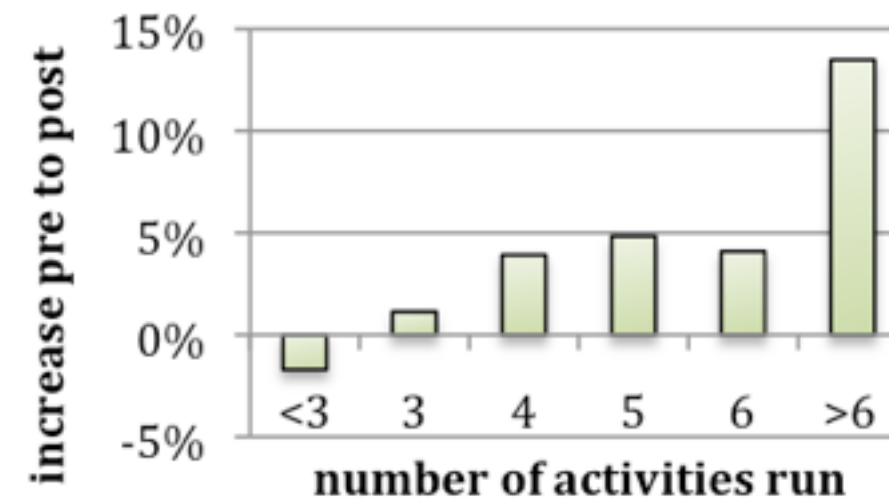
MCI score increase vs. number of activities run (Cohort 2 - chem)



MCI score increase vs. number of activities run (Chort 2 - physics)

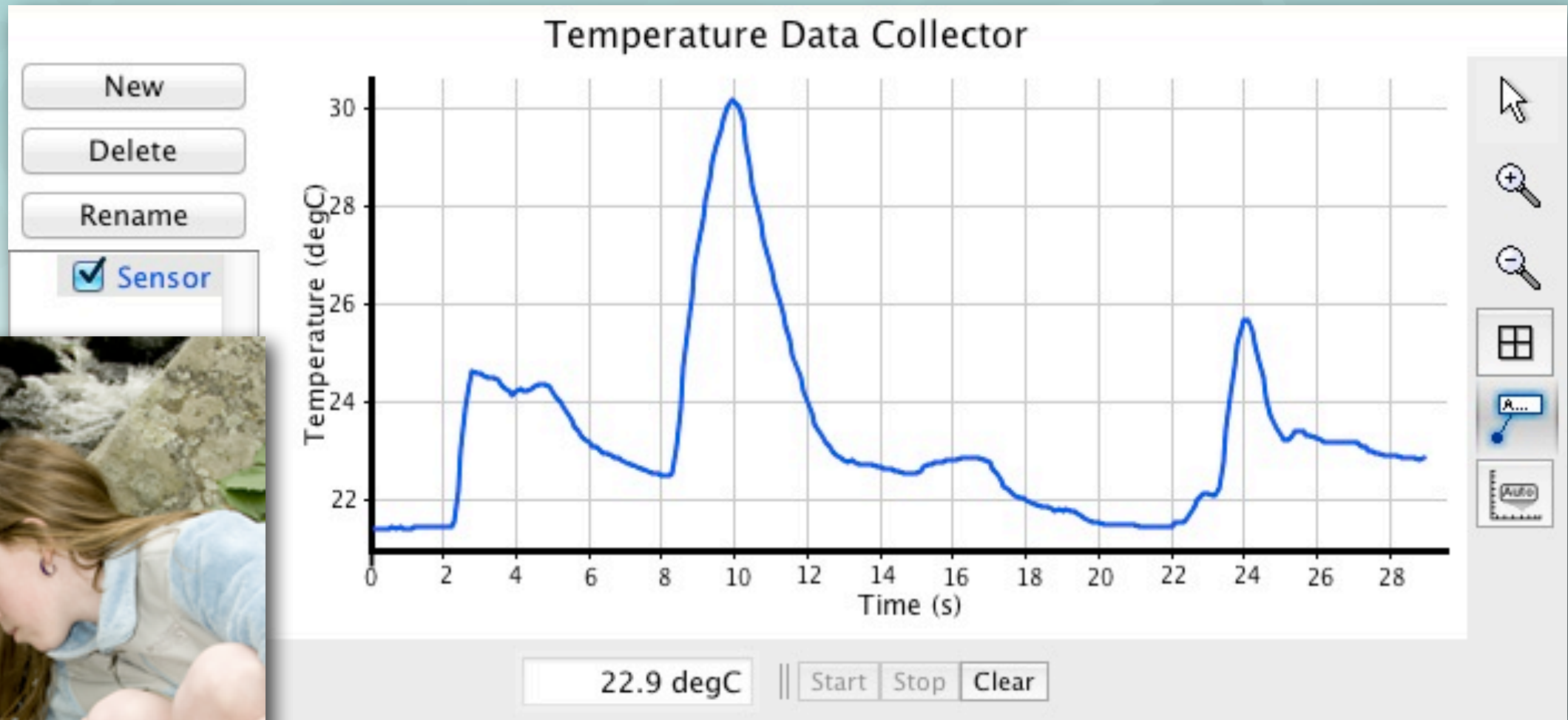


MCI score increase vs. number of activities run (Cohort 2 - bio)



Probes and Graphs

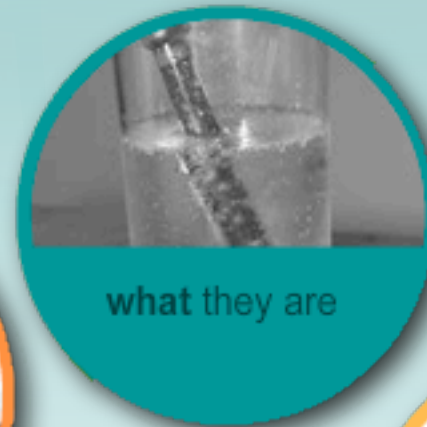
Modes of Inquiry - Probes



Probes are Valuable Tools

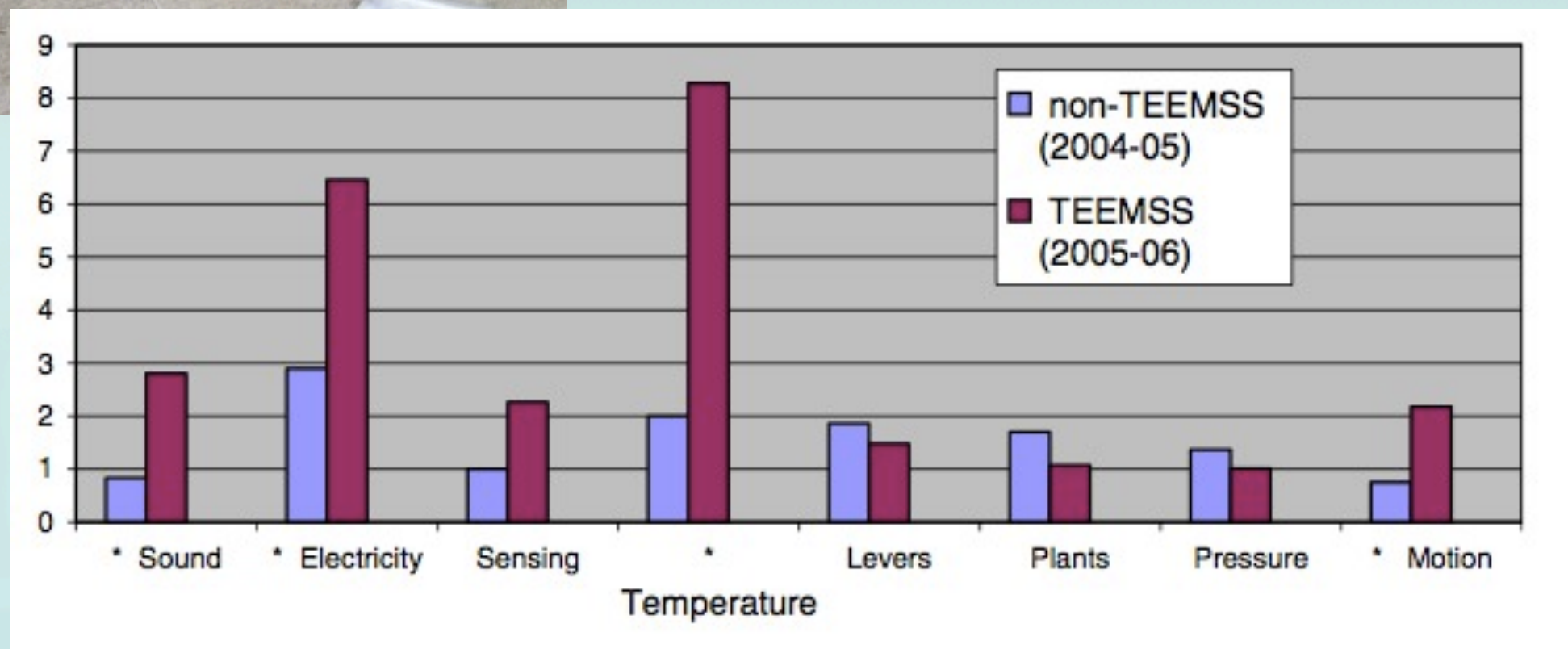
- **displays immediately** data that one normally can't see with another device (sonar ranger displays velocity and acceleration)
- **collects data faster** than normal devices (sometimes over thousands of times per second)
- records and displays **data collected over long periods** of time (some even 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)

ProbeSight





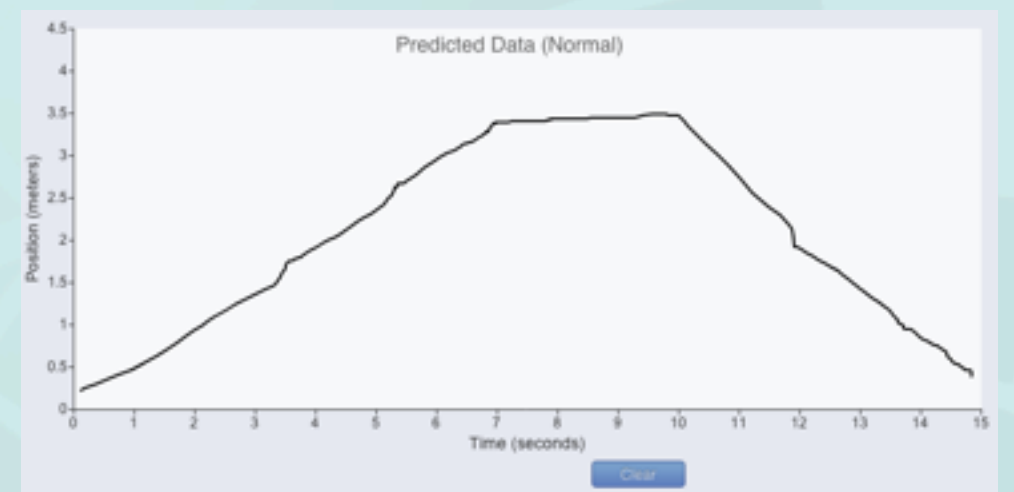
The TEEMSS 2 curriculum was found to have potentially positive effects on general science achievement for elementary school students in grades 3-4.



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

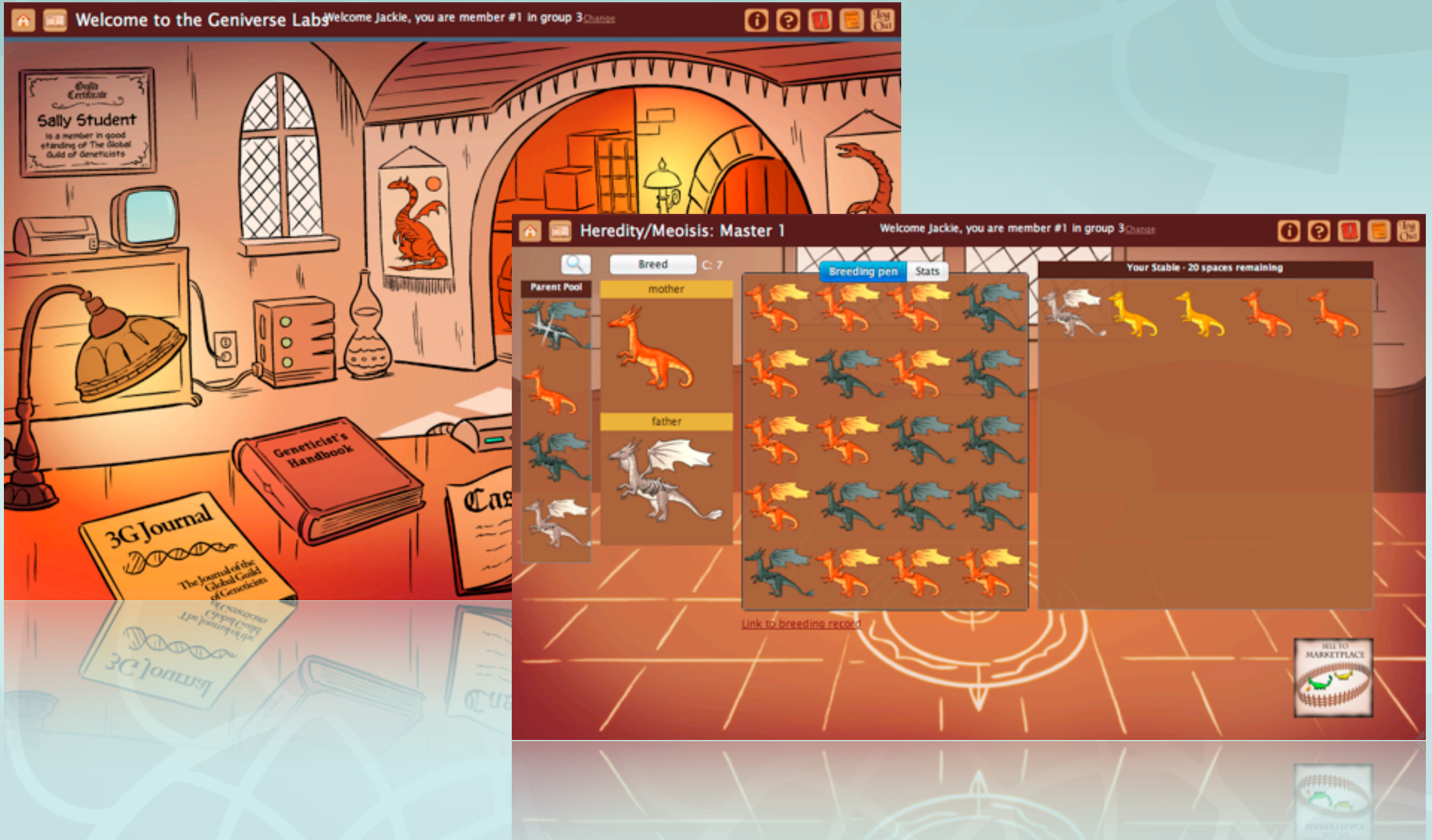
Pre/Post Gains

	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

Geniverse



The screenshot displays the Geniverse Lab interface, which is divided into two main sections: a virtual laboratory and a breeding simulation.

Virtual Laboratory (Left): The scene is a cartoon-style laboratory. On the left, a desk holds a computer monitor, a printer, and a lamp. A framed certificate on the wall reads "Diploma Certificate Sally Student is a member in good standing of The Global Guild of Geneticists". In the center, a window looks out onto a building with a dragon-shaped poster. On the right, a doorway leads to a stable area where a dragon is visible. On the desk in the foreground, there is a "3G Journal" (The Journal of the Global Guild of Geneticists), a "Geneticist's Handbook", and a "Case" file.

Breeding Simulation (Right): The interface is titled "Heredity/Meiosis: Master 1". It features a "Parent Pool" on the left with four dragon icons (two blue, two white). The "mother" and "father" sections show a single orange dragon and a white dragon, respectively. The "Breeding pen" is a 4x4 grid of 16 dragons, with a mix of orange and blue dragons. To the right, the "Your Stable - 20 spaces remaining" section shows five dragons (one white, one yellow, one orange, one blue, one orange) in a row. At the bottom right, there is a "SELL TO MARKETPLACE" button with a marketplace icon.

Navigation and utility icons are present at the top of both windows, including home, search, help, and "Log Out" buttons. A welcome message at the top of each window reads "Welcome Jackie, you are member #1 in group 3Change".

Science vs. Gameplay

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



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



The screenshot shows a website titled "Geneticists' Guild Daily" with a navigation bar containing "Gemiverse News", "My Account", and "My Sites". Below the title is a sub-navigation bar with "Home" and "About". The main content area features several articles:

- Drakes inspire fashion world** (2:51 am by admin): One of the most significant developments in the 30 years since the Guild Hall was built in Empire City was the training of the first hunting drakes. It was 27 years ago that legendary Guildmaster Randolph Anvilstriker introduced the first hunting drakes to the Central Kingdom. Guildmaster Anvilstriker collaborated for two years with experienced falconers [...]
- Reading your drake's body language** (4:09 pm by admin): We have all heard of people who are "good with drakes." What does this mean? Part of the training of new Guild members is learning to handle drakes. There are two vital parts of this training: reading drake body language, and learning to use your own body language as a handler. Reading drake body language [...]
- What's the best drake food?** (2:55 pm by admin): For years, the Guild has recommended a traditional diet for drakes: meat and bones. There is no question that this diet comes very close to what the wild ancestors of today's fancy drakes thrive upon in nature. Purists often insist that the very best diet for drakes consists of what drakes would eat in the [...]
- Toward better hunting drakes** (1:11 pm by admin): Some have argued that the lucrative trade in

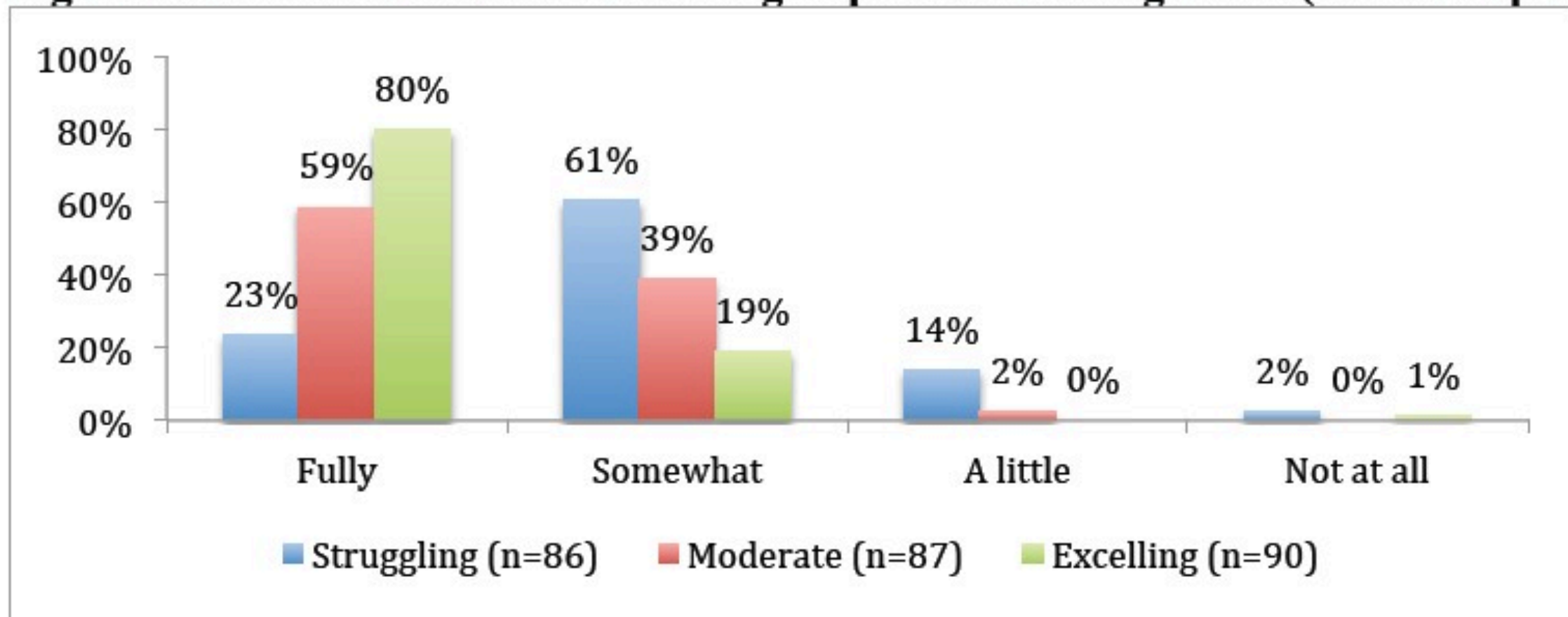
Thumbnail images for each article are visible below the titles.

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 they didn’t get all three stars. The stars are a great idea.”

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



- 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

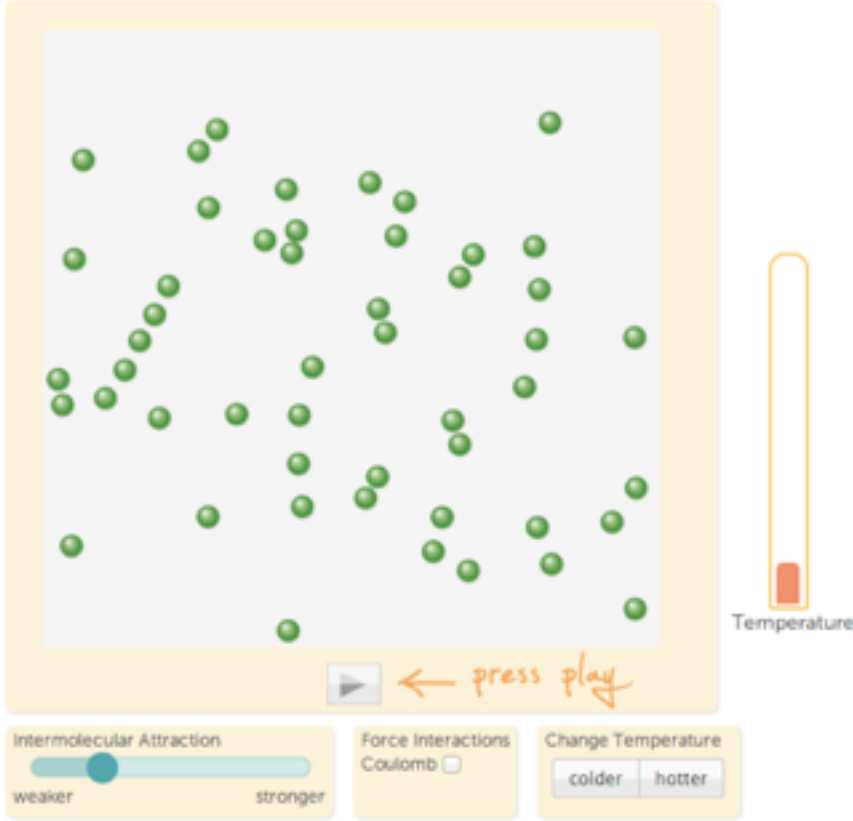
Current Integration Possibilities

- 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>

Atoms. In Your Browser.
Now you can use our award-winning molecular simulations anytime, anywhere.



Temperature



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