



Rhode Island Information Technology Experiences for Students and Teachers

Using Embedded Assessment for Increasing Student Motivation and Teacher Engagement
October 13, 2010



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TPD Goals

- Understand the science of atoms and molecules (SAM) and how it connects with current curriculum.
- Implement SAM learning activities in current curricula.
- Provide related IT career information.
- Utilize guided inquiry of SAM models in teaching.



RI-TEST Goals

- Improve science content knowledge.
- Increase student awareness of related computer modeling careers.
- Bring together a more connected understanding of how the world of atoms and molecules links physics, chemistry, and biology.

PHYSICS

Scientists working in physics-related fields use computer models to understand the origins and fate of the universe. They use models to test designs for new electronic devices before going through the costly process of manufacturing them. They design airplanes, rockets, and spacecraft. They even work to game and special effects companies so the virtual worlds you experience in 3D gaming and movies feel as real as possible.

Engineer

Computer models help me to design all kinds of machines and projects, including those that produce energy from renewable sources like wind power.

The blades of a windmill sweep the air to its surface in a way, so engineering designed and tested in a few minutes can be applied for real energy.

Job Title	Description	Education Level Required	Average Salary
Research Scientist	Research, design, develop, and test new products, materials, and systems.	High school diploma	\$41,982
Metallurgist	Study the mechanical and physical properties of metals and alloys.	Bachelor's degree	\$77,162
Material Engineer	Research, design, develop, manufacture, and test new materials, products, and systems.	Bachelor's degree	\$65,881
Software Engineer	Design, develop, and test software systems and applications.	Bachelor's degree	\$75,760
Physicist	Research, design, develop, and test new products, materials, and systems.	Ph.D.	\$85,742

CHEMISTRY

Scientists working in chemistry-related fields use computer models to design molecules that can interact with our cells. They help companies find new materials like gold, diamonds, and oil. They help model climate change and predict the results of changes in regulations that affect the cleanliness of our air and water. The new field of nanotechnology relies on computer models to guide the design of objects that are too small to see even with a microscope. Objects that will ultimately have unique electrical or chemical properties.

Drug Designer

Using computer models I design molecules that target specific diseases. Some day, cancer may be cured this way.

A particle is a small object designed to test in 100 minutes how long it takes to design and test in a few minutes.

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BIOLOGY

Scientists working in biology-related fields use computer models to predict the spread of disease. They use models to understand how the body works at many different levels, from the way breathing is affected by pollution to the specific details of how a nerve cell sends a signal to the brain. Biologists use computer models to decide what organisms to introduce and what changes to make to restore the environment to a state of ecological balance. With the help of computer models, huge amounts of data in our genes are now being analyzed to better understand genetic disorders and how to treat them.

Wildlife Biologist

Computer models help predict the effects of new developments on habitats and ecosystems.

A map showing the regions that have been affected by an invasive species. Using this map, a computer model can help predict the spread of the species and how to control it.

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HUMAN BEHAVIOR

The field of human behavior covers a wide range of topics from business management to the study of how the brain functions. Some scientists model social interactions between large populations of people while others create models to help them predict the direction of the stock market. Software designers who develop human-like robots model the way we move and even the way we think and express emotion.

Economist

Corporations and governments use the information I get from computer models to help the economy run smoothly.

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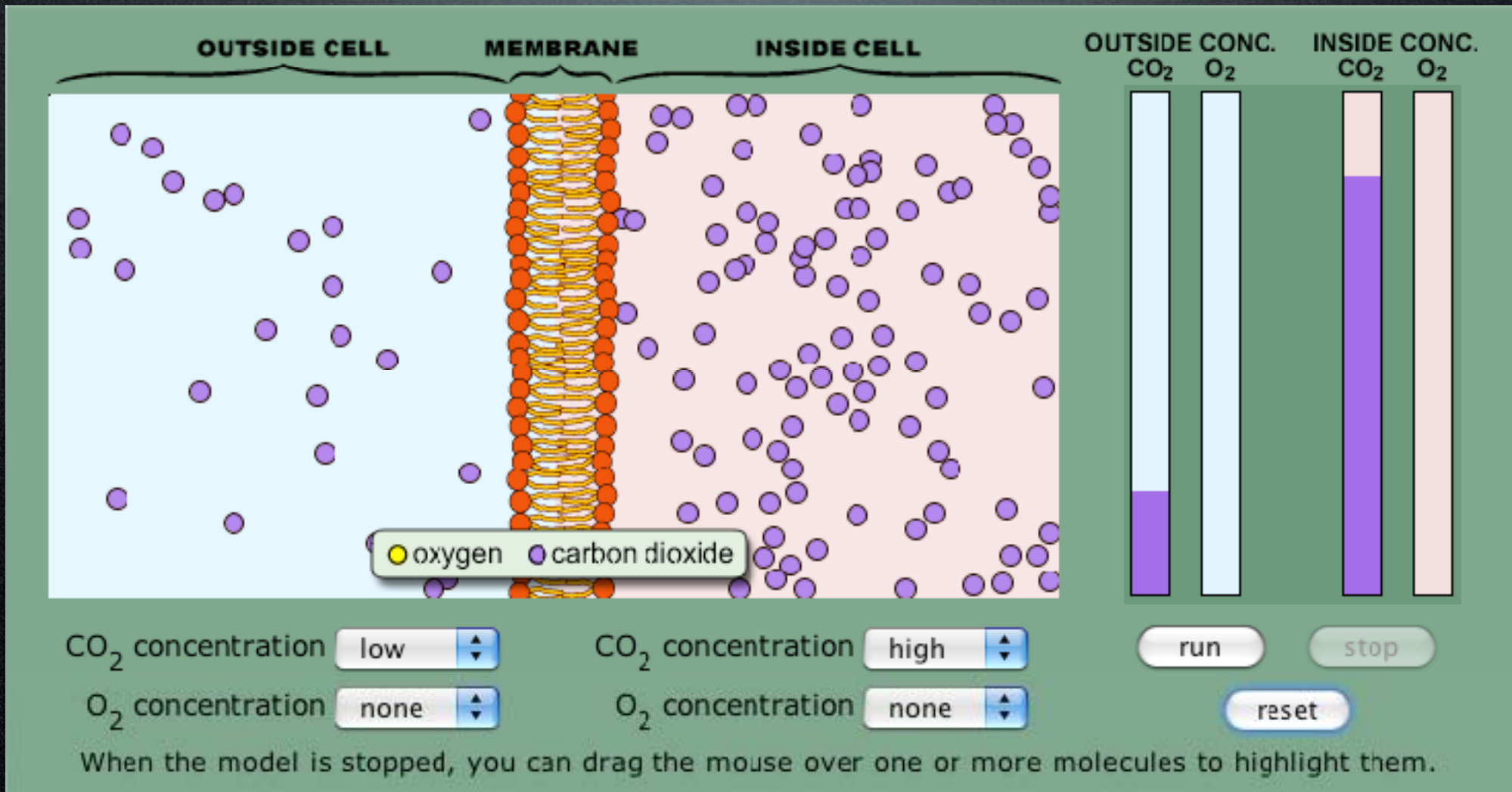
Inquiry Is Key


- Going deeper can simplify science.
 - Most scientific phenomena can be explained by fundamental ideas of energy, force, the atomic nature of matter, and 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.

SAM Activities

	Physics	Chemistry	Biology
Motion and Energy	Atoms and Energy	Phase Change	Diffusion, Osmosis, and Active Transport
	Heat and Temperature	Gas Laws	Cellular Respiration
Charge	Electrostatics	Intermolecular Attractions	Four Levels of Protein Structure
	Electricity	Molecular Geometry	Protein Partnering and Function
		Solubility	
Atoms and Molecules	Atomic Structure	Chemical Bonds	Lipids and Carbohydrates
	Newton's Laws at the Atomic Scale	Chemical Reactions and Stoichiometry	Nucleic Acids and Proteins
			DNA to Proteins
Light	Atoms, Excited States, and Photons	Chemical Reactions and Energy	Photosynthesis
	Spectroscopy		

Interactive Models



 Take a snapshot of the model above

Embedded Assessments

What is true of the rate at which molecules move into and out of the cell at equilibrium?

- ☐ A. More move into the cell than out of it.
- ☐ B. More move out of the cell than into it.
- ☐ C. Equal amounts move into and out of the cell.
- ☐ D. They move randomly, so it is not predictable.

Check Answer

Embedded Assessments

*“I like the Check Your Answer thing –
it gives me reinforcement of my
understanding of the concepts.”*

Embedded Assessments

Cells generally stay in equilibrium with their surroundings. What are two ways you know the cell has reached equilibrium?

- ☐ A. Water stops flowing into and out of the cell.
- ☐ B. The concentrations inside and outside of the cell are the same.
- ☐ C. The osmotic pressure inside and outside of the cell is the same.
- ☐ D. The cell gets as small as it possibly can.

Check Answer

Embedded Assessments

Describe how the chemical energy in ATP is converted into electric potential energy. ([hint](#))

Embedded Assessments

Set up the model so that it is **IN** equilibrium. Then use the "snapshot" button below the model to take a picture of your setup. Use the "open" button below to place that image here.

Click the Open Button,
and then drag a thumbnail here.

Open

Clear

Embedded Assessments

“Students begging to do more units on the computer ... [and] ... writing more than they usually do in response to something they did only moments before.

Structure of Activity

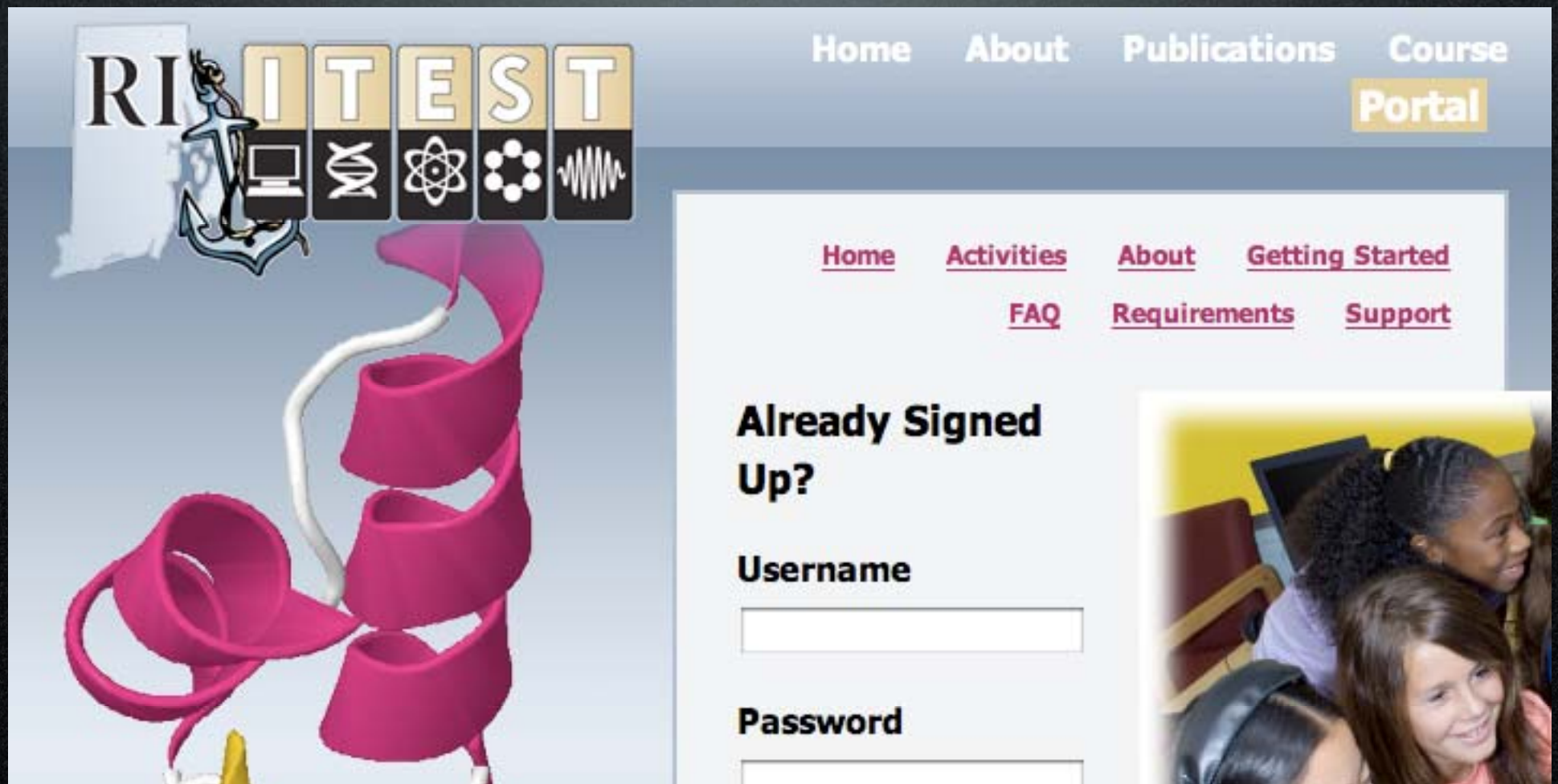
- Introduction
- Several pages of interactive models interspersed with embedded assessments of various types.
- Check answer option included in main body pages.
- Summary page with no check answer.

Constructing Activities

- Use Molecular Workbench
 - Flexible Tool
 - Allows for importing any Java applet
 - Can even be used just for surveys
- Transitioning to new portal/authoring system.

Materials Development

- Teacher/student portal and reporting. <http://riitest.concord.org>



The screenshot displays the RIITEST website. On the left, the logo features the text 'RIITEST' with a stylized figure holding a computer monitor, and a large 3D model of a pink protein ribbon structure. The top navigation bar includes links for 'Home', 'About', 'Publications', and 'Course Portal'. A secondary navigation bar contains links for 'Home', 'Activities', 'About', 'Getting Started', 'FAQ', 'Requirements', and 'Support'. The main content area is titled 'Already Signed Up?' and contains input fields for 'Username' and 'Password'. A photograph of two young girls looking at a laptop is positioned in the bottom right corner.

RIITEST


Home About Publications Course Portal

Home Activities About Getting Started
FAQ Requirements Support

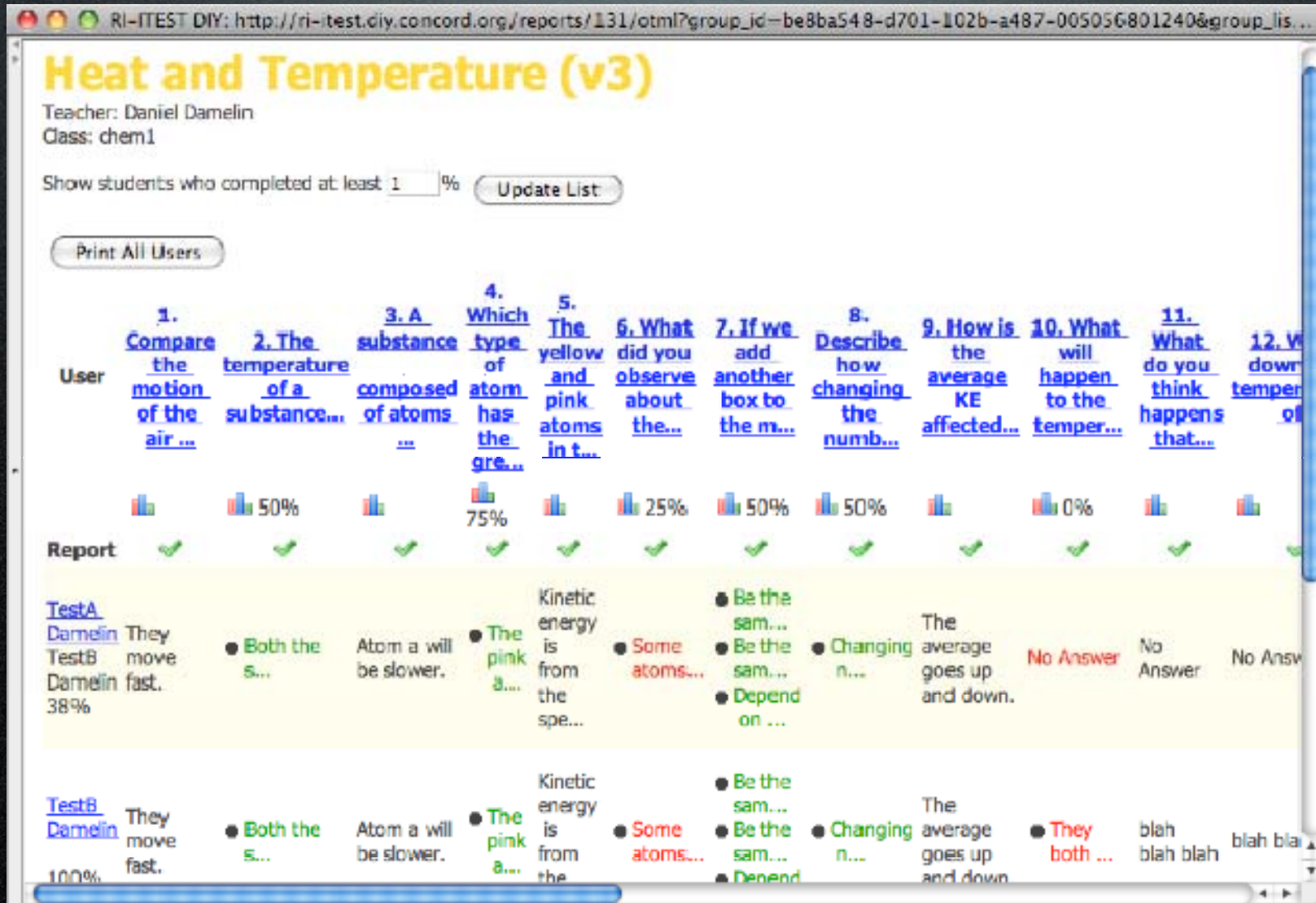
Already Signed Up?

Username

Password



Teacher Reports



Teacher Reports

RI-ITEST DIY: http://ri-itest.diy.concord.org/reports/131/otml?group_id=be8ba548-d701-102b-a487-0...

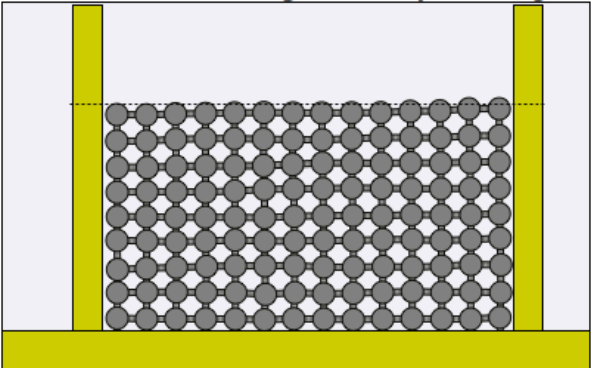
Heat and Temperature (v3)

TestC Damelin
Teacher: Daniel Damelin
Class: chem1
Other Group Members:

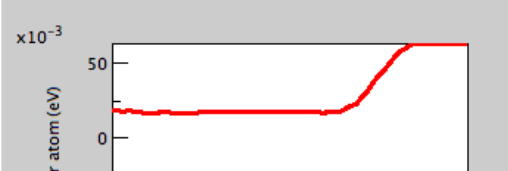
1. Compare the motion of the air molecules at high and low temperatures.
They look the same to me.

4. Which type of atom has the greater mass?
● The pink atoms.

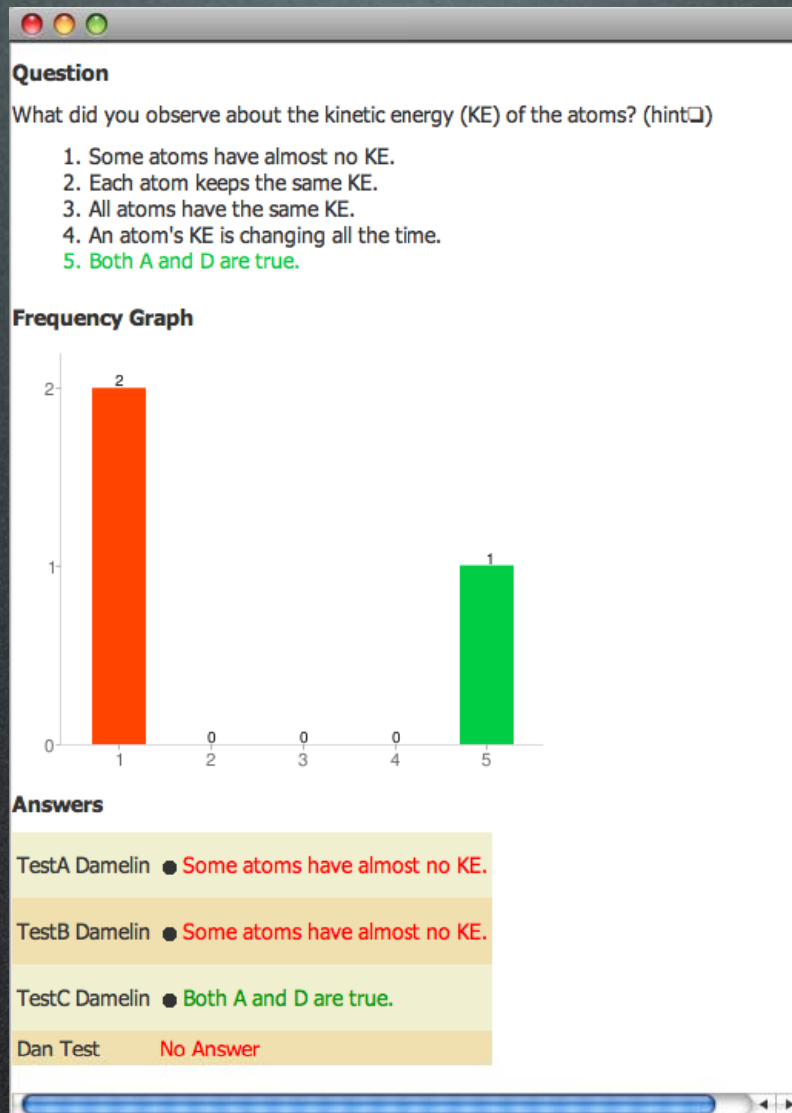
17. Take a snapshot of the model that shows thermal expansion, and then follow the instruction below to drag in the snapshot image.



18. Take a snapshot of the graph that shows the increasing of energy when heated, and then follow the instruction below to drag in the snapshot image.



Teacher Reports



Molecular Concept Inventory (MCI)

- Pre-post test of student and teacher knowledge.
- Students took subject specific test.
- Teachers took combination of student MCI tests.

Molecular Concept Inventory (MCI)

- Molecular concept tests covering Physics, Chemistry, and Biology

33. Imagine a cell that has a membrane through which potassium ions freely enter and leave. Suppose this cell contains a high concentration of potassium and is put in distilled water that has no potassium. Which is the BEST description of what will happen?

- a) All of the potassium ions will leave the cell.
- b) Potassium ions will move only from high concentration to low concentration.
- c) Potassium ions will leave the cell until there is the same concentration of salt inside and outside the cell.
- d) (correct answer) Potassium ions will reach a point when they will continuously enter and leave the cell at equal rates.

Research Findings

Some Stats

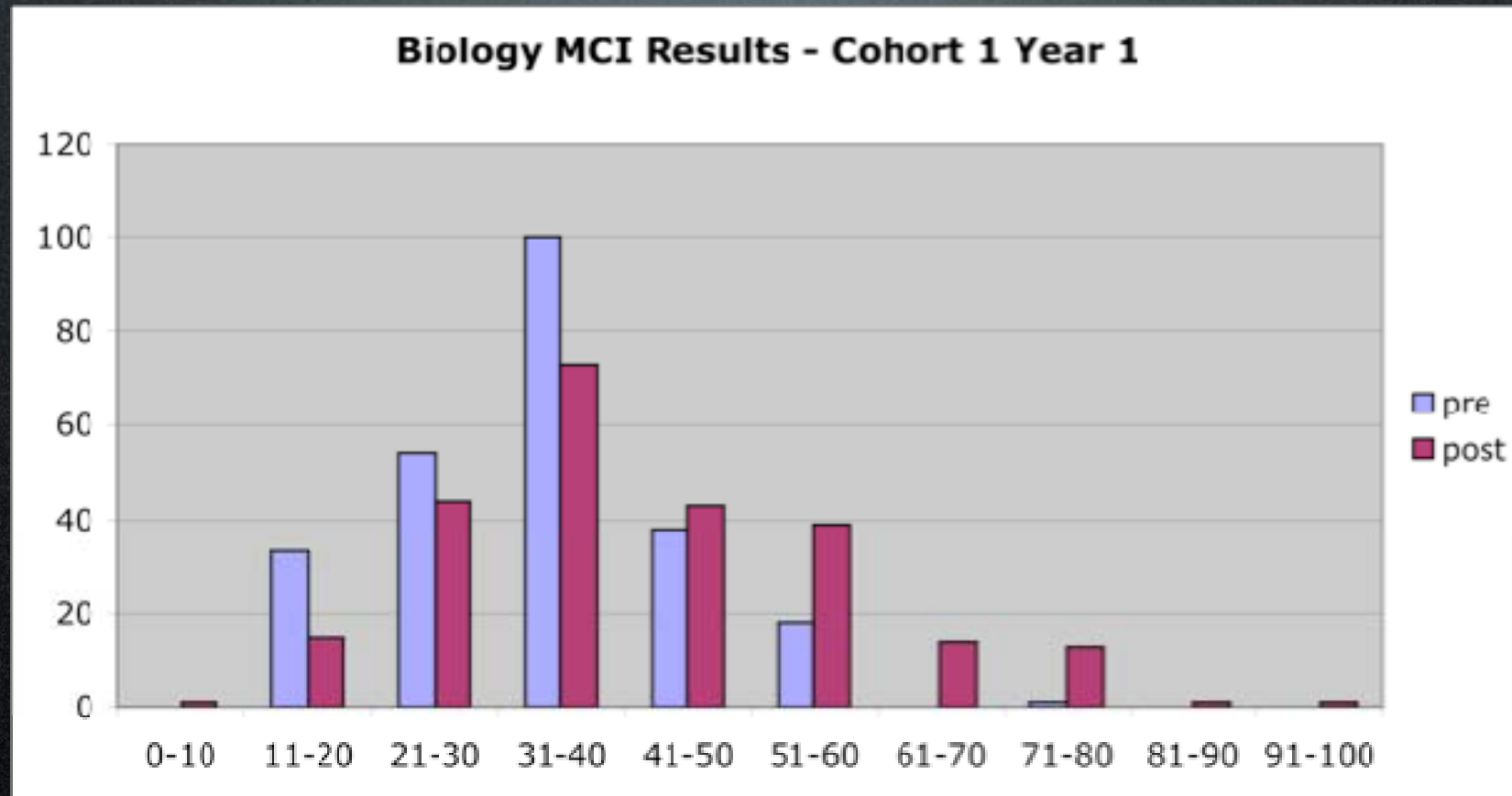
- Since project started 177 teachers registered in portal, with 11,368 students in those classes.
- Last year about 4,600 students ran activities, generating 17,000 reports.
- Doesn't pick up DVD/LCD only usage.

Student Impact

- Do understand science concepts better after using the RI-ITEST program?
 - **59% yes**
- Do you feel that you are more interested in science as a result of working with RI-ITEST?
 - **29% yes**

MCI Results

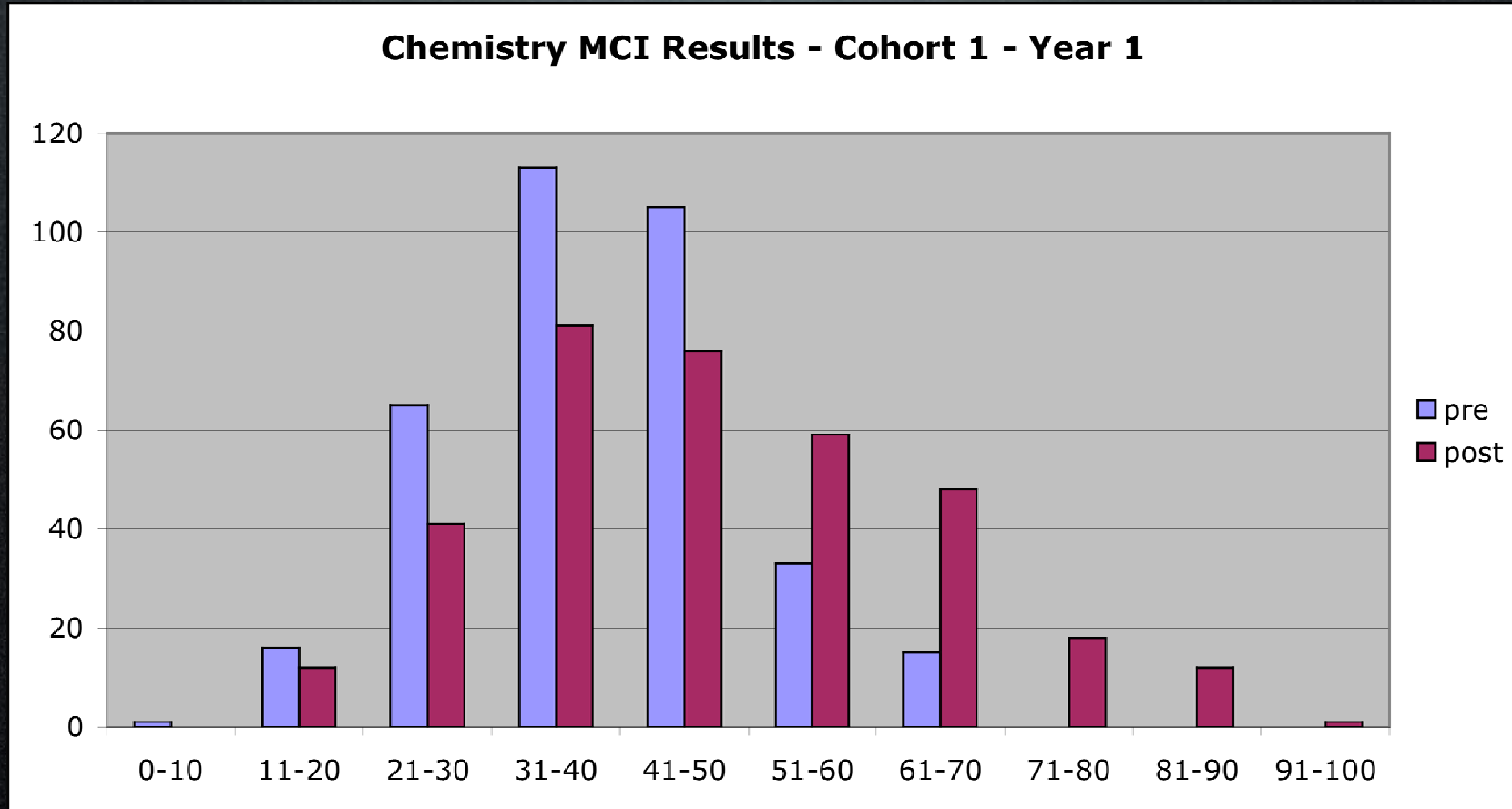
Cohort 1 - Bio



Group	Pre-test mean	Post-test mean	n	p-value based on paired t-test	Cohen's d	Effect size
Biology	34%	42%	244	1.9e-15	0.6	Moderate

MCI Results

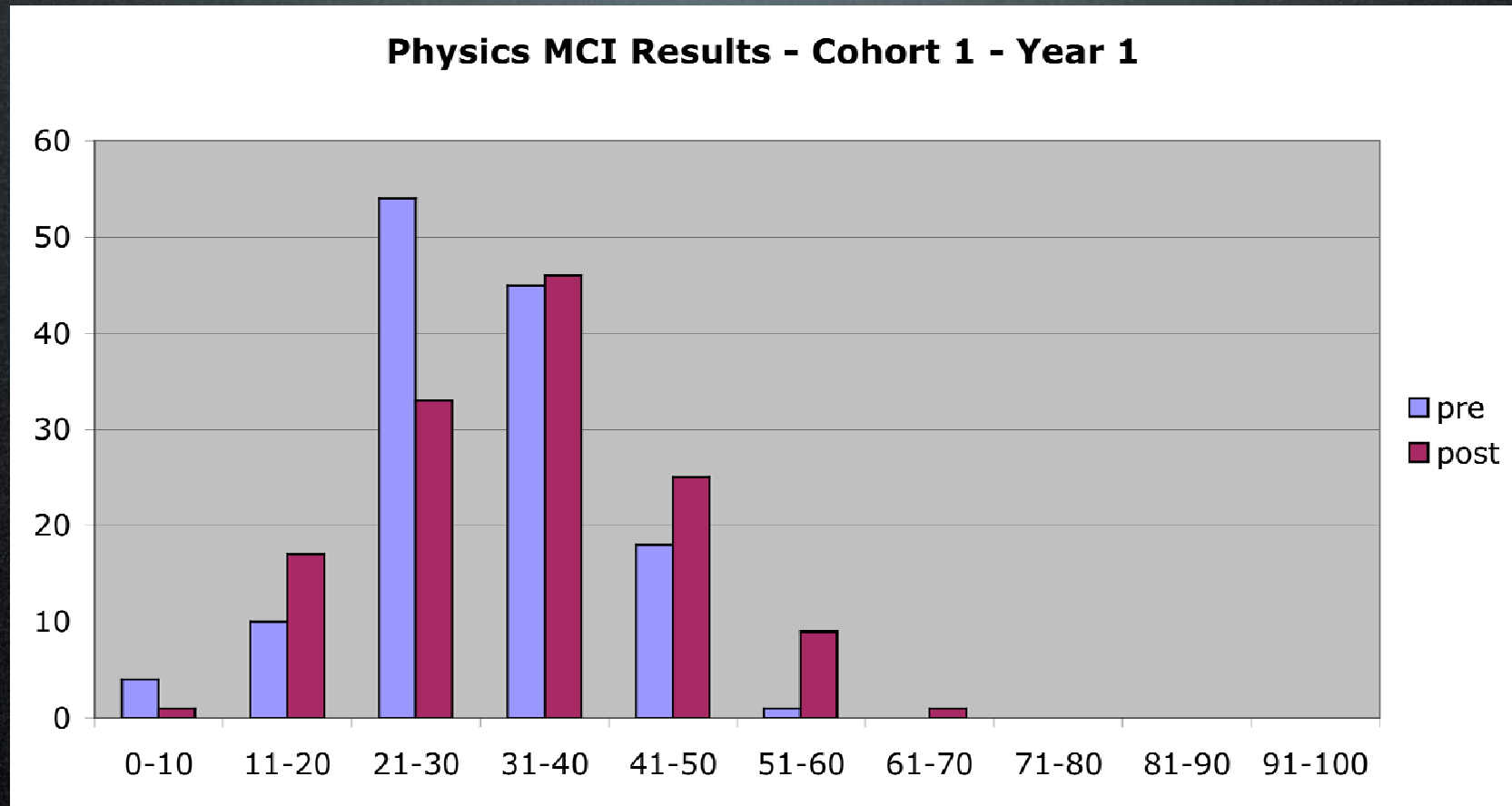
Cohort 1 - Chem



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

MCI Results

Cohort 1 - Physics

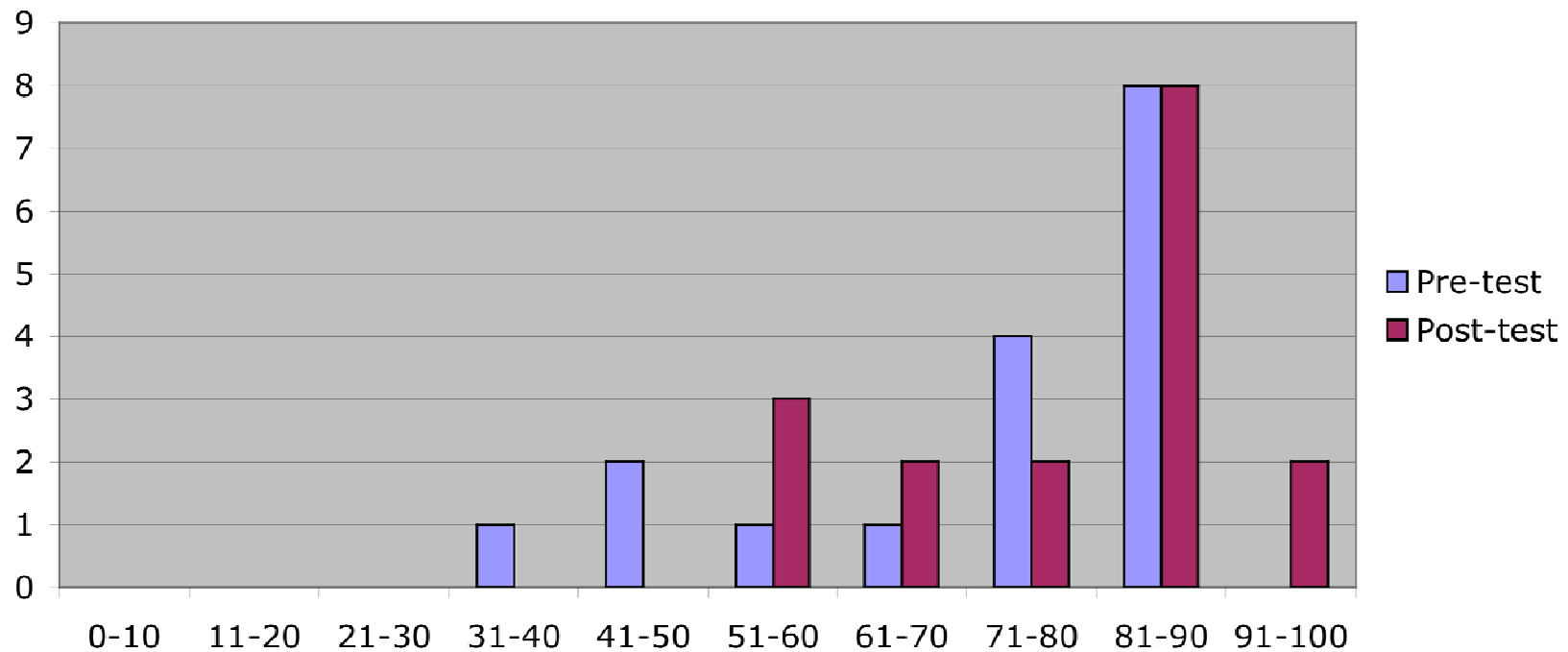


Group	Pre-test mean	Post-test mean	n	p-value based on paired t-test	Cohen's d	Effect size
Physics	32%	35%	140	0.0015	0.3	Small

MCI Results

Cohort 1 - Teachers

Cohort 1 Teachers MCI Results

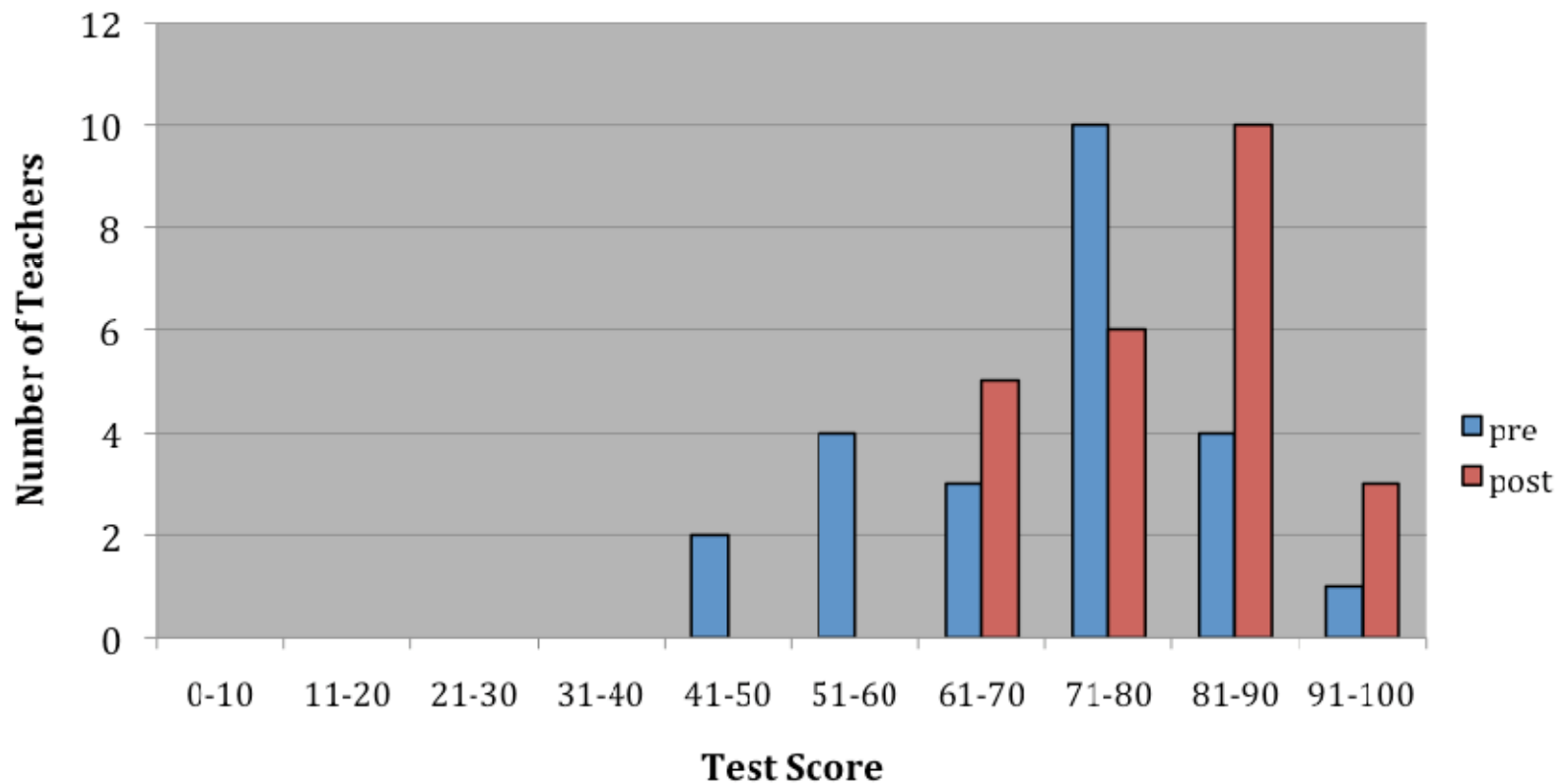


Group	Pre-test mean	Post-test mean	n	p-value based on paired t-test	Cohen's d	Effect size
Teachers	73%	76%	17	0.030	0.2	Small

MCI Results

Cohort 2 - Teachers

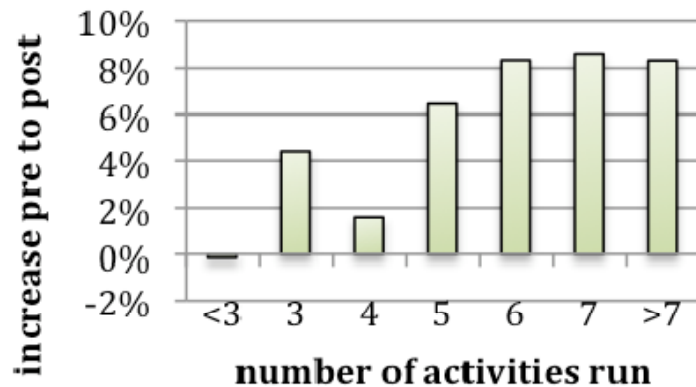
Cohort 2 Teachers MCI Results



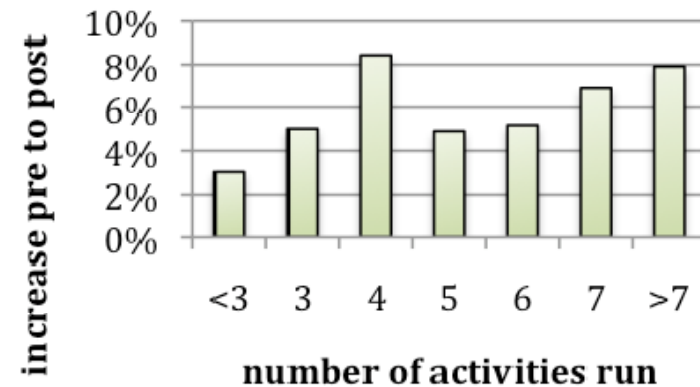
Cohort 2 Group	Pre-test mean	Post-test mean	n	p-value based on paired t-test	Cohen's d	Effect size
Teachers	72%	80%	24	5.3e-6	0.8	Large

Score increases related to number of SAM activities completed

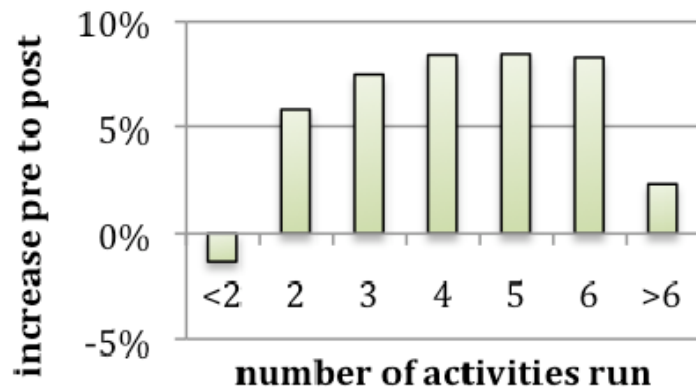
MCI score increase vs. number of activities run (Cohort 1 - chem)



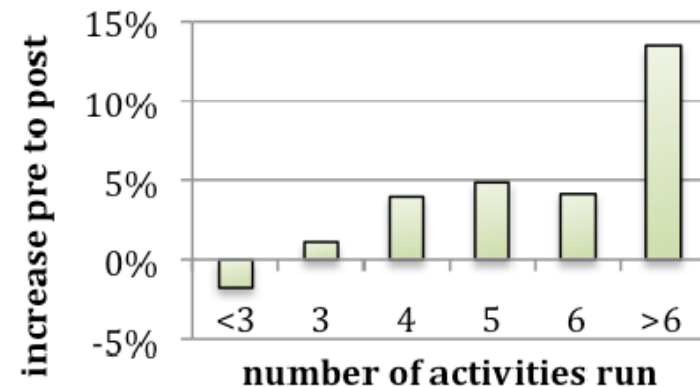
MCI score increase vs. number of activities run (Cohort 2 -chem)



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



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



Contact Info



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