Hands on, Minds on Periodic Table: Visualizing the Unseen

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The Challenge!

- The state of California mandates that 5th grade (9 and 10 year olds) middle and high school:
- *Students know* that each element is made of one kind of atom and that the elements are organized in the periodic table by their chemical properties.

The Problem:

- Many 5th grade teachers have not taken a chemistry course in college
- Most people that took chemistry in college do not understand how the periodic table is organized, or what an element is
- How do you teach students something you do not understand yourself?

Another Problem:

- The state end of year exam asks (even 5th grade) students to predict combining ratios in binary, main group compounds as a way of demonstrating their knowledge of how the periodic table is organized.

Goal:

Devise a way to teach both teachers and students how the Periodic Table is organized using:

- Hands On Inquiry
- Constructivism (construct your own knowledge)
- Realistic (good chemistry)
- Cheap (teachers are under funded)

Things to Think About!

What is confusing to first time learners about the periodic table?

- Main group elements separated from each other
- Transition elements "stuck" in the middle
- F-block elements are "clipped" from the main body and "pasted in" at the bottom

Things to Think About #2!

Need to address misconceptions about atoms, elements, compounds, molecules!

There is a lot of confusion about:

- What compounds are
- What chemical formulae mean
- What atoms are
- What molecules are
- What elements are

So, we decided to:

- Provide atoms to participants
- Show what this model represents
- Have them make binary compounds

Rules for Making Binary Compounds

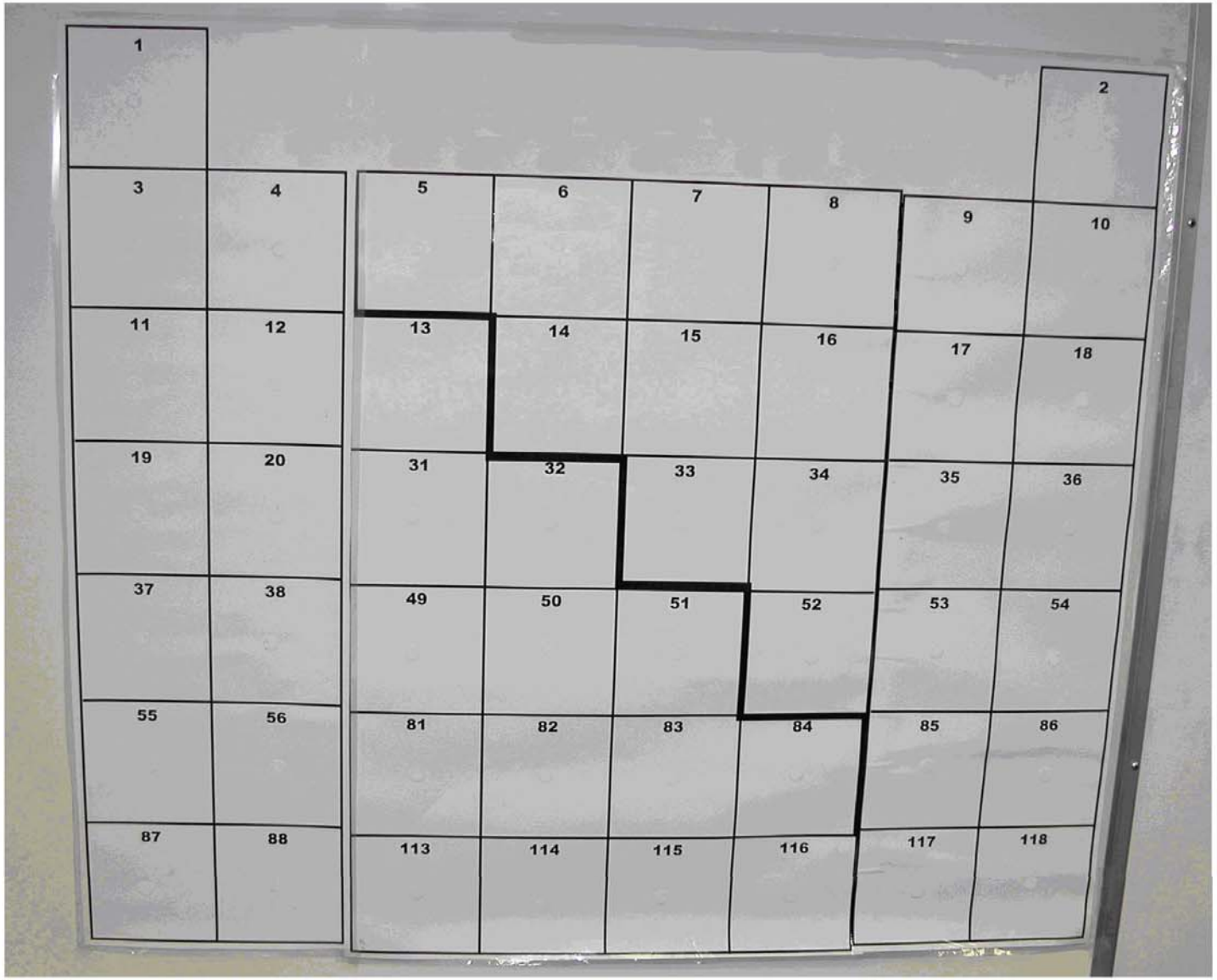
- Use only two differently colored (or two types of) atoms to connect the unpaired electrons to other atoms - use as many as you need borrowing from other groups as necessary.
- You are all done when all unpaired electrons have a single partner and none are left unpaired.

Writing Chemical Formulae

- 4 black, 1 blue $\Rightarrow$ 4 B, 1 Bu $\Rightarrow$ B_4Bu
- This demystifies why some elements have a second letter in their symbol
- What a chemical formula means
- Why 2 units of B_4Bu is not equal to B_8Bu_2 and can be written 2 B_4Bu

Then, we decided to:

- Focus attention to the periodic table and where these atoms/elements belong on it
- Remove d- and f- blocks from periodic table
- Have everyone place atoms on periodic table in such a way so that they are "organized"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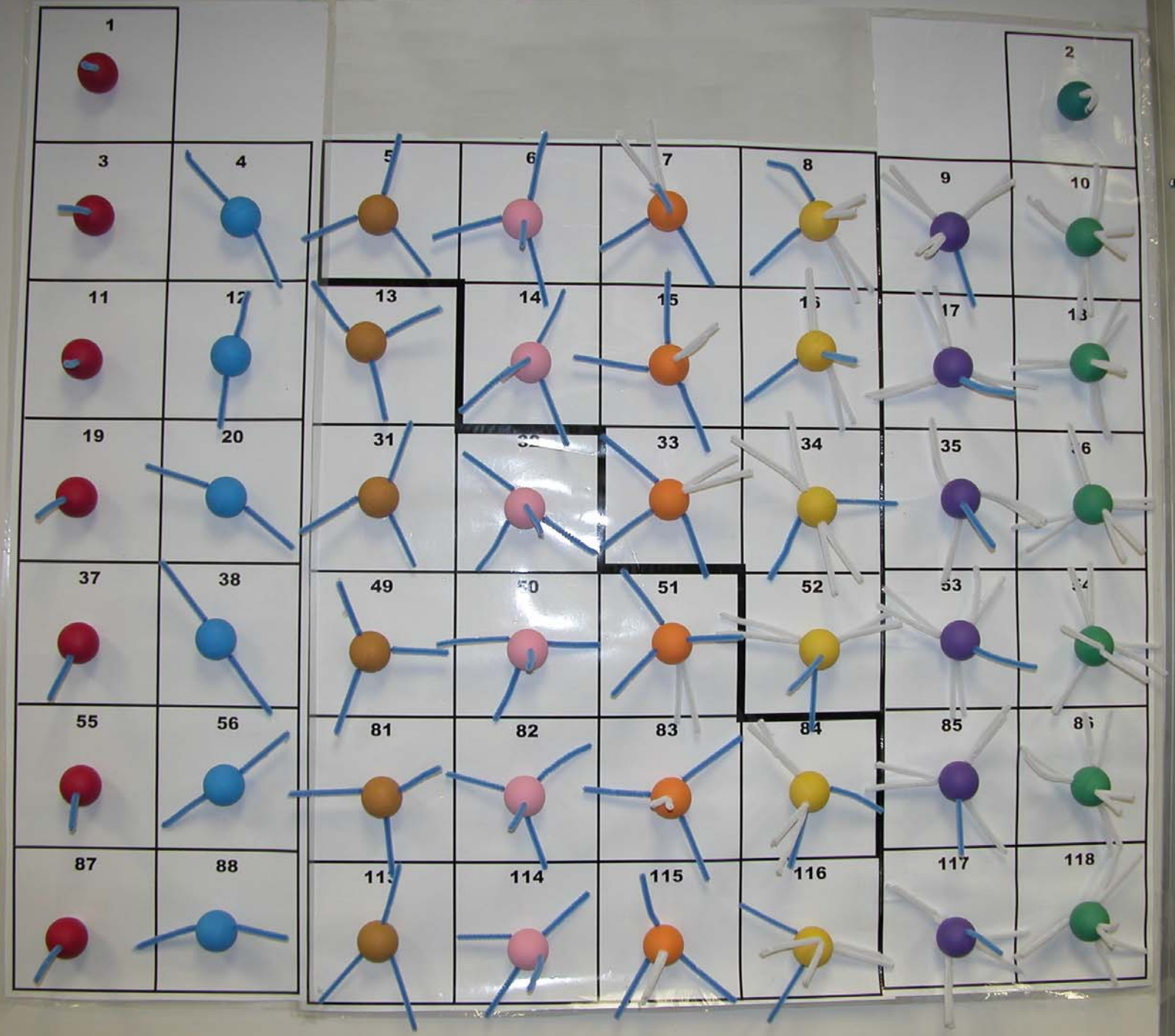
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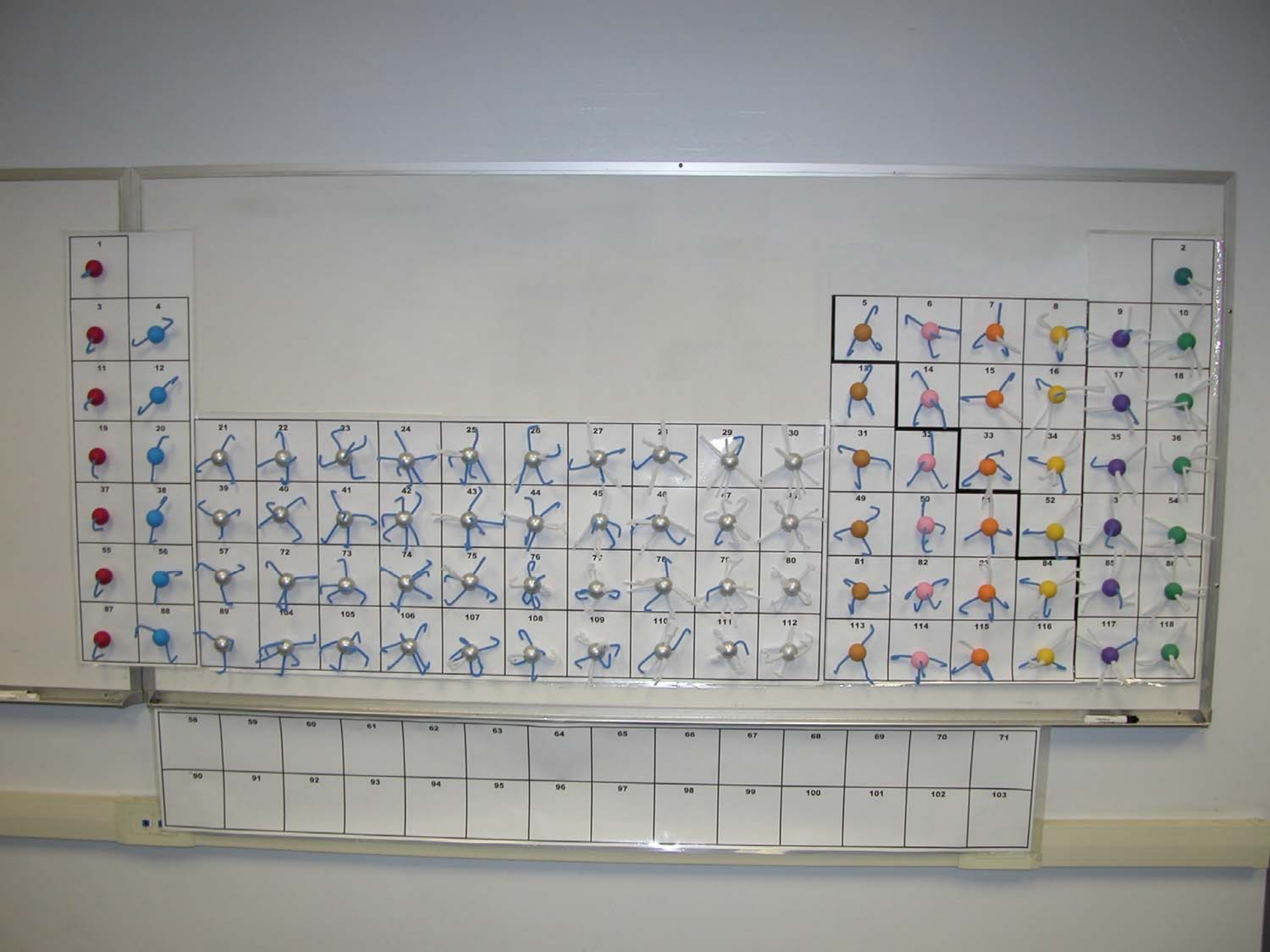
Using these atomic models, you can teach:

- Bonding ratios in binary compounds
- How to write chemical formulae
- Conservation of matter during a reaction
- Types of bonds (covalent, polar, ionic, metallic)
- Why elements in a family have similar chemical behavior

Then add in the Transition Metals!

- Pass out more atoms
- This time, atoms have between 3 and 12 electrons (VSEPR geometries, of course)
- Have participants sort atoms onto new portion of periodic table so that the new data is organized



Final Assessment!

Use buttons to represent atomic properties

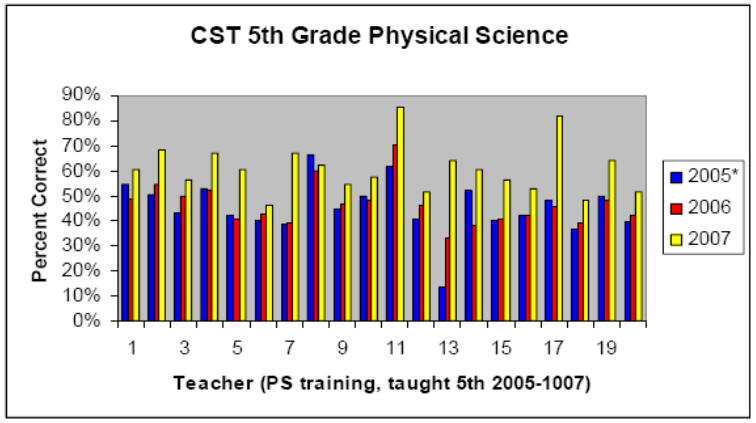
Results:

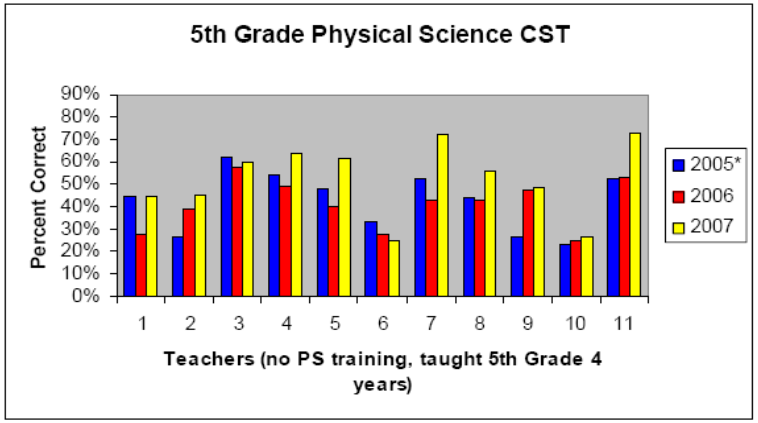
- Teachers are more confident; they now know how the periodic table is organized
- Teachers are actually teaching the organization of the periodic table to their students
- California is now testing 5th grade students to determine what they know about science
- This method also used with middle school, high school, and college students.
- Even scientific colleagues (professors) learn something new during participation.

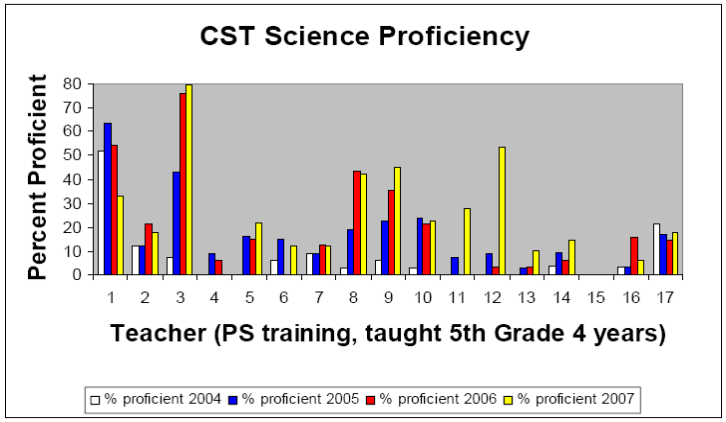
Results:

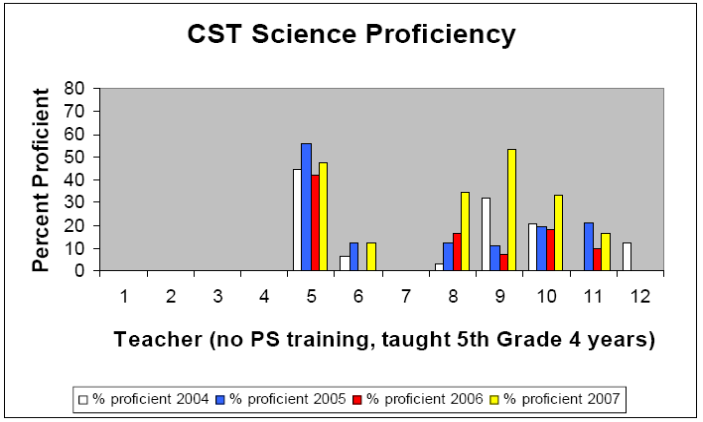
- Data shows that elementary students are able to learn to "read" the periodic table as evidenced by their ability to correctly predict combining ratios in binary compounds
- Student scores on CST (physical science) has been increasing year by year (including special needs students)

CST Physical Science Data

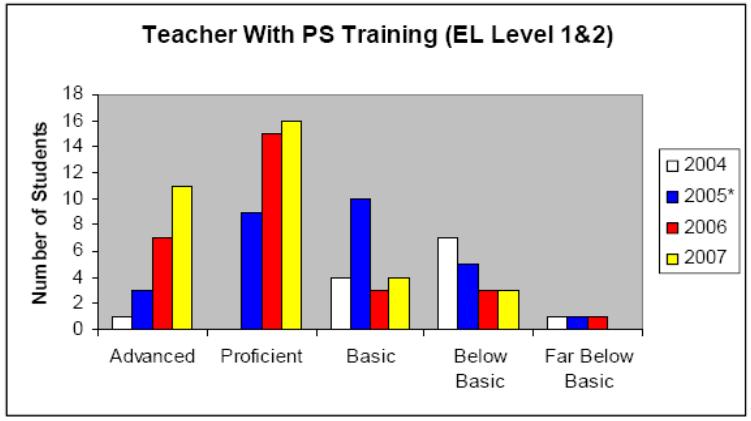


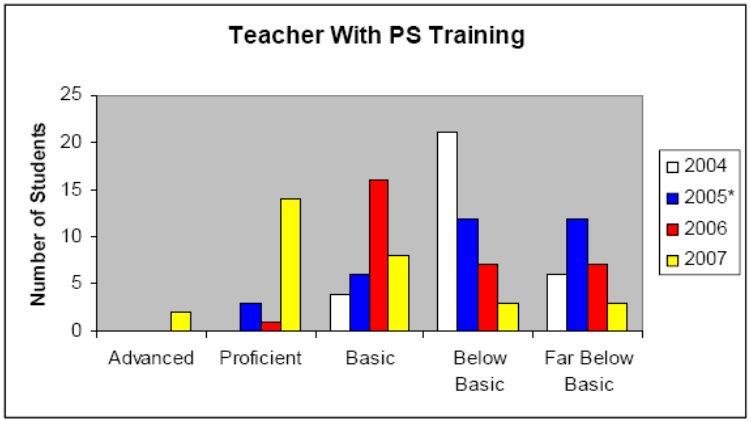


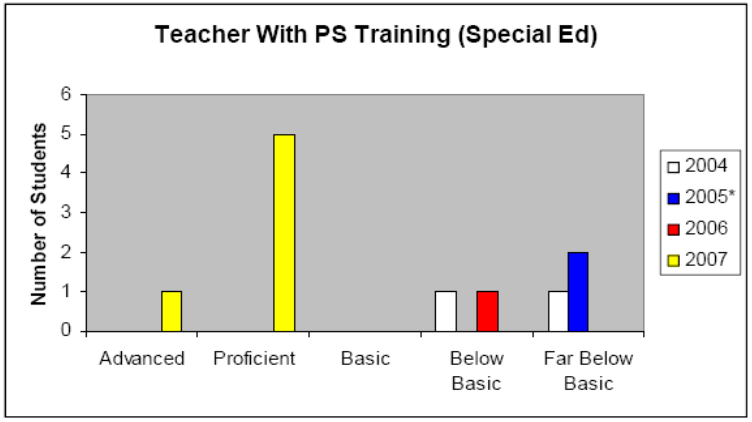


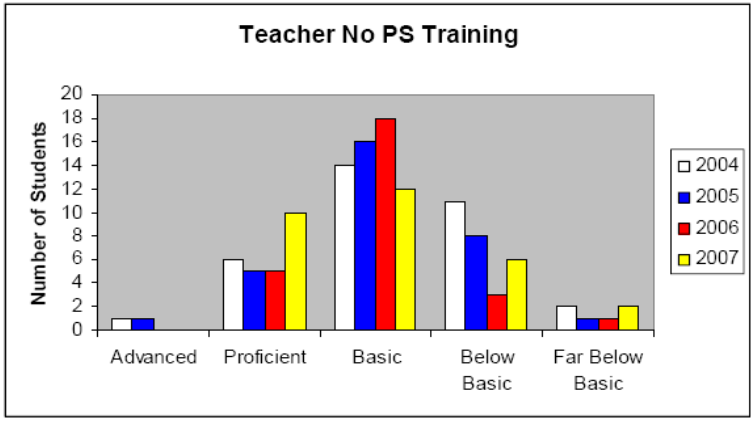


Individual Teacher Data









Acknowledgements:

- Sue Chan
- Rialto Unified School District 5th grade teachers and students
- CaMSP (California Mathematics and Science Partnership) grant
- Dr. Ed D'Souza for having the wisdom to make us a teaching team

Interested in learning more?

- **Lessons available for elementary, middle and high school/college**
- **Files available to print Periodic Table skeletons**

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http://www.csupomona.edu/science/scienceLessonPlans.htm