K-12 Education at the MIT Edgerton Center

Who's involved:

Amy Fitzgerald, M.Ed., is the Outreach Program Coordinator, and teaches the lessons.

Jessica Garrett, M.Ed., wrote the teacher's guide and teaches the lessons. She taught math and science to grades 3-6 prior to coming to MIT.

Amanda Gruhl, (MIT '99, Ph.D. '08), a former high school biology teacher, created the graphics.

Ed Moriarty (MIT '76) is an instructor at the Edgerton Center and designs engineering curriculum for a local high school

Kathy Vandiver, Ph.D, created the LEGO models and lessons. She taught middle school science for 16 years prior to coming to MIT.

Prof. J. Kim Vandiver directs the Edgerton Center.

Hands-On Learning with LEGO® Atoms and Molecules by Debbie Levey

Tell sixth graders to memorize the difference between a mixture and a compound, or how atoms form molecules, and they might pass an exam. But let them build molecules and recombine chemicals represented by LEGO bricks, and they will understand and remember sophisticated chemical processes. This solid foundation in basic chemistry will continue to help them in high school.

While visiting the MIT Edgerton Center outreach programs, public school students and teachers eagerly participate in "LEGO chemistry," just one of the Center's many hands-on offerings for kindergarten through 12th grade. Led by experienced teachers, students work through a curriculum written by science educators. They create a chemical reaction with exciting color changes and fizzing, then figure out exactly what happened by modeling the molecular changes with LEGO bricks.

If the LEGO Chemistry unit were a scientific experiment, we could summarize it in this way:

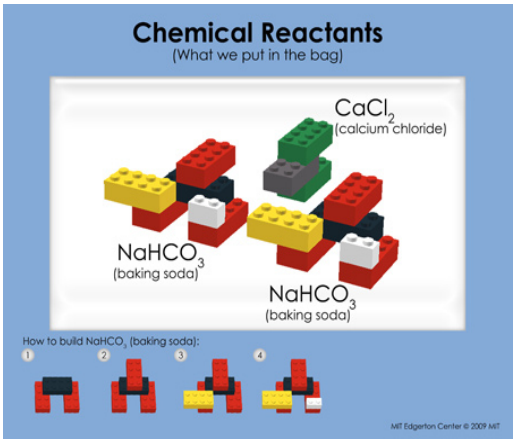
Hypothesis
The LEGO Chemistry lesson teaches tough abstract ideas in concrete ways. Instead of memorizing poorly understood vocabulary, middle school children master basic concepts by building atoms, molecules, and chemical transformations with LEGO bricks.

Materials and people
Students and their teacher meet Amy Fitzgerald, Jessica Garrett, and several MIT student helpers in the Edgerton Center classroom. Each pair of students receives a "LEGO Atoms and Molecules" kit with the correct number and type of bricks for the experiment. The wet lab segment uses familiar substances such as baking soda and calcium chloride (ice melt).

Procedure
Fitzgerald and Garrett lead the students through a set of hands-on exercises, taking care that students understand each step. After seeing the chemical reaction dramatically change reactants into products, they model the reaction by building and recombining LEGO brick molecules.

Results
By manipulating LEGO bricks, students grasp how elements are composed of atoms, how atoms combine to form molecules, and how compounds differ from mixtures. As they rebuild their LEGO molecules, they realize how chemical reactions produce different products.

Conclusions
With an accessible curriculum

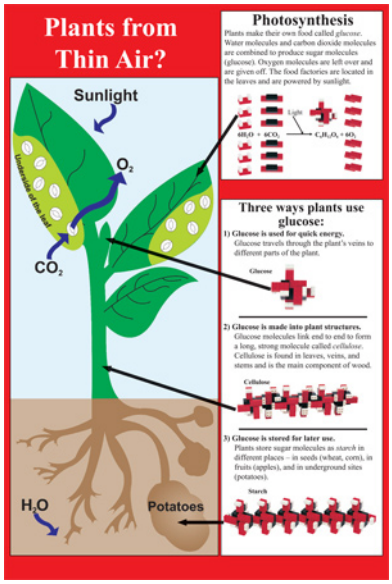


An example student page from LEGO Chemistry.

designed by Kathy Vandiver, an award-winning former classroom science teacher, students enthusiastically master essential scientific principles. Even groups with limited English proficiency understand the lesson, proving that they absorb concepts rather than memorize vocabulary. Increased funding would provide more classroom LEGO kits and train more teachers to adopt this effective science unit.

Background

Early in her career, teaching sixth grade science in Lexington, Massachusetts, Kathy Vandiver realized that, "the major problem with kids learning about matter was that everything was defined in words they didn't understand. For example, they had no way to visualize the difference between a mixture and a compound."



The LEGO Atoms and Molecules Kit can be used to teach concepts like Photosynthesis.

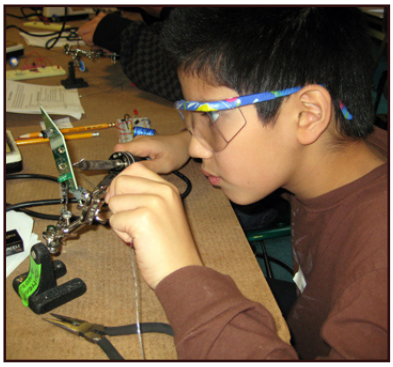
Borrowing her children's LEGO bricks, Vandiver designed a unit where each brick represented an atom. A stack of identically colored bricks became an element, and combinations of elements snapped together became molecules. "Almost every kid has heard of H_2O, and the light dawns when they see how that formula means two atoms of hydrogen and one of oxygen," she said.

To emphasize that chemical reactions create new products, Vandiver used a wet lab exercise in a plastic bag (from Lawrence Hall of Science, GEMS: Chemical Reactions), followed by a LEGO brick representation of the chemical changes. She explained, "The kids have a great wet lab with fizzing and color changes, and they can visualize what happens with the LEGO bricks. They know that the plastic bag initially contains baking soda, ice melt, and water with an indicator red dye. After the chemical reaction, the bag contains carbon dioxide, chalk, water and table salt. The carbon dioxide extinguishes a match stuck in the bag, students can write on the blackboard with the chalk, and they can see the cubic crystals of the salt after the water is evaporated."

Taking LEGO bricks built into molecules of the initial ingredients, students recombine them into the new molecules of the final products. In the process, they learn how to read chemical equations. They quickly discover that all atoms have rearranged themselves into new compounds with nothing left over.

Beyond LEGO chemistry

The Edgerton Center offers 12 different hands-on programs to local students including topics on mechanical engineering, electrical engineering, computer programming, biology, optics and photography, and forensics. Many of these lessons use LEGO bricks to teach complex concepts involving DNA, RNA, and amino acids, or the steps of mitosis and meiosis in cell division. Other lessons have students explore LEGO gears and pulleys, or design LEGO cars and robots.



This 4th grader is learning to solder a circuit board.

Now Edgerton Center staff are writing up those lessons as curriculum packages, and building kits of LEGO bricks. The LEGO Atoms and Molecules kit contains the LEGO bricks necessary to teach concepts of chemistry as well as photosynthesis. The project, entitled ***The Mind and Hand Alliance***, is exploring ways to disseminate curricular materials and train teachers to use them to best effect. Future plans include creating a series of instructional films showing teachers how the lessons should proceed step by step.

The Mind and Hand Alliance project is also developing methods to allow for MIT alumni volunteers around the US to bring such programs into their local schools, inspiring the next generation to study Science, Technology, Engineering and Math.

How you can help:

For $150, you can enable the Edgerton Center to purchase LEGO bricks and provide a classroom with LEGO Atoms and Molecules kits, and a curriculum for both chemistry and photosynthesis, including teacher's guides and instruction sheets for students. Vandiver emphasized, "This unit combines excitement with learning, and teaches valuable content."
Giving to MIT: http://giving.mit.edu/
Search for LEGO or 2732234

The Edgerton Center works with Lori Tsuruda, director of People Making a Difference, an organization that helps corporations and groups to do community service. Volunteers through this group have already assembled hundreds of LEGO Atoms and Molecules sets to distribute to science teachers. You can volunteer or support this effort with funding.
People Making a Difference: http://www.pmd.org

For more information:

Edgerton Center Outreach: http://web.mit.edu/edgerton/outreach
The Mind and Hand Alliance: http://mindandhandalliance.org/educators
MIT Outreach: http://web.mit.edu/outreach/