But Associate Professor Diane Bunce — who has won many teaching awards, written chemistry books that use her teaching methods, and been suggested as a political appointee to the Department of Education — has made a career out of developing creative methods for teaching chemistry.

That can mean donning plastic pool toys, bunny ears and other unusual attire for class.

“There’s no reason chemistry needs to be stuffy,” says Professor Bunce, pictured above right, who never tires of coming up with innovative ways to prove one of her teaching philosophies: “Chemistry is for everyone.”

“Voting citizens in a democracy need to understand basic chemistry — or know how to find out chemistry-related facts — before they can make informed decisions on issues like nuclear power or air and water quality,” she says. “Otherwise, voters can be swayed by interest groups or the media.”

Seeing how chemistry works in the real world instead of in the abstract is invaluable, students say, describing a host of classroom experiments their professor has used to bring chemistry to life (see pages 23 and 25).

“Her classes have been some of my favorites at Catholic University,” says Crystal Malcolm, a freshman from Salem, N.H. “She just makes everything make sense.”

That magic happens during demonstrations and small experiments, students say — at least one per class.

There are the holiday experiments, like the “Parade of Elements” orchestrated for Halloween, when the professor asks her students to impersonate elements from the
periodic table or other chemical compounds (which explains the pool toy — Professor Bunce was impersonating water). Then there are the useful demonstrations, like how to make the “instant heat” packets people stuff in their mittens while skiing. Students fondly remember the time she handed out ultraviolet light-sensitive bracelets for everyone, so she could explain how they changed color because of the ultraviolet radiation in sunlight.

She’s even taught them how to make Silly Putty.

“A teacher’s job is to modify the environment so a student can learn,” Bunce says. “It’s not just to lecture.”

An Extra Step

Professor Bunce was named the District of Columbia’s 1993 Professor of the Year by the Council for Advancement and Support of Education. Five years later, she received the Chemical Manufacturing Association’s national Catalyst Award for excellence in science and chemistry teaching. In June 2001, she was invited to testify before Congress about why it should fund continuing education for science teachers. Her testimony so impressed Rep. Vernon J. Ehlers (R–Mich.) that he put her name on a short list of candidates for political appointment as undersecretary of the Department of Education (although she has no current plans to leave teaching).

Letters of recommendation written by her colleagues and former students mirror feedback from her current students: Professor Bunce is a dream teacher.

She combats what she calls “chemistry phobia” by taking concepts that non-science majors find fearsome and explaining how they work in everyday life.

“For example, to a chemist, there’s a big difference between melting and dissolving,” she says, explaining that material melts when you apply some sort of energy, like heat. Something dissolves when its matter is attracted to the molecules of an added material — usually water — that acts as a solvent.

“Which is why the Wicked Witch of the West isn’t quite right when she says, ‘I’m melting!’ because she’s had a little water

A Halloween ‘Parade of Elements’

Halloween is show time in Professor Bunce’s class, a day when she calls on students to embody the abstract characteristics of chemical elements and compounds.

Her students — all of voting age, their trick-or-treating days long past — show up to conduct a “Parade of Elements” during the class closest to Oct. 31. Wrapped in aluminum foil or wearing T-shirts marked in bright colors or glitter, they throw out clues based on their research about the element or compound they’re supposed to be, if their peers can’t tell from the costume alone.

Hint: I’m a noble element found in a substance that can bring down Superman.

Answer: Curses! It’s Krypton!

Students who select Californium have been known to dress up like surfers. Thorium fans fashion themselves as the Norse god of thunder, Thor. Sodium lovers have outfitted themselves in mock salt containers. Sometimes they team up: One year three students donned an ocean wave costume to suggest a water molecule’s triadic make-up: two hydrogen atoms and one oxygen atom.

Professor Bunce doesn’t shirk her dress-up duties, either.

One year she came dressed as a monk to explain a legend of how the 15th century monk Basil Valentine discovered the element antimony:

“Brother Basil was searching for a way to fatten the monastery’s pigs when he noticed that the pigs put on weight when they ate food that had been contaminated with the remains of his laboratory work on stibium,” Professor Bunce explained. “In an effort to help his fellow monks put on weight, Brother Basil secretly added stibium to the monks’ food. Unfortunately, it did not have the same effect on the monks and they all died. Brother Basil felt terrible that he had killed the other members of his monastery, so he traveled all over Europe telling anyone who would listen that stibium was no good for monks — hence the name (anti monie, which means ‘against monks’), and thus the name antimony became the chemical name for stibium. The symbol on the periodic table for antimony is Sb.”
thrown at her,” Professor Bunce says. “She’s actually dissolving.”

Professor Bunce says the trick is to use non-science metaphors or examples to help students understand chemical properties or processes. That can be especially helpful when teaching chemistry to non-science majors.

“She makes the concepts understandable,” agrees Emily Metoyer, a freshman nursing major from Houston. “You know how teachers sometimes hate to slow down? She always takes the time. She puts things into basic English, and she makes sure everybody understands before moving on.”

Professor Bunce teaches chemistry courses for nursing majors — courses which are required and sometimes taken with trepidation.

Ms. Metoyer remembers her initial nervousness.

“I was horrible at chemistry in high school; I really struggled,” she says. “It’s like a foreign language to me. I was really dreading it, but I knew I had to take it if I wanted to be a nurse.”

Ms. Metoyer recalls her first day in Professor Bunce’s class: “She walked in and you could immediately see what a concerned teacher she was. She really is an awesome teacher and she’s so willing to go the extra step. She sends e-mails if she’s concerned about you. She will rearrange her schedule to make sure we can attend her office hours. For the Halloween class, she got dressed up along with us. As much as I dread chemistry, I’ve managed in the class, and it’s because of her teaching.”

Teaching the Teachers

When Professor Bunce isn’t teaching her own students about noble gases and heavy metals, she’s writing textbooks for other students. She is a co-author of *Chemistry in Context: Applying Chemistry to Society* (American Chemical Society), a textbook for humanities majors that uses everyday words to explain scientific concepts.

She also organizes workshops for high school students, which can include “who-dunit” exercises in which the students must use lab experiments and principles of forensic chemistry to solve a murder mystery on CUA’s campus.

But the main drive of her academic research has been developing effective ways for other teachers — at the elementary, middle school, high school and college levels — to improve the ways they teach chemistry. That means understanding the way young people learn, and using teaching methods that reach them.

“You have to remember you’re not the sage on the stage — you’re a guide on the side,” says the professor, who offers this advice during teachers’ workshops.

“Professor Bunce is a great ally to have right now as a teacher,” says Christina Monkres, who received her CUA bachelor’s degree in chemistry in 2001. Ms. Monkres currently teaches chemistry at Elizabeth Seton High School in Bladensburg, Md. “I go to her workshops [for teachers] at CUA and they’re so refreshing. If you had a bad week at school, you go and get a new perspective — and the kids definitely respond to her methods.”

Professor Bunce has made a serious study of the way children learn and how they should be taught, incorporating theories of the pioneering Swiss philosopher and psychologist Jean Piaget. She also incorporates many aspects of Constructivism, a learning theory which holds that lectures alone won’t do the trick — students must experience how new and unfamiliar information relates to their existing knowledge.

“Rather than give students straight definitions, you have to get them to relate new information to what they already know,” Professor Bunce says. “That’s learning. That’s changing their mental structure.”

In one of her papers about Piaget’s theories, she writes: “Educators who were influenced by Piaget’s theory de-emphasized the traditional lecture and placed more emphasis on providing a variety of activities that enable students to interact with the physical world.”

Hence the Halloween Parade of Elements, with a Tin Man asking questions about the properties of aluminum, or the Silly Putty workshop. Professor Bunce has built her classes around letting students interact with the physical world of chemistry.

Over the years, those teaching methods have infused her everyday life, she says.

“I did science experiments for birthday parties with my kids,” she says. “I do experiments for stories in the local papers during the holidays. Chemistry is not something I do, it’s something I am.”
Bunce’s Experimental Education

What the Turkey Doesn’t Tell You

A little known (and somewhat disturbing) fact: Paper towels and mashed potatoes have more in common than one might guess.

Students find this out first-hand — by chewing on both — during Professor Bunce’s lecture on the chemistry of Americans’ classic Thanksgiving dinner.

During this class, a traditional turkey dinner is usually set on a festive table next to another table from which Professor Bunce will conduct her experiments. She is usually dressed in her traditional lab coat and pilgrim’s hat to explain:

• Why a turkey timer works: Sealed within the plastic pop-up timer is a drop of solder which holds the spring down. As the internal temperature of the turkey rises, the solder melts, releasing the spring.

• Why muffins rise: As the reaction between the milk and baking soda progresses, it releases carbon dioxide, which rises and takes the batter with it. The heat of the oven bakes the batter in the risen position as the carbon dioxide is released.

• Why we can digest the starch in potatoes, but not in paper towels: Both starch and paper towels are made of glucose units that have bonded. We humans have an enzyme that can break those linkages in starch, thus releasing the glucose molecules that will eventually be used to fuel our bodies. We don’t have the enzyme to break down the glucose linkages in paper towels, however. (Termites, on the other hand, have the specialized enzymes to make a fine holiday meal out of those paper towels and other wood products.)

She also explains how wine is fermented, and “most importantly, how antacids work.”

A Bunny’s Laboratory

Easter means egg experiments — and fake rabbit ears and a tail — in Professor Bunce’s laboratory.

Students learn how to make their own egg coloring kits by mixing food coloring with one tablespoon of vinegar. But first they learn why simply dipping the egg in water and food coloring won’t do the trick.

“The outside of the egg is covered by a cuticle, a protein layer covering the calcium carbonate of the shell,” Professor Bunce explains. “Using an acid such as vinegar causes the cuticle to acquire a positive charge and attracts the negative charge of the dye molecule.”

Mix the dye with other acids such as orange and lemon juice, and the dye will still stick, she adds.

But if you use sandpaper to rub off that cuticle on part of the egg, you’ll see that the dye has nothing to bond with and the color will not stick to that spot, Professor Bunce illustrates.

Students also create their own dyes by boiling colored onion skins in water and make interesting hues with paprika and turmeric.

Understanding St. Paddy’s Revenge

Professor Bunce does her part to discourage St. Patrick’s Day excess by describing the chemistry of hangovers and their associated headaches, nausea and fatigue.

Cogeners, a natural product of the fermentation and processing of beer, wine and spirits, are largely responsible for hangovers, she explains.

“Dark-colored distilled spirits such as scotch, rye and bourbon have the greatest number of cogeners, while vodka, gin and white wines have the fewest,” Professor Bunce says.

A headache is an allergic reaction to the cogeners. Alcohol irritates the mucous lining of the stomach, causing nausea. Upset stomach, headache and thirst can be considered forms of mild withdrawal from the alcohol.

Fatigue is the aftermath of an often higher-than-normal activity level during drinking and the fact that alcohol increases blood sugar for about an hour but then causes a plunge in blood sugar levels for several hours, she explains.

She warns that “aging in casks increases the level of cogeners in distilled spirits. Thus 25-year-old scotch may result in more hangover effects than 5-year-old scotch.” — C.H.