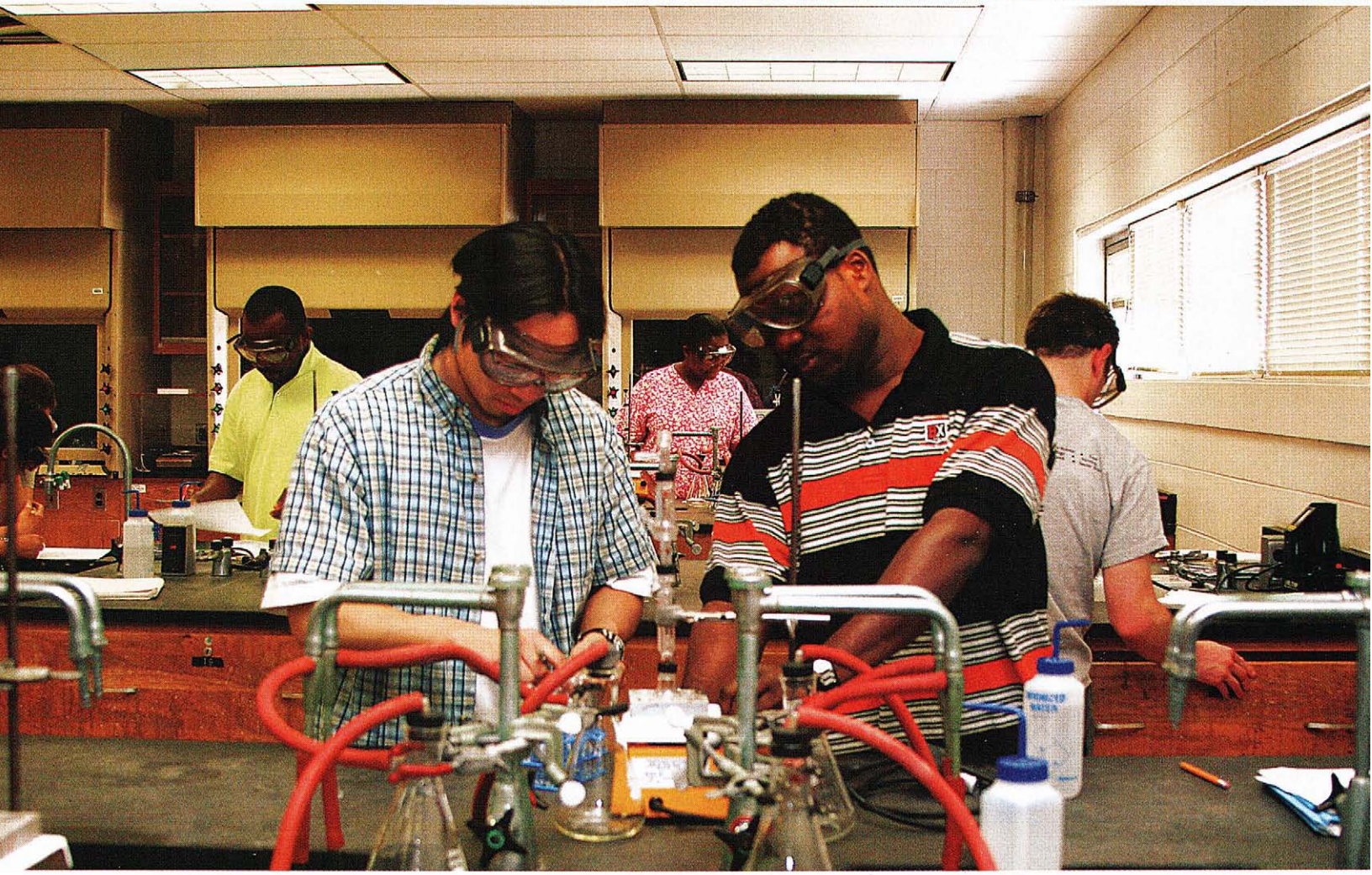

FAITH HAYDEN/C&EN

ROADS LESS TAKEN

THIS YEAR'S EDUCATION supplement sheds some light on the corners of education that haven't gotten much notice. It's a reminder that the highways we travel in life are rarely straight, and there's always something to be learned from trips along the back, side, and dirt roads.

First, Senior Correspondent Stu Borman introduces readers to fellows—faculty-like investigators who do independent research at academic institutions. It's a career option that is more common in biology, but does exist in chemistry. Fellowships are an opportunity to conduct productive research and have rewarding career experiences that aren't tied to a tenure-track position.

Next is a story about high school teachers who are using new tools such as podcasts, movies, electronic whiteboards, and online discussions in the classroom to enrich the learning experience for their students. Associate Web Content Editor Noah Shussett talks with teachers who have integrated technology into their curriculum in meaningful ways.

There are many wrong assumptions made about community colleges—for example, that they are primarily for students who can't succeed at a four-year institution and that the quality of the affordable education they offer is low. Assistant Editor Faith Hayden reports that the truth about community colleges flies in the face of these stereotypes. They are now attracting those who fit the typical four-year university profile and some offer their students solid science programs.

Finally, I ask former members of U.S. Chemistry Olympiad teams about their experiences and how their career decisions after the International Chemistry Olympiad were influenced as a result. Although only some of the students pursued a career in chemistry, all of them regarded the competition as a valuable and confidence-boosting experience.—CORINNE MARASCO

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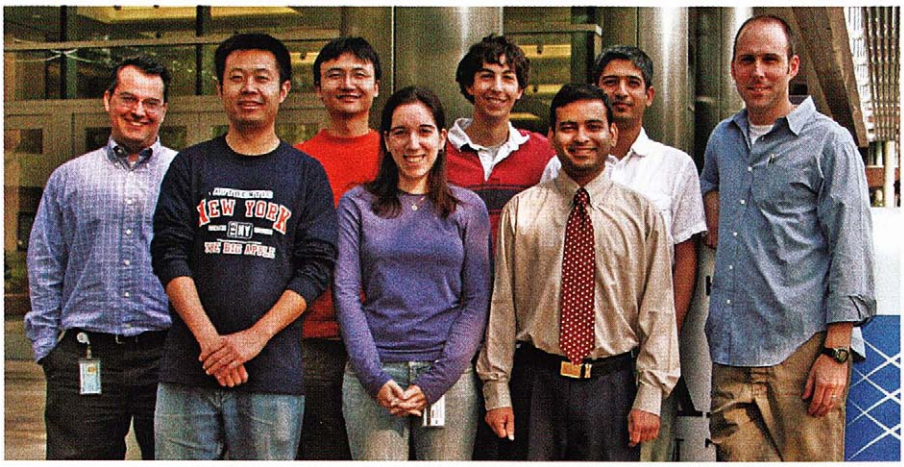

RALPH MAZITSCHEK

SHAW TEAM Shaw (far right) and his team at the Broad Institute. Shaw recently moved on to join the faculty at UC Davis.

FELLOWS ARE AN INDEPENDENT LOT

Non-tenure-track research positions offer ALTERNATIVE CAREER PATHS

STU BORMAN, C&EN WASHINGTON

ACADEMIC RESEARCHERS generally get their jobs by earning a doctorate in their field, perhaps serving as a postdoctoral associate for a senior investigator, and then applying for a tenure-track position at a college or university. For some time now, however, a select group of young scientists have been taking a different path. After earning a Ph.D. or completing a postdoc, they have become independent research fellows.

Independent fellowships are not well-known in chemistry. But for some young scientists, they provide a quick route to research independence and are considered excellent launching pads for future tenure-track academic careers.

Independent fellowships are non-tenure-track faculty-like positions that give young researchers the ability to run their own labs, manage a small group of grad students and postdocs, and carry out their own research agendas. The fellowships are better known and more common in biology than in chemistry.

An advantage of fellowships is that they give young investigators a chance to carry out independent research as soon as possible, at an exceptionally creative and productive point in their careers. Fellowships can also serve as way stations, giving young researchers who have failed to obtain a tenure-track academic appointment an opportunity to reapply later.

Sometimes fellows go on to accept tenure-track faculty positions at their fellowship institutions, but in most cases they accept appointments at other academic institutions and in industry.

Independent fellowships demonstrate that "productive research and rewarding career experiences can exist outside of a tenure-track position," says chemist Jared Shaw of the University of California, Davis. Shaw used an independent fellowship at Harvard University/Massachusetts Institute of Technology Broad Institute as a stepping stone to his academic position at UC Davis, where he just started working this semester. Previous Broad Institute chemistry fellows have moved on to take positions in academia, as Shaw did, and in the pharmaceutical and biotech industry.

Independent fellowships are not new. For example, chemistry professor Roald Hoffmann of Cornell University was a Harvard fellow in the early 1960s, when he worked with Robert B. Woodward to formulate the Woodward-Hoffmann rules—research that provided a basis for Hoffmann's shared 1981 Nobel Prize in Chemistry for theories "concerning the course of chemical reactions."

Hoffmann says that in his Harvard fellowship he "had absolute freedom for three years, not working with anyone, but on my own, with a salary not different from that of an assistant professor." Harvard's independent fellows are formally called Junior Fellows and are members of Harvard's Society of Fellows. The university's fellowship program "goes back to the 1930s," Hoffmann says. Woodward himself was a Harvard Junior Fellow—as was Harvard chemistry professor Dudley R. Herschbach and other notables in scientific and nonscientific fields.

Independent fellowship-type programs are found at places like Burnham Institute for Medical Research, La Jolla, Calif., and Whitehead Institute for Biomedical Research in Cambridge, Mass. Peter S. Kim, president of Merck Research Laboratories, is among those who have served as fellows at Whitehead Institute.

At Janelia Farm, the Howard Hughes Medical Institute's new research campus in Ashburn, Va., there are currently eight independent fellows, and the institute plans to appoint perhaps a dozen more. "We envision they will come from a wide variety of backgrounds, such as chemistry, physics, engineering, and neuroscience," says HHMI Associate Director of Communications James E. Keeley Jr.

Shaw says he accepted a fellowship at the Broad Institute because he "had completed a postdoc and wanted to stay in research. My wife, who was three years behind me, was starting her postdoc. So a temporary position, where I was doing independent research for a period of time, worked perfectly for me."

Shaw's fellowship was initially funded entirely by the institute, but he later got grant support as well. For example, when he and several colleagues applied for and obtained a shared National Institutes of Health Chemical Methodologies & Library Development grant, that "became one of my main funding sources," Shaw says.

ONE FRUSTRATION of independent fellowships, however, is that "many grants are only available to tenure-track faculty members," Shaw says. He hopes that that practice will change in the future, especially if independent fellowships become more common.

Independent fellowship programs are also found at non-U.S. institutions, such as the National Centre for Biological Sciences (NCBS), in Bangalore, India. Kaustubh Rau, who specializes in biological responses to mechanical forces, including

GRADUATE FELLOWSHIPS
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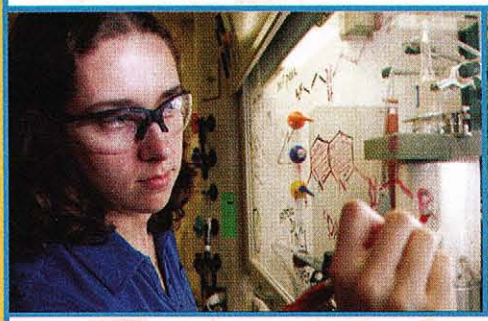
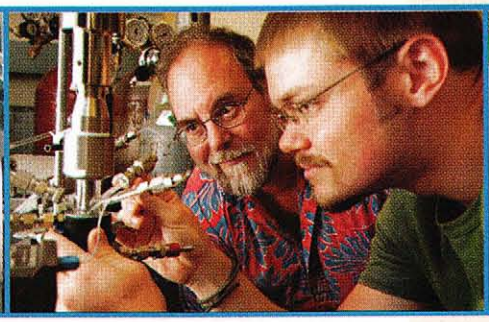


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NCBS

RAU GROUP Rau (seated and in striped shirt) and part of his team at NCBS.

laser damage to cells and tissues, is one of several independent fellows at NCBS. Major goals of the center's fellowship program are "getting young people on a research track as quickly and with as few hassles as possible and seeding new areas of biological research by attracting people with diverse backgrounds," Rau says. The fellowships also enable the center to fund risky projects without committing long-term resources to them, he notes.

At NCBS, each fellow "has an appointed mentor they can interact with, but the scientific questions they can study are completely their own," Rau explains. A review committee consisting of the center's director, an academic dean, and the fellow's mentor "oversees progress on a yearly basis and offers criticisms, comments, and suggestions," he says.

Fellows are free to accept grad students and postdocs into their groups, and "teaching responsibilities are minimal to nil," Rau says. "Research is funded by NCBS through a start-up grant that allows you to set up your lab," he adds, and fellows are given funds for consumables each succeeding year. They are also welcome to apply for grants to supplement their funding. Rau's group is currently funded in part by a Fogarty International Research Collaboration Award from NIH.

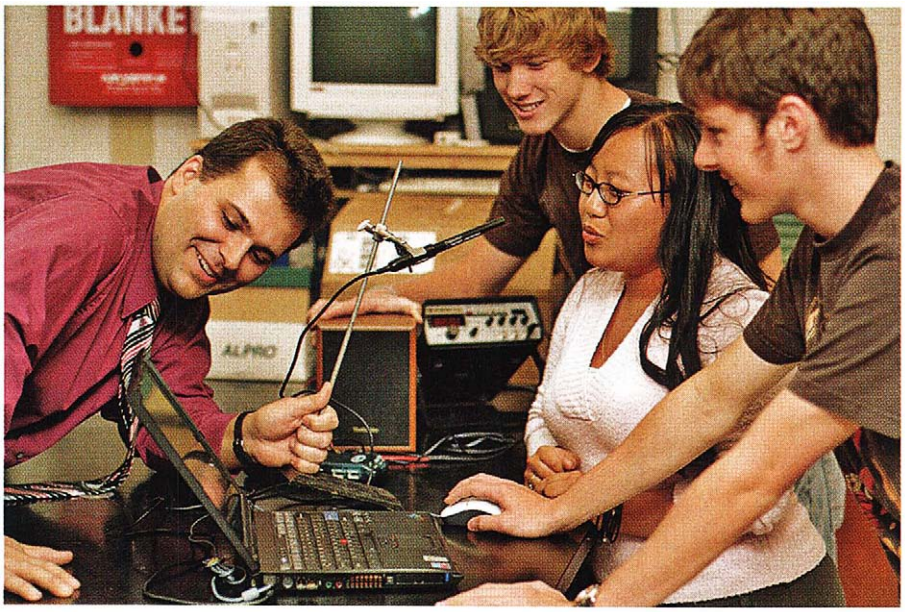
Looking toward his future, Rau says, "One can imagine that having been a fellow at NCBS, a prestigious research institute in India, your job prospects are enhanced."

Shaw believes his job prospects were also enhanced by his Broad Institute fellowship. "The fellows program gave me a tremendous opportunity to gain experience as an independent investigator while learning about new aspects of my field in the area of chemical biology," he says.

"I was able to get a head start on new independent projects, grant writing, and working with academic collaborators in other fields, which are all areas that present big challenges to new investigators," he adds. "The opportunity to work in this environment without also having to juggle committee obligations, teaching, and all of the other responsibilities of a tenure-track position was a perfect fit for my career trajectory."

As a result, "I have been able to hit the ground running at my current position at UC Davis," Shaw says—which just goes to show that the road not often taken can often be the road best taken. ■

APPLETON AREA SCHOOL DISTRICT



HIGH-TECH Basler and students observe a graphical representation of different sounds.

WIRED FOR LEARNING

Teachers are tapping into youths' **DIGITAL SAVVY** to take science education into the future

NOAH U. SHUSSETT, C&EN WASHINGTON

TEENAGERS have always been early adopters of new technology. Today, their MacBooks are replacing stacks of textbooks and their headphones connect to iPods rather a Walkman. She has a Motorazr phone to her ear; he's battling it out on a PlayStation Portable. They know where the Wi-Fi hotspots are and other places with free wireless Internet access, of course, because they're reading blogs, watching videos on YouTube, updating their pages on Facebook, downloading music from iTunes, and talking with a friend in Osaka, Japan.

Today's youth are growing up in a technologically advanced digital world; for them, high-tech gadgetry is normal. And some teachers are adapting and taking advantage of this trend to enable breakthroughs in the teaching and learning of science.

Among those are the teachers of Red Lion Area High School, home to roughly 1,850 students in grades nine through 12. Nestled near York, Pa., just beyond the bustling Philadelphia suburbs and Pennsylvania's Amish country, Red Lion has a small-town feel but a high-tech school system.

The Internet is their medium, says Jared Mader, a science teacher for nine years who was recently appointed district director of technology for the Red Lion Area School District. "These kids are multitaskers; they are IMing with one hand, texting with their cell phone in the other hand, and they're Skyping or chatting or whatever with voice over IP."

The medium has its own vocabulary. "IMing" (pronounced eye-em-ing) refers to instant messaging, a way of communicating with others over the Internet; "texting" is text messaging, a way of sending a message in text from your phone to another; and "Skyping" refers to the use of Skype, a peer-to-peer Internet telephony product with a growing base similar to Voice over Internet Protocol (VoIP). There's also podcasting (broadcasting of a digital media file via the Internet with playback capabilities on portable media players), blogging (creating entries on a website that are displayed in reverse chronological order), and wikis (a collaborative website that can be directly edited by anyone with access to it).

"The way students learn today is different from the way we learned because today's students are able to process so much information at once," Mader says. "We would be doing a great injustice to them if, as teachers, we didn't start to tap into that."

For example, before computers became ubiquitous, when students were at home and got stuck on a homework problem, other than a phone call to a fellow student, they didn't have access to immediate help. Capitalizing on the presence of computers in at least every other U.S. household, Mader has started online discussions with materials that include his podcasts, whiteboard notes, and live discussion, all via the school district's website. "It's like evening office hours for high school students, if you will," Mader says. Some of the top chemistry and physics students have downloaded podcasts straight to their iPods, he says, so they have information from a live class to take with them for reference.

Mader is not alone in leveraging the digital savvy of students. He and his Red Lion colleague Ben Smith, a veteran physics teacher and fellow technology advocate, have put together training programs for teachers, presentations at local and national conferences, a string of journal articles, and, of course, websites to promote technology in the classroom.

It's not just about the subject matter, Smith says. He wants his students to learn how to communicate, solve problems, and collaborate, and he believes acquiring those skills may be helped, if not directly driven, by technology.

FOR EXAMPLE, Smith explains, students learn the importance of communication by creating their own podcasts, blogs, and wikis. He sees problem-solving in action when his students realize that a song by a heavy-metal band may not be the best soundtrack for a podcast discussing yesterday's class. He sees evidence of increased collaboration in their online discussions in chat rooms and on discussion boards that provide opportunities for students to converse about class topics among themselves and for him to also join in.

Halfway across the country and a bit more than an hour's drive from Lake Michigan is Appleton East High School, the professional home of the retiring president of the Wisconsin Society of Science Teachers, Dale Basler.

Basler has a student website, which, he says, was an experiment when he created it during the beginning of the tech boom, when high-tech gadgets were still novelties. He aimed to get his students more involved and comfortable with technology by posting quizzes and class goals and objectives. He also allowed students and parents to have access to a grade portal on the site.

In the beginning, most students did not

take advantage of tracking their grades because they were unfamiliar with the technology. Now, Basler says, everyone at his school who has a class website has seen increased communication and involvement from parents.

"I used to receive very few e-mails from parents of my students," Basler says. "Now, with their kid's information right in front of them on the computer, they just shoot me an e-mail." He is happy that parents contact him with concerns about assignments and exam scores early in the quarter, rather than waiting until the last week of classes. Posting information online lets parents monitor their child's progress throughout the year.

MEANWHILE, at Upper Merion Area High School in Pennsylvania, Peter Vreeland, the head of the science department, has an entirely paperless classroom, a result of the Pennsylvania grant program, "Classroom for the Future." The program aims to get a "pure one-to-one" student-to-laptop ratio ("pure" means each student takes their laptop from class to class and home). It delivered a cart of 30 MacBooks to Vreeland's classroom as part of the $153,673 awarded to the school district.

The program enabled Vreeland to shift from traditional teacher-prepared assignments to more student-developed projects and ideas, eventually leading him to a paperless classroom. Vreeland distributes homework, notes, investigations, and quizzes on district servers. Students can submit their work or questions via the district network or e-mail. Students can also save their class notes on the server, which is backed up on a weekly basis as a precaution in case of a network crash.

"Now that everything is electronic, I can expect more of my students," Vreeland says. "I don't give as many tests as I used to in favor of more investigative activities and lab projects and reports." Students even videotape their work and turn it in as part of a lab report or as the lab report itself. "The data have become multimedia," Vreeland says.

When grading a laboratory report, Vreeland says, instead of looking at a data table, he looks at the experiment and hears what the students had to say about it while it went on. He believes he can get a better sense of the students' understanding by hearing them discuss what happened and by being able to "watch each group perform each part of the lab."

The students, in turn, are more productive. "The amount of work they did this year far exceeded any other year or amount of work they were doing, and they didn't feel like they were actually doing schoolwork," Vreeland says. "Students can choose the format in which they want to show me their work, and the students appreciate it more than the paper environment where they couldn't hand me a lab report with a movie in it."

This flexibility, notes Vreeland, raises the quality of work he receives from his students. With these tools, students are willing to put in more effort to polish their work, rather than just signing their names on lab sheets.

One Internet-based tool that seems on the way to becoming standard in schools is the podcast, an effective means for creating a portable classroom. Having class lectures and step-by-step problem solutions in podcasts allows students to catch up when they miss a class and lets them focus more of their attention on what's going on while in class. Podcasts can turn a bus ride home into a learning opportunity, Basler says. He puts a podcast of his classes on his website on Fridays, and by the time of his Monday class, a majority of his students have listened to it, he says.

Smith says he transmits his podcasts just moments after his classes are finished. "One day, I forgot to hit transmit from an earlier class, and my students came in two periods later asking where the podcast was," he recalls. Smith says he gets everything he can into a digital format for his students. In addition to class lectures, he also podcasts his notes so his students can work out problems at their own pace anywhere they please.

A device that digitally captures scribblings on a board is another nifty teaching

"The way students learn today is different from the way we learned because today's students are able to process so much information at once."

aid, and two that are popular are the mimio and SMART Board. A mimio is a device that hangs on the side of a regular white board and captures pen strokes in a digital format. SMART Board does the same thing but requires a SMART marker and immediate uploading of the work to a computer. The mimio allows the notes to stay on the board all day long.

AND THERE'S MORE. Smith's students use handheld clickers instead of raising their hands, and he also posts grades online. In addition, he uses online word processing and spreadsheet utility sites, teacher-friendly blog sites, content management sites, feed aggregators, photo sharing and editing sites, and iMovie interfaces. Applications like screen-capture utilities (stills and videos), multimedia software, and project mapping utility are also in regular use.

Vreeland does not podcast his class, but he does record his board work with a SMART Board and places the file on the class server for his students to review. In the classroom, he uses Excel, Word Notebook—a virtual composition book also used by students for note-taking—and Grapher, a simple graphing program.

Despite all the gadgetry, all the teachers contacted for this story believe there is a breakthrough waiting to happen that is being stopped at the classroom doors. They refer to social networking sites like MySpace and Facebook, which, for a number of reasons, many school districts are blocking.

"It's a shame," Smith says. "Wouldn't it be great if you could start a lab in Pennsylvania and it finishes in California or in China?"

Parents and teachers are concerned that such sites may expose children to danger. An online social network would be attractive to parents and fellow teachers alike if it were in a safe and controlled environment in the schools, Smith says, but right now decision-makers are happy to just block them all.

"Facebook isn't a bad website, there are just bad people out there," Basler says. "The baby is really being thrown out with the bathwater on this one."

Vreeland is puzzled that these social networking sites are being dismissed by school districts, without any research and exploration of their benefits. "I won't prematurely dismiss them as something useless. In a sense, they are a way to communicate and get things done," he says. "The International Society for Technology in Education even has a MySpace page."

With technology moving at such a brisk pace, it may be easy to get carried away, a sentiment echoed by the four teachers. "We all may think kids are more tech-savvy than they are," Basler says. "Not every kid in my classroom is the tech-savvy neighbor who can reboot your computer."

One thing is clear: Technology in the high school science classroom—which both infinitely expands the possibilities of the classroom and captures student attention and interest—seems to be the next trend in "cool." Just don't tell the kids that "it's all about the learning," Smith says. ■

FAITH HAYDEN/C&EN

HANDS-ON Students work on an experiment in a chemistry lab at Montgomery College.

COMMUNITY LAUNCH PADS

Students find great value in low-cost, high-quality **TWO-YEAR COLLEGES**

FAITH HAYDEN, C&EN WASHINGTON

IF YOU'VE BEEN a college-bound student in the past 20 years, you may have been on the receiving end of this threat: "Study hard and score high on those SATs, or you'll end up at a community college."

But students are no longer "ending up" at their local community colleges because they are out of options. Rather, they are deliberately choosing that path for a variety of well-thought-out reasons ranging from cost to quality.

Although community colleges offer only associate degrees, students seeking bachelor's degrees can use them as a less expensive route for general education credits.

At one time, two-year schools were considered second-tier, mainly due to their inexpensive tuitions and open-door policies. No criteria exist for getting into a community college other than the willingness to learn, and students aren't required to take the SATs.

Education also comes at a fraction of the cost of four-year universities. According to the College Board, the average annual tuition for a state school is $5,836, compared with $22,218 for a private school. Two semesters at a community college, however, will set students back an average of $2,272.

In the eyes of some, this low-cost education equals a low-quality education. This stigma is changing, however, as is the average age of the community college student. According to a 2005 Department of Education report, "As of 2001, students under the age of 22 constituted 42% of all credit-seeking students in community colleges" compared with 32% a decade ago. Between 1991 and 2001, the median age of community college students enrolled for credit declined from 26.5 to 23.5 years old. This distribution may skew even younger through 2010 as the children of the later-year baby boomers—the "baby boom echo"—reach their college-age years and increase college enrollments.

"We have begun to notice a decline in the average age already," says George R. Boggs, president of the American Association of Community Colleges. "More students from high school are going directly to community colleges. Higher costs are a major driver, and community colleges have improved their reputations."

ONCE THOUGHT OF as the destination for older students not seeking a four-year degree, more community colleges are attracting 18- to 24-year-olds whose goals reach far past an associate's degree. Some of these goals even include careers in science and medicine.

Take Seemi S. Patel, 21, for example. With a 1350 on her SATs, she had a plethora of top-notch four-year universities to choose from. Her choice? Maryland's Montgomery College (MC), a two-year community college called "Princeton on the Pike" by students—a reference to the location of the campus off Rockville Pike.

Patel's reasons for choosing MC were practical. "I live with my parents, so I wanted to go to the University of Maryland, but it was far and I didn't have a car," says Patel. "Plus, when I talked to counselors about financial aid, MC was attractive."

MC has three campuses across the county, in Germantown, Rockville, and Takoma Park/Silver Spring. It offers students honors opportunities such as Montgomery Scholars, a program reserved for new high school graduates who intend to move on to a four-year university. The program has an 83% graduation rate, and students have gone on to graduate from universities such as Georgetown, Wake Forest, and Notre Dame.

On top of MC's reputation for academic success, the school offers a few things those big universities don't: small class sizes, personal attention from professors, and, according to students, an excellent Science Learning Center, where advanced science students help their peers with their studies.

"The tutors that come here are very down to earth and helpful," says Mike Davidson, 26, a nursing major taking organic chemistry. "It's not 'What do you want?' It's 'Do you guys need anything?' "

As for class size, MC averages 24–30 students per class, which allows professors to give students more personal attention than they would find in a lecture hall that seats 300.

"We will bend over backwards to help students in any course," says Donald Newlin, professor of chemistry at MC. "It's that mind-set that separates us from another college or university where the faculty is there during their office hours and that's it, and if you have questions, you talk to one of the teaching assistants."

Chemical engineering major Tommy Tamarkin, 26, knows about this firsthand. Armed with a high school GPA of 3.97 and an SAT score of 1190, Tamarkin began his college career at the University of Maryland, Baltimore County (UMBC). He had already spent four semesters there when his situation changed.

"My dad got cancer, so I was going back and forth a lot," says Tamarkin, whose parents lived in Montgomery County. "Every

FAITH HAYDEN/C&EN

PERSONAL APPROACH Susan Thornton, professor of chemistry at Montgomery College, goes over an assignment with her student.

weekend I was coming home, and it was becoming too much."

Tamarkin transferred to MC and finished his general education requirement courses. "The classes are smaller, so students get more attention," Tamarkin says. "The professors at MC are very knowledgeable. The professors at UMBC are teaching 300 students at a time, so you're fighting everyone else for the professors' time when you ask a question." He is now at the University of Maryland, College Park, where he is working toward a bachelor's degree in chemical engineering with a minor in geology.

Gideon O. Ifianayi, 23, a biochemistry major at Des Plaines, Ill.-based Oakton Community College, has similar sentiments about the education he received at Oakton versus the University of Illinois, Chicago (UIC), the large four-year school to which he eventually transferred.

"I was impressed by how chemistry was taught at Oakton," he says. "Most UIC chemistry professors are extremely hard to understand, and the classes are usually large. The chemistry courses at Oakton are more realistic. Professors teach courses with models, and their materials are much easier to understand."

Like MC, Oakton has an honors program, as well as undergraduate research experience for students in the science fields. The school also received a grant from the National Science Foundation of nearly $800,000 to support the science, engineering, and math curriculum.

In the summer of 2005, Ifianayi participated in a research program on DNA sequencing at Northwestern University, which was funded by NSF.

"I synthesized various polymers and copolymers of acrylamide derivatives," he says, "then characterized these polymers using various spectroscopic techniques."

NSF also sponsors a science, technology, engineering, and mathematics (STEM) fellowship at the college. This NSF program is designed to encourage students to pursue STEM careers and receive postdoctoral degrees in STEM studies.

"Oakton is doing a lot of work to recruit more students from high school into the science program," says Connie Churchill, a chemistry professor at Oakton. "We are also offering more support services. The grant has provided more funding for course tutors."

For Salvador G. Alvarez, community college changed his life. Alvarez, 43, now a Ph.D. chemist working at Genelabs Technologies, was once a high school dropout. Alvarez went on to get his general education diploma and spent three semesters at California State University, Fresno, but his GPA "was hovering around zero," he says. "I could not adjust to the fast-paced university life, and I also did not know how to study."

Alvarez transferred to Cosumnes River College (CRC), in Sacramento, Calif., where he took his first chemistry class. "My teacher made chemistry fun and exciting," he says. "He was an inspiration, and I discovered my passion for chemistry."

After spending two-and-a-half years at CRC and making the dean's list, Alvarez transferred to the University of California, Davis, and majored in chemistry.

BUT WHAT WAS IT about attending a community college that turned Alvarez into a model student?

"One gets a solid, well-rounded skill set at a community college because of the smaller class size as compared with a university," Alvarez says. "Also, I could easily interact with my professors, and they remembered my name. It was more personal, while at the university, it was more impersonal and the class sizes are larger. We interacted more with teaching assistants; professors were too distant."

With all the academic opportunities for students at community colleges, it's no wonder more 18- to 24-year-olds are choosing them right out of high school.

"Maybe more and more people are realizing that college education is very expensive, so why not go the less expensive route for a couple of years and then go to a bigger university," says MC's Newlin. "I would encourage my kids to do the same thing."

"A community college is like a launch pad to success," says Alvarez. "You can develop a strong, rounded skill set to succeed in a university and in life." ■