When Andy Miner first told his physics students they were going to run experiments on radioactivity with a Geiger counter in Australia, the high school juniors and seniors were skeptical.

"Working with an instrument that was a world away? They thought I was just a nerdy teacher messing with them," says Miner, a science teacher at Evanston Township High School in Illinois.

Once the students began to use the remote lab, though, they were sold. They could design an experiment, input the data, ask the machine to run it for them, and get the results back within a day.

"There was a higher level of commitment to what they were doing," says Miner. "It wasn't fabricated."

To run these experiments, Miner tapped into the free iLab Network at Northwestern University. He has also used interactive virtual labs through other university websites to help bring science to life in his classroom.

"It's hard to find a way to make science meaningful to high school students," says Miner. "I think this will be the future of education."

Remote and virtual labs are another tool for science teachers struggling to appeal to digitally savvy students. And conducting experiments online can save time and money and allow students to work with dangerous elements or high-end equipment that they wouldn't otherwise have access to.

While some traditionalists still believe there's nothing like a hands-on lab experience—yes, beakers get broken, but students learn from their mistakes—the best solution may be a blended approach, using both virtual and in-person labs.

**A Blended Approach**

Virtual and remote labs have been around for more than a decade, but as they improve and increasingly become affordable, schools...
More schools are turning to **VIRTUAL LABS** to lower costs and engage students.

By Caralee Adams

"Anyone who is a science teacher knows about the costs associated with the hands-on lab, materials, tools, what happens if you break something," he says. "The cost factor is quite appealing when we talk about schools going through financial difficulties, which pretty much every school is, and there is a virtual possibility that provides nice access."

The Science "Techbook" Where do you start when choosing materials? Some labs are available free online, while others are accessible through a subscription or via digital textbooks. Many are designed to work in conjunction with hands-on labs to provide a blended experience.

are beginning to take notice. "It's growing pretty rapidly. There is a lot of momentum driven by budgets and pedagogy," says David Evans, executive director of the National Science Teachers Association, based in Washington, D.C.

Virtual labs are accessible and generally affordable, and studies show they can be effective as physical labs for some kinds of learning. The best virtual labs are ones in which the student is an active participant, says Evans. For instance, a lab about electronic circuits allows students to click on the screen to pick up electrical components and connect the circuits. These labs reduce the need for equipment and can engage reluctant learners.

Evans, like others, advocates for a combination of approaches. "I'd hate to have virtual labs completely replace the [traditional] laboratory experience, because actually doing things is part of the discovery. You learn things through touch," he says. For example, students can dissect a frog with virtual tools, but they can better understand the nature of the layers of the skin and tissue when they actually have to separate them.

As technology becomes a bigger part of the classroom, though, it's inevitable that the use of virtual labs will expand, says Andrew Miller, an ASCD faculty member.
“IT’S HARD TO MAKE SCIENCE MEANINGFUL TO HIGH SCHOOLERS,” SAYS TEACHER ANDY MINER. “I THINK THIS WILL BE THE FUTURE OF EDUCATION.”

Since 2011, Discovery Education has been offering Science Techbook. It has been adopted in 47 states and is used by 700,000 students. Districts purchase the digital textbooks for $38 to $55 per student for a six-year subscription. This often represents a cost savings; most states pay about $70 for a traditional textbook. (Other companies providing digital curriculum include JASON Learning, Houghton Mifflin Harcourt, and Pearson.)

Discovery’s approach includes providing schools with a curriculum (available for K–12) that incorporates the interactive, virtual labs into unit instruction. Students often start a lesson doing the virtual lab led by the teacher, followed by a physical lab. Or, they can do a hands-on experiment and then dive into the concept more deeply online.

“It’s a combination of both. They work hand in hand,” says Linda DeLuca, K–12 district science specialist at Collier County Public Schools in Naples, Florida, which has used the Discovery Science Techbook since its inception.

Most virtual labs are animated and some include a video clip. “Kids just gravitate to that media,” DeLuca says. “Ask kids a question and they are going to go Google it. We are reaching them at a level they are used to.”

STEM Launch, a K–8 school in Thornton, Colorado, began using the Discovery Science Techbook this year.

“It’s a game changer to put this robust material in the hands of every student,” says Principal Kellie Lauth, adding that it also made sense economically.

While kids see the value right away, the biggest challenge has been for teachers to shift their mind-set and how they teach, says Lauth. DeLuca agrees: “When you have something new, teachers tend to be not so sure. It takes time to get it rolled out in the classroom.” But, she adds, seeing the success of the students and the learning going on helped to push the teachers in her school toward adopting the curriculum.

STEM Launch’s Lauth says her school’s transition to digital science books and labs has been relatively seamless; any minor problems they’ve had with the technology were taken in stride. Plus, since teachers are not relying solely on the digital material, they can make adjustments when the system has glitches.

Virtual Labs

ABOUT THREE YEARS AGO, online curriculum provider K12 developed virtual labs to accompany its Web-based high school science program and products (true to its name, the company offers lower-grade curriculum as well). Daniel Franch, director of science for the Herndon, Virginia–based company, says the labs are another tool to help students master biology, chemistry, physics, or environmental science.

With the illustrated or animated videos, students interact with and enter the data they observe. If a student makes a mistake and does something in the wrong order, the program responds. While nothing quite replaces a physical lab and having a lab partner, says Franch, these virtual labs are a valuable option.

Smart Science has been around since the late 1990s. Founder Harry Keller, a software developer and college chemistry professor, wanted to improve how kids in high school were learning about science, so he used his expertise to start the company. With Smart Science’s online labs, students make predictions before beginning an experiment. Then, they interact with the video-taped labs, adjusting variables, recording data, and doing post-lab online reports. “An online lab must use a real experiment. Online learning experiences can be different, but they need to be real,” says Keller. Keller’s site, Smartschools.org, has nearly 160 labs online that middle schools, high schools, and colleges subscribe to for about $30 per student, per course.

“In an ideal world, you could spend all day, every day doing labs...but there isn’t enough time to do that,” says Keller. Students can conduct more experiments and complete them faster in the virtual world, but also supplement the experience with hands-on activities. “You need something kinesthetic where you can feel it, smell it, manipulate it,” says Keller. Smart Science software has virtual, wet, and hybrid labs built in.

Kemi Jona, research program coordinator at the Office of STEM Education Partnerships at Northwestern University, coordinates the remote labs that give high school and college students access to high-end scientific instruments over the Internet. When students have the opportunity to use a remote lab, he says, they are three times more likely to run more labs than required by the assignment compared with students conducting traditional labs.

Often the logistics and time needed to do a physical lab get in the way of deeper conceptual learning. “The remote lab allows for a personalized learning experience that you often don’t get in a traditional high school lab working in groups,” Jona says.

Though there is increasing interest in remote labs—nearly 9,000 users have registered on iLab Network’s parent site, iLabCentral.org, since May 2009, running a total of almost 12,500 experiments—Jona recognizes it will take time to strike the right balance. “We have a lot of work to do to understand what mix of experiences are most optimal for which kinds of learners—some combination of hands-on exploration that leads to use of online simulation or a lab.”

ARE VIRTUAL LABS FOR YOU?

GO VIRTUAL FOR THE RIGHT REASONS.

Decide why you are doing a virtual lab, suggests Andrew Miller of ASCD. Perhaps it’s because you don’t have adequate materials or you want to provide a differentiation tool. “Once you know what that is, you can ask the questions related to it.” Instead of getting “too happy about the technology, match what you use with the school’s needs.

* Also, consult with teachers and don’t mandate the tool. “Teachers know their students best,” says Miller. One group of students may benefit from a virtual lab, another may not. The curriculum will direct the kinds of labs that work, so involve teachers early in the technology selection. * Finally, provide adequate PD. The instructional leader needs to show teachers how the labs work and provide professional learning opportunities to match their interests. Virtual labs must be used intentionally, but variations are okay.