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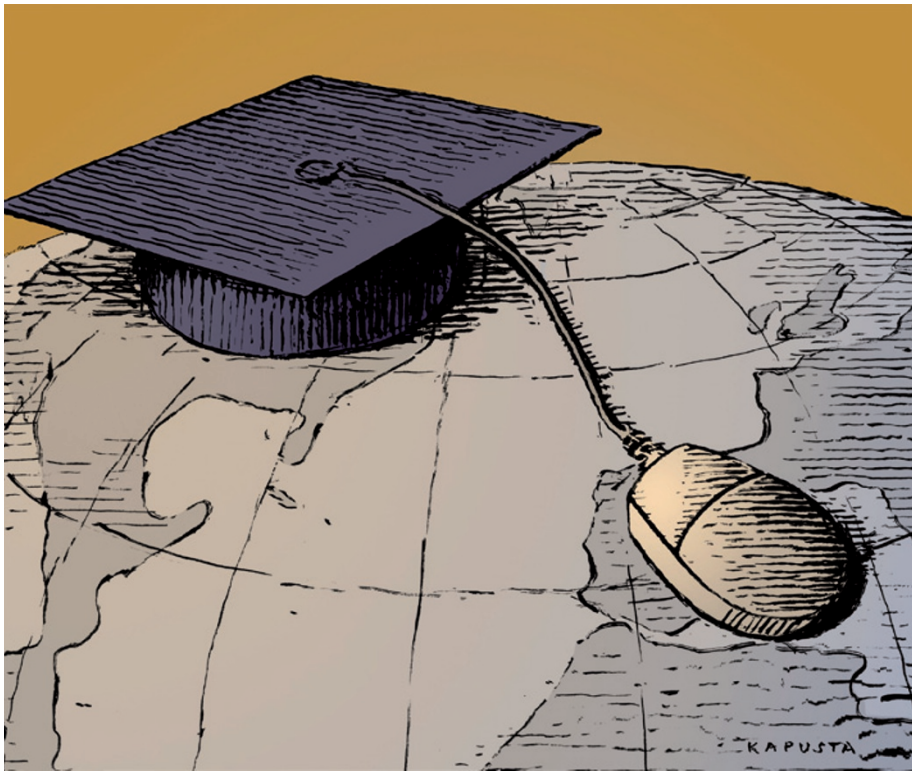

DISTANCE LEARNING

Online education

Internet-based degree programmes are gaining acceptance, but doubts remain about their suitability for graduate science.

BY SARAH KELLOGG

When Lauren McBryde Gray began her graduate studies at the University of North Carolina Wilmington, she was a chemist working at a biopharmaceutical company on the east coast of the United States, happily married and thinking about starting a family. Her busy schedule couldn't accommodate the regimentation of on-campus courses. "It was important I bring in an income for my family, but I wanted to get my master's to give me an edge in terms of my career," says Gray. "I needed another option, a better option."

That option was the university's hybrid online master's degree in chemistry. The innovative Corporate MS Chemistry Program offers online courses to professionals working at partner companies. Students learn online and complete compatible research in laboratories at their workplace, supervised by two university professors and a senior colleague from the company who has a PhD. "It really turned out to be win–win," says Gray.

For Gray, studying online was the perfect solution. That's not always the case, however. The number of online science graduate-degree programmes is slowly rising in the United States and other countries, including the United Kingdom and Australia (see go.nature.com/9yefal for a sample). But they have not kept pace with the growth of online degrees in fields such as computer technology, education and business. Studying science through distance learning can be problematic because it provides few or no opportunities for collaboration with peers or intensive laboratory research. But in fields in which these aspects are less crucial, studying science online at the graduate level has become accepted and useful for those seeking a flexible schedule. And some hybrid programmes offer the hands-on experience that scientific studies require.

A POPULAR ALTERNATIVE

Online learning eases pressure from burgeoning university enrolment, limited campus facilities and the increasing cost of higher education; it feeds interest in life-long learning; and it is convenient, especially given advances in web-based communications in the past decade. "I do not predict the demise of the residential campus," says Michael Lambert, executive director of the Distance Education and Training Council in Washington DC, a US accreditation agency for online learning. But campuses are at capacity in many respects, he adds. "We don't have enough seats or dorms," says Lambert, "and colleges and universities and students and their parents cannot afford for residential campuses to grow much larger."

According to the US Department of Education, 20% of all undergraduates in the United States — some 4.3 million students — took at least one distance-learning course in 2007–08, the latest year for which data are available. About 800,000, or 4% of all undergraduates, took their entire programme through distance education.

The number of online graduate students is smaller. About 22% of all US students with bachelor's degrees — 760,000 of them — took distance-education courses in 2007–08. Of that number, some 302,000 took their entire programme online. More than 23,000 students took life-sciences courses online, and 4.2% of all life-sciences students took their entire programme through distance learning.

Other countries' institutions continue to expand offerings. The government and universities in Britain, for example, have been particularly aggressive in their efforts to woo overseas students to university distance-learning programmes. According to the United Kingdom Council for International Student Affairs, some 115,000 international students use distance learning to study at UK higher-education institutions.

Universities have struggled to design online programmes for science and engineering. ▶

"It isn't simple to create a programme that meets all the requirements" for scientific graduate work, says Kenneth Green, founder and director of the Campus Computing Project in Encino, California, the largest ongoing study of the role of information technology in US colleges and universities.

Essential features of an on-campus science degree that are hard to replicate online include teamwork and laboratory-based research. These are a particular problem for online PhD programmes. Arthur Motta, a nuclear engineer at Pennsylvania State University (Penn State) in University Park, teaches online and campus-based courses to graduates. He believes that the online model is inadequate for PhD research, in terms of both learning and financing.

"Online definitely works for certain master's programmes, but it's not good in my view for the PhD," says Motta. For example, principal investigators typically receive grants that include student support in the form of tuition fees and stipends. That support comes with expectations — that PhD students conduct research projects on campus under the supervision of their principal investigator. "I'm their supervisor," says Motta. "They have tasks to perform on the project."

UNIVERSITIES EXPERIMENTING

Despite the challenges, many universities are experimenting with online master's programmes. Faculty members say that online learning-management systems such as Blackboard and Moodle, to which teachers can upload their course content and recommended reading lists, translate on-campus curricula into effective online courses. For example, a teacher would use the same lectures, slides, problem sets, quizzes and tests for an online graduate physics course as for an on-campus one. At some universities, online materials for distance learners are also made available to on-campus students, to allow them to watch lectures again or to review slides that they might have missed in class.

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"We created a way for them to get through a graduate programme and do some significant research work for their companies."
Jimmy Reeves

Universities have developed inventive solutions to research concerns. Students can come to the campus for brief residencies at the beginning, middle or end of their studies, work at partner institutions such as a national laboratory or another university, or do research in their workplaces. "We created a way for them to get through a graduate programme and do some significant research work for their companies," says Jimmy Reeves, chair of the department of chemistry and biochemistry at the University of North Carolina Wilmington and an instructor for the corporate master's degree.

Online students can also do research through remote and virtual laboratories. Virtual labs, used widely in undergraduate courses, are expanding into master's programmes. They allow students to complete coursework by conducting simulated experiments in fully interactive animations of biomedical, chemical and physics labs. For example, students can combine chemicals and check whether the results are in line with their predictions. Alternatively, students can conduct original research projects over the Internet by remotely controlling instruments in distant laboratory facilities. As universities become comfortable with new technologies and different learning models, they will be less reluctant to offer hard sciences through distance learning, argues Frits Pannekoek, president of the International Council for Open and Distance Education, a membership organization based in Oslo, and president of Athabasca University, a distance-learning centre in Canada. Critics, however, say that campus visits and virtual labs cannot offset the loss of mentoring opportunities, especially when students are completing a thesis or dissertation.

OPPORTUNITIES FOR STUDENTS

Faculty members say that online programmes are especially effective for older students who have the discipline to complete their work with little supervision and are assertive enough to seek help when they need it. Because course materials are always available, students can access materials whenever necessary. Some critics argue that online learning offers too many distractions, but distance learners say that physical classrooms are no guarantee of attention or attendance, and online courses often allow for a more focused experience.

"You basically have the ability to come home from work and unwind and put on a lecture while you cook dinner," says Michael Mierzwa, a nuclear engineer with Westinghouse Electric Company in Pittsburgh, Pennsylvania. Mierzwa was attracted to Penn State's degree in nuclear engineering because it was entirely online. "It's hard to work all day and then come home and study, but these programmes give you the wherewithal to pound through it and get on with your career," he says.

Online programmes let students tailor their degrees to their needs. At Penn State, Mierzwa could choose between a master's of science or a professional science master's degree (PSM). The standard master's required research time on campus or in the workplace, whereas the PSM, which does not require original research, allowed Mierzwa to work entirely online. He is more interested in the business side of nuclear engineering than in research, so he chose the PSM. "It allowed me to drill down more, find more depth," says Mierzwa.

Although there are many reputable online science programmes, some distance-learning institutions are questionable, merely places where students pay a fee and receive a degree. Most universities with online courses and degrees that are accredited promote that fact, and prospective students should do their research before registering for any online programme.

"Online definitely works for certain master's programmes, but it's not good in my view for the PhD."
Arthur Motta

Many online degree programmes are indeed of high quality. A 2009 report from the US Department of Education conducted a meta-analysis of 99 existing studies of all types of online instruction, and concluded that in terms of learning outcomes and programme design, undergraduate and graduate courses compared favourably with on-campus study across a range of disciplines, including the sciences.

Moreover, employers do not seem to be biased against online degrees. A 2010 survey by Eduventures, a US higher-education research and consulting organization based in Boston, Massachusetts, found that alumni of various online programmes saw improvements in their salaries and titles after acquiring an online degree. "These findings seem to refute the popular media perception that employers favour traditional face-to-face degrees rather than online degrees," says Kamelia Valkova Turcotte, a senior analyst at Eduventures. Many employers are now partnering with universities to assist their employees' online degree programmes by providing on-site laboratory space. Observers expect more science programmes to offer online master's degrees in the coming years, as they respond to economic and enrolment pressures.

Beyond the research and laboratory considerations, the success of online graduate science education ultimately depends — as does the success of on-campus learning — on the students and their commitment to a course of study. "It's all about teaching and learning," says John Bourne, executive director of the Sloan Consortium in Newburyport, Massachusetts, a US research and advocacy group that studies distance learning. "It's not about whether it's online or on the ground. You can have good or bad experiences in both areas." ■

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