



# CAMPUS AS LABORATORY

Innovative ways of teaching, learning and doing research are helping universities around the globe to adapt to the modern world.

MODERN UNIVERSITIES ARE HEIRS TO A THOUSAND-year tradition of scholarship. But they are also being buffeted by twenty-first-century upheavals in technology, economics and society. Through trial, error and experiment, they are now trying to find new ways of thinking and acting that will help them to prosper.

## GERMANY: THE INNOVATIVE UNIVERSITY

BY ALISON ABBOTT

When chemist Wolfgang Herrmann began his first term as president of the Technical University of Munich (TUM) in 1995, he was determined to challenge an academic status quo that had prevailed for more than two decades.

Germany had responded to the social upheaval of the 1960s by declaring that all universities were equivalent and taking steps to

ILLUSTRATIONS BY ELIOT WYATT



prevent the development of a privileged elite, a move that tended to undermine any competitive spirit in the faculty. New rules had also guaranteed a place for any student with a school-leaving certificate — which meant that universities had no say in who took their courses — and kept faculty members bound to bureaucratic civil-service laws. The result was an inward-looking ivory-tower culture that had stagnated intellectually and financially.

Herrmann's vision was to turn the TUM into a nimbler, more internationally competitive 'entrepreneurial university' that would encourage innovation, risk-taking and business initiative among students and faculty members alike. To do that, he restructured the TUM along the lines of successful US institutions such as the Massachusetts Institute of Technology (MIT) in Cambridge. In 1999, he made one of his first — and, within Germany, pioneering — reforms by installing a board of trustees that replaced the Bavarian education ministry's direct control of the TUM and allowed for much quicker decision-making. Since then, he has used that freedom to introduce some of the first German graduate schools: institutions that provide PhD candidates with rigorous common standards for coursework, instead of leaving them to the vagaries of individual supervisors. Herrmann has also created a private fund-raising



**THE UNIVERSITY EXPERIMENT**  
A *Nature* special issue  
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foundation to allow flexible and independent financing of some university projects; formed an institute of advanced studies; and launched a tenure-track system that obliges the university to promote and permanently employ academics who make the grade, and sack those who do not. The latter system is a familiar concept in the United States, but revolutionary in Germany.

The changes did not go down well at first with some faculty members, who were uncomfortable with the perceived emphasis on applied research and commercial pay-off at the expense of basic research. But the discontent has faded as the university's scholarly output has soared, from 2,276 publications in 2002 to 5,827 in 2013. The TUM's funding from government agencies and industry — nearly €300 million (US\$380 million) this year — is among the highest in Germany.

In 2012, Herrmann was re-elected to his post for his fourth consecutive six-year term by a university board that includes representatives from the faculty, students, non-academic staff and the surrounding community. He has announced that this term will be his last. But his unusually long tenure, which will total 24 years when he leaves in 2019, has given him time and clout to push the regional Bavarian government to relax one restriction on the TUM after another. "Now that I know virtually everyone in politics and government, they are sometimes afraid to say 'no' to me — because they know others will ask them why they are being uncooperative," he says, only half-joking.

When the federal government introduced its Excellence Initiatives — competitions in 2006 and 2012 designed to encourage universities to actively shed their restrictions and win elite status (see *Nature* 487, 519–521; 2012) — it gave other German universities an incentive to undertake reforms. But nowhere have those changes proceeded as rapidly as at the TUM, which was a winner in both competitions. Bavaria has agreed to pay one-quarter of the running costs of the TUM's Excellence Initiative projects when the federal money runs out in 2017.

"This new culture is now ingrained," says Herrmann. "The next generation of leadership will continue in this vein."

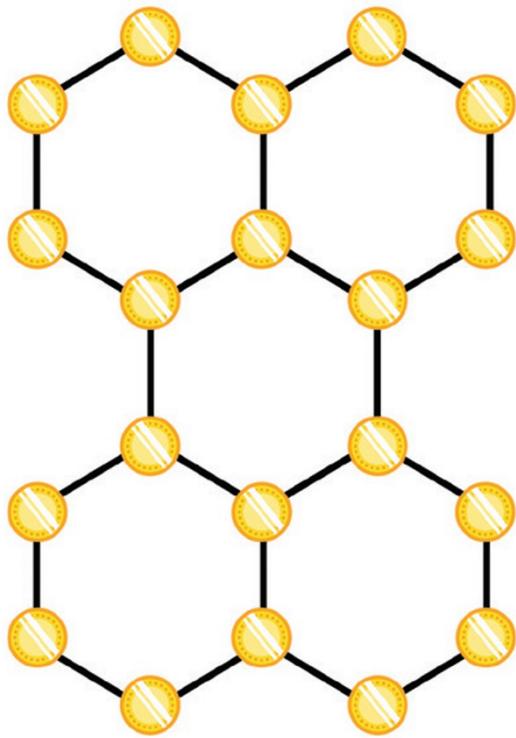
## SOUTH KOREA: THE FLIPPED UNIVERSITY

BY MARK ZASTROW

Tae-Eog Lee has a simple philosophy about what academics should do in lectures: anything but lecture. "Usually, in a conventional classroom, students don't think," he says. "They just follow the professor's teaching."

So at the KAIST science and technology university in Daejeon, South Korea, where Lee heads the Center for Excellence in Teaching and Learning, he is working to implement a 'flipped classroom'. Instead of sitting through endless one-way lectures, students watch online lessons at home, and then come to the classroom to discuss the concepts and work on problems in small groups. Teaching assistants and the lecturer are there to supervise — but most of the learning happens among the students themselves. Lee calls this Education 3.0, and sees it as a way to spark creativity, teamwork and the willingness to ask questions, all of which are suppressed by the nature of lecturing — and, say many, by South Korea's hierarchical society.

KAIST is not the first university to try out this concept, but strong support from its administration has made it a leader in the flipped-classroom movement in just two years. From 3 pilot classes in the spring of 2012, the effort has grown to nearly 60 classes this autumn. And over the next 3 years, Lee hopes to raise that to 800 classes, 30% of KAIST's



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total. Observers at institutions elsewhere are impressed by the magnitude of KAIST’s efforts. “They’re changing culture at a massive scale,” says Sanjay Sarma, director of digital learning at MIT.

That is the sort of cultural shift that KAIST has been seeking since the early 2000s, when the Korean government began overhauling the university to compete in a globalized world. The reform effort took off in 2006, with the selection of Nam Pyo Suh, a Korean American mechanical engineer at MIT, as president of the university. Suh crafted an environmental and sustainability initiative that brought a wave of government funds and elicited private donations. This enabled the university to go on a hiring spree, recruiting lots of young faculty members — who in turn brought in grants. KAIST’s position in *Times Higher Education’s* global university rankings skyrocketed, from 198th at the beginning of Suh’s tenure to 69th three years later.

But faculty members soon began to protest, striking out at Suh’s unsparing performance assessments and his insistence on instruction in English instead of Korean. Then, in early 2011, four students committed suicide within three months, rocking the institution to its core. The tragedies put another of Suh’s reforms under scrutiny. In an attempt to raise both standards and funds, he had started levying the university’s first tuition charges — but only on students who earned poor grades. Those who succeeded academically would continue to pay nothing.

Students say that the social stigma of paying off low grades amplified the already hyper-competitive environment of KAIST — and of South Korean society at large, which has the highest suicide rates in the developed world. Facing calls to resign, Suh apologized, scrapped the fees and reinstated instruction in Korean. He also expedited the launch of Education 3.0, “in part because I wasn’t sure how long I would be there”, he says. (He was finally forced to resign in February 2013.)

Education 3.0’s flipped-classroom approach has been prospering. An estimated 30% of KAIST’s 10,000-strong student body have taken an Education 3.0 course so far, and their test scores are at least as good as those of students in standard classes. Most important to Lee, however, are the intangible benefits. For example: 71% of the Education 3.0 students report an improved understanding of the material, increased motivation and better concentration. But a significant minority remain unconvinced. “Presentation and discussion are not familiar to Korean students,” says Seong Keun Kang, a graduate student in nuclear and quantum engineering. “I’m not sure it is better than the original classes.”

Still, other universities are following KAIST’s lead. Seoul National University, one of South Korea’s most prestigious institutions, introduced its first flipped classes this year.

Universities throughout Asia are watching KAIST, says Gerard Postiglione, who studies Asian higher-education development at the University of Hong Kong in China. According to the QS World University Rankings, KAIST is now the second-best university in Asia. Institutions “want to see: how do you do this, how do you rise so quickly?” says Postiglione.

## UK: THE SOCIAL UNIVERSITY

BY ELIZABETH GIBNEY

In 2011, a handful of prestigious US universities released the first wave of massive open online courses (MOOCs): recorded lectures that could be delivered on the web to tens or hundreds of thousands of students around the world for free. Other institutions scrambled to follow suit, and the media filled with hype about how MOOCs would spark a total transformation of higher education.

Mike Sharples took such rhetoric with a grain of salt. But he works at the Open University in Milton Keynes, UK, which has been delivering courses to students around the world by post, television and computer for some 40 years — and the university was determined not to be outdone. By 2012, Sharples, chair of educational technology at the university, had joined with a team of fellow British academics to create next-generation MOOCs inspired by the work of the late Gordon Pask: a British educational psychologist who believed that students construct their knowledge through mutual interactions. The new MOOCs would put social engagement at the centre of learning, and encourage conversations as intense as those in online games. “It was something of a gamble,” says Sharples. “It seems obvious in retrospect that people would want to talk about their learning, but it wasn’t obvious a year ago.”

The first 36 of the new MOOCs were developed last year by various partner institutions and offered through FutureLearn, a wholly owned subsidiary of the Open University. The catalogue has expanded greatly since then, and now ranges from Introduction to Forensic Science to England in the Time of King Richard III. The MOOCs enable discussions on every single piece of content, allowing users to ‘like’ comments or follow those posted by particular classmates, as in a standard social network, and even letting students assess each other’s work. The FutureLearn software is designed to work on tablets and mobile phones, as well as desktop or laptop computers. And the courses often include strong storytelling elements — a prime example being the forensic-science course, which was developed by the University of Strathclyde in Glasgow, UK, and which leads students through the material using an unfolding plot about a murder scene.

FutureLearn now has 40 partners, 10 of them outside the United Kingdom. Data on its early courses show that some 22% of students who start a FutureLearn MOOC complete the majority of steps and all assessments. This figure drops to 12% when the count includes all

the students who enrol in a course but never start, but it still compares favourably to other MOOCs, which average less than a 7% completion rate. (Detailed comparisons are difficult, because each MOOC provider has a different definition of 'completion'.)

FutureLearn's MOOCs also get high marks from outsiders such as Sally Mapstone, pro-vice-chancellor for education at the University of Oxford, UK. Although Oxford has elected not to join a MOOC platform — and Mapstone has doubts about such courses' potential to revolutionize education — she says she does admire FutureLearn's "simple and attractive" approach.

In many ways, FutureLearn is still trailing the first wave of US MOOCs (see *Nature* 495, 160–163; 2013). It has more than 500,000 registered users and 130 courses — whereas leading MOOC company Coursera, founded in April 2012 by computer scientists at Stanford University in California, has almost 10 million registered users and more than 400 courses. Anant Agarwal, chief executive of edX, a MOOC provider in Cambridge, Massachusetts, that has around 3 million users, says that FutureLearn's approach is creative. But his platform too is "evolving at a torrid pace", he says, using student feedback to improve how discussion forums and cohorts work.

"We need to experiment a whole lot more with hundreds of courses and millions of users before generalizing" about what works best for the students, says Agarwal.

And Sharples, for one, is eager to do just that.

## SOUTH AFRICA: THE INCLUSIVE UNIVERSITY

BY LINDA NORDLING

During most of South Africa's apartheid era of strict racial segregation, the country's leading universities catered mostly to the white elite. Shortly before the apartheid system was dismantled in the early 1990s, however, the University of Cape Town (UCT) joined with a number of other South African universities in reaching out to impoverished students — the vast majority of whom were black.

The general idea behind the UCT's programme has been to help students from disadvantaged backgrounds to acquire the skills that their wealthier contemporaries take for granted. It provides support including language-development courses for those whose first language is not English, instruction in good study habits and even psychological counselling. It also includes group sessions that let students discuss challenges ranging from how to manage their personal finances to ways to cope with stress.

For science students, the UCT offers foundation courses in biology, physics, chemistry and mathematics to patch any knowledge gaps. A winter science programme runs trips to Cape Town's aquarium and nearby fossil parks, and provides other science-related experiences that students may have missed while growing up. To make time for these extra activities, the UCT's Bachelor of Science programme gives students the option of stretching the normal three-year undergraduate curriculum to four years.

Since they were introduced in 1986, the UCT's four-year undergraduate courses have trained more than 2,000 students. Mokete Koago was one: he enrolled in what was then known as General Entry to Programmes in Science (GEPS) when he came to the UCT in 2008. A bright student from a poor township in South Africa's rural Free State province, Koago found the extra time, tutoring and mentoring essential. "I don't think I would have made it through my degree without GEPS," he says.

The programme is still evolving. Until last year, for example, undergraduates on science courses were channelled into three- or four-year streams as soon as they enrolled. Now, all students start in the same



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course. Only after six weeks do they choose whether to stay on the three-year track or opt for the four-year Extended Degree Programme.

The idea, says David Gammon, a UCT chemist who serves as a senior advisor for the extended science programmes, is to let students' paths at university be determined by their performance rather than where they went to school or the colour of their skin. This approach also means that students are actively involved in choosing their own paths — an important consideration given that there could be a stigma attached to joining the longer course.

Transformation is proving slow. A report on undergraduate-curriculum reform published by South Africa's Council on Higher Education in 2013 found that, although the fraction of the country's black 20–24 year olds attending university has risen slightly, from 10% in 2005 to 14% in 2011, it is still dwarfed by the figure for white people: 57%. And of those black students who do make it to university, only one in five completed their undergraduate degrees within four years, as opposed to 44% of white students.

Still, there have been many individual successes. During Koago's four years at UCT, for example, he discovered a passion for meteorology, climate and ocean science — an unexpected love for a boy who had grown up in the dusty interior of South Africa. "When my parents came down for my graduation, it was the first time in their lives that they saw the sea," he says. He is now a research assistant in the UCT's Climate Systems Analysis Group, and he hopes to embark on a master's degree in oceanography next year.

Eventually, Koago hopes to bring his passion for science home — and perhaps to inspire other young people to follow in his footsteps. "I want to bridge the gap between people living in townships and the science," he says. "The biggest problem out there is that people are ill-informed." ■