Hong Kong's physics departments adapt to education overhaul

In September universities in the Chinese territory switched from three-year, English-style degree programs to four-year, US-style degree programs.

Less than 3% of Hong Kong's GDP comes from manufacturing. Finance, trade, and other knowledge-based service sectors make up the rest of the economy, which is among the world's wealthiest and healthiest. To keep its economy humming and its population employed, Hong Kong needs a smart, flexible workforce.

As the territory entered the 21st century, its government concluded that the education system it inherited from the British was too rigid, narrow, and elitist to produce such a workforce. After concentrating on one subject for three years, students graduated from university with a bachelor's degree but without being taught the knowledge and skills they might need to navigate the complexities of a modern, globalized society.

Starting this year, freshmen at Hong Kong's eight public universities will study a mix of majors, minors, and required courses—just like their counterparts in Australia, Canada, and the US. Mandated and funded by Hong Kong's government, the new degree structure aims to provide broader, more useful education. As the Chinese University of Hong Kong's undergraduate prospectus puts it, the new structure is "not just 'one more year,' but incorporates a change of emphasis, and a new way of viewing undergraduate education."

Because Hong Kong's high schools prepared students for specialized three-year degrees, reforming tertiary education also entailed reforming secondary education. Instead of leaving high school at 16 or spending the ages 16–18 studying a handful of subjects, students now spend the final three years of high school studying a broader mix of subjects. And they graduate at 17.

High schools made the switch to the new system in 2009. The first cohort of students educated under the new system entered university in September. Because the last cohort of students educated under the old system had to complete an extra year of school, the two cohorts entered university at the same time.

Besides coping with super-sized freshman classes, the six Hong Kong universities that have physics departments have also had to adapt to the new, four-year curriculum. The introductory classes that physics professors teach are now larger than before and have students of more diverse educational backgrounds.

With those challenges, however, have come benefits. The required courses expose more university students to science, including physics. Physics departments have hired or are hiring more faculty members. And, attracted by the new curricula, more foreign students are applying to attend Hong Kong's universities.

Common cores

The new, four-year curricula offered by Hong Kong's public universities conform to broad guidelines established by their funding agency, the University Grants Committee (UGC). Majors in applied physics at City University of Hong Kong, for example, must accumulate at least 120 credits to graduate. Like all other CityU students, those majoring in applied physics have to complete 30 credits of what the university calls gateway education, which includes courses in the English language, Chinese civilization, arts and humanities, sociology and business, and science and technology, along with electives.

CityU physics students may choose a minor in a subject, such as electrical engineering, that complements their major. And in addition to courses in basic physics, students take electives organized in four streams: nuclear environmental physics, photonics, materials physics, and biomedical physics and engineering. Final-year students are also required to work independently on a research project that could involve a local company or government agency.

The curricula at the five other physics universities follow a more or less similar template. Chinese University of Hong Kong's equivalent of CityU's gateway education, the general education foundation, includes an ambitious course called Dialogue with Humanity

The University of Hong Kong, like other universities in the territory, has embarked on ambitious building programs to accommodate the increased influx of students. The buildings in the foreground are part of the university's new Centennial Campus. (Courtesy of Sun Kwok, University of Hong Kong.)

that addresses such philosophical questions as What is a good life? and How should people govern and be governed? Among the books on the reading list are Aristotle's *Nichomachean Ethics*, Confucius's *Analects*, and the Qur'an.

The University of Hong Kong, the territory's oldest higher-education institution, has been boldest in adapting to the new system. Two years ago, before the switch to four-year degrees took place, the university introduced a common core from which all first- and second-year students must choose courses.

Together, the common core courses aim to expose students to a broad range of ideas and disciplines, just like CityU's gateway education or Chinese U's general education foundation. What's different about the common core courses is that they all are interdisciplinary. Hong Kong U's dean of sciences, Sun Kwok, teaches one of them. Called Our Place in the Universe, Kwok's course begins with ancient civilizations' various conceptions of the universe, continues through the Copernican revolution, and culminates in astronomers' current understanding of the cosmos.

Green energy science

Bold reform also took place at Hong Kong Baptist University's physics department, albeit neither initiated nor welcomed by the department itself. By expanding the number of course offerings, the new degree structure reduced the number of students declaring certain majors, among them physics. Anticipating tougher competition for physics students, Baptist U's administration compelled the physics department to withdraw its physics degree program and replace it with something more distinctive and appealing.

Department chair Kok Wai Cheah and his colleagues came up with Green Energy Science, an interdisciplinary course that plays to the department's strength in photovoltaic devices and LEDs.

The course also aligns with Hong Kong's needs. Thanks to its citizens' extensive use of public transportation and its service-heavy economy, the territory already leads the world in GDP per unit of energy use. Yet the territory still imports almost all its energy and has a growing problem with disposing of its waste. Becoming greener is a Hong Kong priority.

The need to offer courses that are distinctive and relevant has underlain the Hong Kong Polytechnic University's engineering physics degree program since its inception 20 years ago. Like their predecessors under the old system, students study both engineering and physics, spend time working at local companies, and conduct a capstone project in their final year. PolyU's physics chair, Helen Chan, expects students who graduate under the new system to find jobs as readily as the department's current graduates do in such fields as LED manufacturing, medical engineering, and telecommunications.

Making adjustments

Enrolling, accommodating, and teaching this year's supersized freshman classes has challenged Hong Kong's universities. The start of the fall semester was delayed by a week to help their admissions offices cope. Lecture halls and cafeterias are crowded. And in a city-state where high land prices result in tall buildings, students and professors queue more than before to use elevators.

Nevertheless, the transition has been a smooth one. Michael Altman, who chairs Hong Kong University of Science and Technology's physics department, credits that success to what he and his colleagues did in advance. "In the preparations for the transition," he recalls, "there were endless meetings, discussions, planning on a full range of subjects from curriculum, resources, admissions to classroom space, catering, and transportation. All of that hard work paid off."

To ease the transition to a four-year program, the UGC allocated HK$5.84 billion ($753 million) to fund capital projects and topped off each university's annual grant by HK$1.5 billion. Not all the buildings were ready in time. At the time of this writing, Hong Kong's physics departments had a total of seven open positions. More are expected.

One challenge has been developing flexible curricula. CityU's introductory physics class contains 600 students of different educational backgrounds and different majors. An applied physics major who spent her last two years of high school studying physics under the old system might be sitting next to a bioengineering major who took no physics in his last three years under the new system.

Kwok Sum Chan and Jensen Li developed and teach CityU's introductory physics course, which incorporates an online environment for students to learn and practice. By providing additional lectures and tutorials, he and his colleagues aim to have all students exit the course at the same level.

In enacting the reforms, the Hong Kong government's principal goal was to improve education, but another goal was to make the territory into the preeminent higher-education hub in the South China region. Hong Kong is already attractive to international students. Half of humanity lives within a five-hour plane trip. English is the language of instruction. And Hong Kong itself offers a vibrant, accessible mix of Chinese and Western cultures.

The education reforms appear to have added to the attraction. In July the *New York Times* reported that applications from foreign students for the 2012–13 academic year had shot up. Compared with the previous year, foreign applications rose 42% at Hong Kong U, 50% at Chinese U, and 55% at HKUST.

Charles Day

Robotic vehicles taking up positions under the sea

Autonomous vehicles offer budget savings and can free up manned ships for other duties, US Navy officials say.

Propelled by the US Navy, autonomous underwater vehicles (AUVs) are beginning to make their mark in applications that range from mine clearing to antisubmarine warfare. A number of AUV startup companies have spun off from the academic and oceanographic institutions where they were established and are now producing the vehicles in small quantities.

Among the military applications that the navy has identified for AUVs are intelligence, surveillance, and reconnaissance; mine countermeasures; antisubmarine warfare; inspection and identification; oceanography; payload delivery; and time-critical strikes. Commercial applications include underwater surveys, fisheries research, search and recovery, wreck and navigational hazard mapping, and water profile sampling.

According to the 2011 Pentagon report *Targeting U.S. Technologies: A Trend Analysis of Reporting from Defense*