

Online Learning & the Transformation of Global Higher Education

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This essay examines the global impact of online education in the decade following the widely publicized introduction of MOOCs (Massive Open Online Courses) in 2012 – exploring the demographics and preferences of learners, the effectiveness of online learning, the surprising and substantial impact on the labor market, and the implications of scalability for reducing the cost of education. The essay concludes that online education has broadened the range of activities undertaken by leading universities and will continue to dramatically expand the population of learners with access to low-cost, high-quality education.

In 2012, online education burst into public view with the publication of a *New York Times* article entitled, “The Year of the MOOC.”¹ The article described the sudden growth in popularity of Massive Open Online Courses and the startup platforms that provided them (Coursera, edX, and Udacity). A balanced and judicious account, it nonetheless precipitated an avalanche of fears and hopes. Faculty questioned the effectiveness of online learning, but nonetheless feared that the MOOC would replace classroom teaching, reduce the demand for professors, and transform them into teaching assistants. By contrast, trustees hoped that online instruction might reverse, or at least arrest, the relentless increase of tuition, and they urged presidents to invest for fear of missing out. The trustees of the University of Virginia even attempted to fire their president over her reluctance to embrace technology with the alacrity that they expected.² Universities around the country rushed to sign up with edX, a nonprofit joint venture of MIT and Harvard, or Coursera, a for-profit startup founded by two Stanford professors. European, Latin American, and Asian universities soon followed. By mid-2014, Coursera and edX had more than one hundred fifty unique university partners between them, most of which ranked in the global top 200.

A decade later, some early goals have been met and others have not; some fears remain while many have been laid to rest. As is typical of overhyped innovations, imagined revolution has given way to evolution. Slowly and steadily, online learning is transforming postsecondary education around the world, both inside and outside the academy, in ways that were not fully anticipated in 2012.

Online education predates the Year of the MOOC by four decades. In 1971, the Open University began to televise courses throughout the United Kingdom. Two years later, Jim Gibbons at Stanford conducted fascinating experiments combining videotaped lectures with live, onsite tutoring, anticipating lessons relearned in the MOOC era.³ Education scholar Linda Harasim is often credited with offering the first fully online, for-credit university course in 1986 (accessed primitively by dial-up modems over landline telephone infrastructure), although Harasim herself identifies numerous precursors elsewhere between 1981 and 1986.⁴ The University of Phoenix began offering fully online bachelor's and master's degrees just three years later, and other for-profit organizations, as well as nonprofits, followed shortly after. A decade later, at the turn of the millennium, top-tier universities entered the arena, offering single courses via streaming video, but Fathom (Columbia), E-Cornell, and AllLearn (a joint venture of Oxford, Stanford, and Yale) failed to achieve scale or commercial viability. In 2008, a new venture, 2tor (later renamed 2U), developed a platform for hosting online degrees offered by established universities such as the University of North Carolina at Chapel Hill and the University of Southern California, and received a share of tuition revenue for supplying the technology, assisting with course production, and recruiting students – chiefly through paid advertising.

By the Year of the MOOC, there were 7 million students enrolled in at least one online course through a U.S. university, and 1.5 million enrolled in fully online degree programs.⁵ Most online degree programs charged tuition fees comparable to those paid by students on campus, and enrollment was typically less than enrollment in counterpart programs on campus. The MOOC promised something radically new and different – famous professors from top universities, massive scale, and low cost. For the first time, institutions of higher education could imagine achieving high quality, wide access, and affordability in the same offering.

Such imagining was possible only because MOOCs, unlike most online degree programs then and now, did not require the presence of a live instructor. Students watched videos, took quizzes and tests, and worked on collaborative projects with each other asynchronously, which meant that the same course could reach large numbers in different time zones at low cost per student. Asynchronous courses and degree programs built upon them had the potential to increase the number of students reached by a single faculty member from tens or hundreds to tens or hundreds of thousands, or more.

In this essay, I hope to shed light on the current and future impact of online learning on global higher education. To do this, I will begin by asking two questions about the demand for online postsecondary education: 1) who are the learners? and 2) what do they want to learn? The answers are surprising, especially to faculty and administrators in traditional higher education. I will also discuss who is supplying educational content online, how it is delivered, and whether it is effec-

tive. Finally, I will offer a perspective on two further questions: 1) can online education serve the learning needs of the global workforce in an era of rapid technological progress? and 2) can online education help universities around the world in their quest for the holy grail of high quality, accessibility, and affordability?

In 2012, the conversation among U.S. academics assumed that the audience for MOOCs would be pre-college or college-age students, principally residing in the United States. But, contrary to expectations, a 2015 Coursera survey revealed that only 11 percent of surveyed learners were under age 22, just under half were 22–45 years old, and the balance were over 45 years old.⁶ And the learner population was, and remains, overwhelmingly international. By the end of 2022, only 21 percent of Coursera’s learners resided in North America. The rest were distributed around the world: 32 percent in Asia, 18 percent in Latin America, 17 percent in Europe, and 10 percent in the Middle East and Africa. Apart from the United States (19 percent) and India (16 percent), no single country has more than 10 percent of the learners on the platform.⁷ These demographics have profound implications for the future of higher education. They demonstrate that the principal consequence of putting courses online has not been to transform teaching and learning on campus, but rather to extend the reach of universities beyond customary geographic and demographic boundaries to millions of learners around the world beyond the normal age of university students.

It is worth dwelling on this point. There are 19 million students enrolled in institutions of higher education in the United States and approximately 250 million enrolled worldwide. Enrollment in online courses will come to dwarf these numbers. By the end of 2022, Coursera alone had 118 million registered learners, growing at an annual rate of 22 percent. Putting university courses on Zoom during the early years of the COVID-19 pandemic to meet the needs of on-campus students was a transient accommodation. Reaching hundreds of millions who are not currently enrolled in higher education is a revolution.

In the early days at Coursera, the entire staff assembled weekly for updates from the leadership team. At the close of each meeting, one of the employees would relate a “learner story.” More than any quantitative evidence, these stories drove home the extraordinary impact of online courses on learners outside the traditional reach of higher education. One moving example was the story of an unemployed taxi driver in Tennessee who – after losing his home, being abandoned by his family, and suffering from depression – took an online writing course that gave him the confidence to enroll in a nearby state university, complete a degree, and get a job as a writer. Another was the story of a woman in Bangladesh who, after escaping from an abusive husband and fleeing to another city, took online business courses that prepared her to open what became a successful bakery. These are only two students among many whose lives were transformed by access to online education.

In the Year of the MOOC, as universities rushed to sign on with Coursera and edX, their faculty and administrators assumed that a large audience would be available for courses across a wide range of subject matters in the liberal arts and sciences. Enrollments were widely distributed and remain so. But in 2013, once Coursera began to charge learners for certificates of successful completion, courses imparting job-relevant skills in business, technology, and data science produced over 80 percent of its revenue. A year later, when Coursera and edX began offering sequences of courses from university partners, these skewed heavily toward practical subjects in business, technology, and data science. At the same time, Udacity abandoned its efforts in general education and concentrated its courses and “nanodegrees” entirely on computer science and data science. Reflecting these developments, Coursera’s survey of fifty-two thousand course completers in 2015 found that “educational benefit” was the principal motivation for 28 percent of those surveyed while “career benefit” motivated 52 percent.⁸

The early MOOC platforms’ experience with vocationally oriented learners was paralleled by the emergence of scores, if not hundreds, of start-ups offering “microcredentials” through live “coding bootcamps” as well as online instruction in computer skills. None has achieved the scale of the MOOC platforms, but some have partnered successfully with universities to offer instruction on campuses. Microcredentials – a category that includes certificates of completion of MOOCs and multicourse sequences – have become a labor-market currency, especially in the technology sector. Jobseekers list these credentials on their resumes and LinkedIn profiles, and recruiters pay attention to them.

In 2016, a study of three thousand candidates for software engineering jobs found that completing Coursera and Udacity courses was the single best indicator of success in technical interviews.⁹ In a more recent survey, 86 percent of employers agreed that microcredentials strengthened a candidate’s job application, and 74 percent believed that earning such credentials improved a candidate’s ability to perform well in an entry-level position.¹⁰

Career-oriented courses and programs – especially those focused on the acquisition of business, computing, and data science skills – remain the principal source of enrollment and revenue for online providers. In 2022, they accounted for three-quarters of Coursera’s 39 million enrollments. Nonetheless, liberal arts subjects continue to flourish online. Of the sixteen Coursera courses with over one million cumulative enrollments, seven are liberal arts courses spanning the disciplines of psychology, neuroscience, economics, English, and Asian languages.

Universities hoping to reach off-campus audiences can post courses on their own websites or YouTube channels, and can also partner with a third-party platform to gain the advantages of potentially larger enrollments, likely lower costs of attracting those enrollments, and technology that

supports a more interactive and personalized learning experience. After the Year of the MOOC, dozens of platforms emerged to work with universities to offer single courses and/or collections of courses (specializations, nanodegrees, micro-master's, and other certificate programs). Among these were Future Learn in the United Kingdom, FUN in France, Swayyam and Simplilearn in India, and Chinese University MOOC (previously known as I-Course), Xuetang X, and CNMOOC in China.¹¹ Universities seeking to offer accredited degree programs, certificates, or executive education programs online can provide them on their own websites or use a third-party platform such as 2U, Noodle, and Coursera (each based in the United States), or a number of strong competitors in India such as UpGrad, Eruditus, or Great Learning. In all these cases, the courses, programs, and degrees carry the university's brand name. Some faculty have operated independently of their institutions by authoring their own courses on platforms such as Udemy or Teachable.

Online postsecondary instruction is not limited to the offerings of universities or freelance university faculty. Well before the Year of the MOOC, Skillsoft, Lynda.com, and others offered video libraries of short courses on business topics over the internet, taught chiefly by instructors with industry expertise but no academic affiliation. When the MOOCs revealed the enormous latent demand for job-related skills acquisition in business, technology, and data science, the field exploded. Hundreds of start-ups in the United States, Europe, India, and China began to offer courses and certificate programs in computing and data science taught by industry experts, wholly online or in hybrid format. Udacity was a pioneer in this movement. It pivoted from Stanford professors to industry experts as instructors as early as 2013. By 2016, even Coursera had begun to offer specializations and certificate programs under the sponsorship of leading companies such as Google in technology and PricewaterhouseCoopers in business. By the end of 2022, it had over 110 industry partners offering job-relevant courses alongside more than 185 universities providing education in both academic and professional subject matter. When a professor at the University of Michigan offers his #1-rated course on introductory programming in Python through Coursera, he is competing not only with courses offered by other professors on edX or Coursera, as well as industry experts on Udacity, Udemy, Skillshare, Great Courses, Codecademy, and Data Camp, but also with courses offered by Google, IBM, and Meta experts on the Coursera platform.

The ecosystem has continued to expand. By the end of 2022, there were at least 256 companies offering online or hybrid instruction in either postsecondary academic subjects or workforce skill development. One-third of these companies are based in North America, 23 percent in Europe, 16 percent in Latin America, and 10 percent in South Asia, with the balance divided evenly among Southeast Asia, Australia, the Middle East and North Africa, and Sub-Saharan Africa.¹²

No one claims that an asynchronous, large-scale class can replicate the learning experience of the live, on-campus seminar involving a professor and ten to fifteen students. In such a setting, an excellent teacher can help a student master far more than the subject matter. Students learn how to form and defend an argument, and how to find flaws in the arguments of others. In short, students develop, through regular practice, the ability to think critically and independently. To date, this experience has not been replicated online *at scale*. Holding a synchronous online discussion with twelve people can produce all or most of the educational benefits of a physical classroom, but without realizing the access and affordability benefits associated with large-scale MOOCs.

The small seminar focused on developing the capacity for critical thinking is not, however, the norm in on-campus higher education worldwide. Lecture courses focused on content mastery account for a much larger share of enrollment. And there is evidence that asynchronous, scalable online courses produce better mastery of content than live lecture courses. Perhaps the most careful study of the subject was undertaken by physicist David E. Pritchard at MIT, who found through pre- and posttesting using edX technology that learning gains in his introductory physics MOOC exceeded those in the traditional, live introductory physics lecture courses studied earlier by physicist Richard R. Hake, although they fell short of the learning gains realized in courses using interactive pedagogy.¹³ Moreover, the learning gains experienced by the 1,080 study participants in Pritchard's MOOC did not differ significantly across cohorts defined by educational background.¹⁴

Why might learning be more effective in asynchronous online courses than in traditional live lecture courses? First, many studies have shown that retention improves dramatically by breaking lectures into short segments and interjecting quizzes at regular intervals of six to ten minutes, a standard feature of Coursera and edX courses. Such practices have long been recommended for live teaching, but they remain far from universal. Second, several online platforms offer learners the opportunity to vary the instructor's speed of delivery from one half to double the number of words per minute – helping learners who are having difficulty and preventing those who find the material easy from becoming bored. Third, online platforms typically have a replay button, so learners who fail an in-video quiz, or who otherwise have difficulty understanding the first time through, can watch a video segment again and again until the material is understood. Fourth, some platforms – Coursera among them – employ algorithms to detect learners having difficulty and guide them to review relevant earlier segments of the course. Fifth, some courses, especially those in the computer science and data science domains, weave interactive exercises throughout the lectures, enabling students to master concepts through practical application.

These observations about the effectiveness of online learning help to explain some of the reactions of teachers and students who were forced to go online

during the COVID-19 pandemic. In general, teachers found interactive seminar classes worked better online than they expected, while lectures fared worse. The first of these impressions is understandable: conversation tended to work reasonably well in classes small enough to fit everyone on a single Zoom screen, even if the experience did not fully replicate the chemistry of live classroom interaction. The second impression is also understandable: given the overnight switch from the classroom to Zoom, most instructors were unaware of what had been learned about teaching lecture classes effectively online, and they simply replicated what they did in the classroom. Uninterrupted lectures of fifty or seventy-five minutes did not hold the attention of online learners who might otherwise have been mesmerized by the live presence of a charismatic lecturer. Moreover, in synchronous online lectures, students lacked the advantages of slowing the instructor down, or hitting the replay button, or receiving algorithmically driven guidance when they were confused. Some of the deficit of synchronous online lectures can be mitigated by recording them and making them available for replay.¹⁵

For many students, particularly those in residential universities, moving classes online was unpopular, because they were deprived of live interaction with fellow classmates as well as the instructor. Overall, however, student reaction was positive. A survey published in April 2021 found that 73 percent of students would like to take some fully online courses in the future.¹⁶ Many working adults attending late afternoon or evening classes at community colleges or state universities embraced online learning because it brought the benefit of eliminating a commute after the workday.

Recent advances in artificial intelligence, and especially radical breakthroughs in natural language-processing algorithms, promise quantum improvement in the effectiveness of online learning, but the inaccuracy of forecasts in the Year of the MOOC cautions against offering predictions with any confidence in the Year of ChatGPT.

A major surprise of the last decade is that online education has had a more profound impact on the labor market than on university campuses. Technological and demographic factors have created unprecedented demand for job-relevant training, and online instruction has provided a low-cost solution that has already reached significant scale, with the potential to grow ten- or one hundredfold in the years ahead.

Since the advent of distributed computing in the 1980s, digital technologies have spread across virtually every job and profession. Technology has created entirely new categories of jobs (for example, data scientists), changed the mix of skills required for most jobs (such as auto mechanics), and rendered many jobs obsolete (including telephone switchboard operators). Numerous studies document the shifts in demand for labor across job categories and skill requirements, and

most project substantial further change in the years ahead.¹⁷ These technology-induced changes in the demand for labor have been exacerbated in the United States and other developed countries by declining working-age populations – a joint consequence of long-term decline in birth rates, decreased legal immigration, and retirement of the large “baby boomer” generation. Among the consequences of these trends are substantial shortages of labor in job categories where demand is growing and technical skills are required, and a pool of unemployed or underemployed workers whose jobs have been replaced or substantially altered by technology. The solution to this problem is accessible, affordable skills training to prepare workers, from entry-level to midcareer, to fill vacancies in new or substantially altered job categories, or to retrain them for employment in established job categories.

At the entry level, this need for job-relevant skills acquisitions is well-met in countries with strong vocational education or apprenticeship programs, such as Germany, Sweden, Switzerland, and Singapore, but much less well-met by U.S. community colleges that are underresourced and torn between providing students with technical training and a pathway to four-year colleges. Online instruction is beginning to fulfill this need with microcredentials, in some instances integrated into community college curricula. Such credentials vary widely in quality and likely will not flourish without some mechanism for accreditation and accountability. But some offerings seem promising. Google, for example, offers five entry-level certificate programs that run six to eight months and train entry-level IT support staff, data analysts, project managers, user experience designers, and digital marketing specialists. These and more than twenty-five other entry-level certificate programs designed by leading companies (Meta, IBM, Intuit, Salesforce, and others) are available for just \$39 or \$49 per month on the Coursera platform. By the end of 2022, nearly 6 million learners had enrolled in entry-level certificate programs.

Providing low-cost, effective, and at-scale training and retraining for midcareer workers has been an elusive goal of many governments for decades, while most companies have focused their training resources on “onboarding” new employees rather than “upskilling” to help employees move up the ladder, or “reskilling” to assist workers in switching jobs, or adapting to changing skill requirements in their current jobs. Increasingly, however, companies are incorporating online resources into their training programs to upskill and reskill their employees, and governments are relying upon them for use in retraining the unemployed or underemployed in need of new skills. Leading online platforms such as Udemy, Coursera, Pluralsight, InStride, Degreed, and Guild Education have emerged to meet these needs in recent years, alongside earlier suppliers of shortform videos such as Skillsoft and LinkedIn Learning (formerly Lynda.com). Pluralsight, which is focused on digital skills training, claims to serve 70 percent of Fortune 500 com-

panies, and over 18,000 business customers in all. Coursera serves nearly 4,000 business customers, and it also supports over 430 workforce training programs for governments in over 100 countries. Workforce training provides a substantial opportunity for higher education to expand its reach and social impact. Although one might expect Coursera's industry partners to dominate its skills training activities, universities account for 44 percent of course enrollments by learners subscribed through companies or government agencies.

Because companies value online offerings for ease of use, low cost, and a curricular breadth impossible to replicate in-house, their use is likely to continue to grow rapidly, especially in imparting digital and technical skills.¹⁸ Live training will not disappear. It is still the medium of choice for developing company culture, teamwork, and other "soft skills," as well as for satisfying the desire of senior executives for "high-touch" contact with professors from leading business schools.

The experience of early and midcareer learners of relatively low educational attainment has somewhat modified the optimistic conclusion of early studies finding learning gains at all educational levels. Government agencies and nonprofits offering workforce development programs have found that unemployed and underemployed learners do not flourish in a purely independent, asynchronous learning environment. Some degree of regular interaction with live teachers or mentors improves their performance. In response, a host of new start-ups have emerged to provide the "hands-on" contact with users of high-quality asynchronous online courses and certificate programs.¹⁹ Perhaps the new AI technologies will enable realization of the benefits of this kind of personalized support at greater scale and lower cost.

It is well known that the cost of higher education rises faster than inflation. But why? Two distinguished Princeton economists, William Baumol and William Bowen, provided the explanation of this persistent phenomenon more than a half-century ago.²⁰ They did so with reference to the performing arts, but the same logic applies to education.

The idea is simple. Productivity (the amount of output per worker) tends to increase over time in many sectors of the economy. The production of a gigabyte of computer memory requires only a minuscule fraction of the labor that was required forty years ago. Consequently, the price of computer memory has declined. By contrast, there is no productivity growth at all in chamber music. Labor input (a quartet, for example) stays constant over time, and, unless the size of the concert hall grows, output (in the form of tickets sold) also remains constant over time. Since inflation is just an average of all price changes in the economy, prices in sectors with high-productivity growth will rise more slowly than inflation, while prices in sectors with low-productivity growth (such as the performing arts) will rise faster than inflation.

The dynamics are no different in higher education. If the average number of students in a seminar remains fifteen, average enrollment in lecture courses remains 100 students, and a faculty member's teaching load does not increase, the cost of educational services and the resulting prices (tuition and fees) will rise faster than inflation. There is only one way to reverse this tendency: the productivity of the university's scarcest resource – its faculty – must increase.

Herein lies the promise of online education: it can provide at least a partial cure for the Baumol-Bowen “cost disease.”²¹ By increasing the number of students a faculty member teaches, the incremental revenue from online instruction can help moderate the rise of on-campus tuition, while also supporting financial aid and other university investments.

Further, online education can be priced well below the potentially unsustainable level of on-campus tuition. In 2014, Georgia Tech priced its pioneering OMSCS (Online Master's of Science in Computer Science) degree at \$6,800, an 83 percent discount from its on-campus program. Coursera quickly followed this example, pricing its degrees well below comparable on-campus programs. Although many universities still price at on-campus levels, 2U, the largest of the online degree platforms, began to discount the degrees of some of its partners after it acquired edX in 2021. The benefits of low-cost online degree programs are beginning to accrue globally. By the end of 2022, eleven of the twenty universities offering degrees on Coursera were located outside the United States – in the United Kingdom, France, Italy, India, Australia, Mexico, Colombia, Chile, and Peru.

A decade ago, faculties in the United States and Western Europe feared that MOOCs created by top-tier universities might become widely used as a substitute for the professorate in the rest of academia, and the prospects facing graduate students seeking academic employment, already grim in many disciplines, would become even grimmer. It still seems unlikely that this will happen any time soon on U.S. and European campuses. But consider the question from the perspective of a country like India, with 37 million university students in 2020 and a declared policy objective of *doubling* the gross enrollment ratio by 2035. Given the growth rate of the population, this objective of the government's National Educational Policy would require an enormous investment in faculty, staff, and brick-and-mortar facilities. The goal is almost certainly unattainable without the use of scalable online resources.

Coursera began licensing courses created by its university partners to a few universities in India, Central Asia, and the Middle East as a pilot project in 2016. After the formal launch of Coursera for Campus in 2019, when the start of the COVID-19 pandemic disrupted teaching and learning around the globe, Coursera responded by offering its entire catalog, free of charge, to any accredited universities that desired access. After the emergency protocols of the pandemic were dropped, Coursera resumed charging universities very modest licensing fees. At the end of

2022, 437 universities were subscribers, and 88 universities (nearly all in developing countries) were offering credit for Coursera courses created by leading universities. Some institutions supplemented the imported credit-bearing courses with resident faculty facilitation. Others offered them stand-alone.

In the Year of the MOOC, the educational activities of nearly all the world's leading universities were no different than they had been fifty years before. Institutions offered high-quality undergraduate and graduate degree programs to full-time students on campus. Over the next fifty years, their educational mission will expand. Universities will offer online bachelor's and master's degree programs, online courses for credit on campus and off, courses and degrees for enterprises and government workforce-development programs, and courses for universities in developing countries enabling expanded accessibility and improved quality. A university's "students" will no longer be concentrated among those between eighteen and thirty years of age. Entry-level and midcareer workers and professionals seeking career advancement, or wishing to change careers, will turn to universities to enhance their skills, and lifelong learners will enjoy access to liberal arts courses well into retirement. The social impact of universities will be greater than ever before, as hundreds of millions of learners around the world will have lifelong engagement with high-quality education, and access to opportunities that they never imagined possible.

ABOUT THE AUTHOR

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ENDNOTES

- ¹ Laura Pappano, "The Year of the MOOC," *The New York Times*, November 2, 2012.
- ² Eric Kolenich, "10 Years Ago, UVA Fired and Rehired Its President, Fearing a Crisis that Never Materialized," *Richmond Times-Dispatch*, June 27, 2022.
- ³ J. F. Gibbons, W. R. Kincheloe, and K. S. Down, "Tutored Videotape Instruction: A New Use of Electronics Media in Education," *Science* 195 (4283) (1977): 1139–1146; and Andrew Myers, "Lessons in Remote Learning from the 1970s: A Q&A with James Gibbons," Stanford University, August 14, 2020, <https://engineering.stanford.edu/node/1951>.
- ⁴ Linda Harasim, "Shift Happens: Online Education as a New Paradigm in Learning," *The Internet and Higher Education* 3 (2000): 41–61.

- ⁵ See Tables 311.20 and 311.22 in *Digest of Education Statistics 2020* (Washington, D.C.: National Center for Education Statistics, 2020).
- ⁶ “Impact Revealed: Learner Outcomes in Open Online Courses,” Coursera, September 2015, https://d396qusza40orc.cloudfront.net/learninghubs/LOS_final%209-21-.pdf.
- ⁷ Data and examples in this essay are drawn disproportionately from Coursera, because of the author’s personal experience as its Chief Executive Office from 2014 to 2017 and the company’s willingness to provide data. From the beginning, Coursera has been by far the largest platform for online university courses.
- ⁸ Chen Zhenghao, Brandon Alcorn, Gayle Christensen, et al., “Who’s Benefiting from MOOCs, and Why,” *Harvard Business Review*, September 22, 2015.
- ⁹ Aline Lerner, “Lessons from 3,000 Technical Interviews...or, How What You Do after Graduation Matters Way More Than Where You Went To School,” *Business Insider*, December 30, 2016. Only three characteristics had a significant correlation with performance on technical interviews: whether applicants had worked for an elite company, whether they had graduated from a “top computer science school,” and whether they had posted a Coursera or Udacity certificate on their LinkedIn profiles. The effect of completing a MOOC was the most strongly correlated, with an effect size more than double that of attending a top school. Moreover, the effect of completing a MOOC was far greater for those who had *not* attended a top school.
- ¹⁰ See Scott Shireman, “New Coursera Survey Shows High Demand for Industry Micro-Credentials from Students and Employers in Tight Labor Market,” Coursera, February 2, 2023, <https://blog.coursera.org/from-higher-education-to-employment>.
- ¹¹ *The Report* by Class Central, an online publication covering the MOOC industry, published a description of twenty-four Chinese MOOC platforms in early 2022: Rui Ma, “Massive List of Chinese Online Course Platforms in 2022,” *The Report*, January 19, 2022, <https://web.archive.org/web/20220706064323/https://www.classcentral.com/report/chinese-mooc-platforms>. In early 2023, the same publication identified 29 additional active MOOC platforms in the rest of the world. See Laurie Pickard, Rui Ma, and Manoel Cortes Mendez, “Massive List of MOOC Platforms Around the World in 2024,” *The Report*, April 10, 2023, <https://web.archive.org/web/20240303234413/https://www.classcentral.com/report/mooc-platforms>.
- ¹² These data were provided by GSV Ventures, the cosponsor of the annual ASU-GSV Summit, the world’s largest gathering of edtech companies, investors, and university and industry partners.
- ¹³ David E. Pritchard, Kimberly F. Colvin, John Champaign, et al., “Learning in an Introductory Physics MOOC: All Cohorts Learn Equally Including in an On-Campus Class,” *International Review of Research in Open and Distance Learning* 15 (4) (2014); and Richard R. Hake, “Interactive-Engagement vs Traditional Methods: A Six-Thousand Student Survey of Mechanics Test Data for Introductory Physics Courses,” *American Journal of Physics* 66 (1) (1998): 4–74.
- ¹⁴ Pritchard measured learning by the percentage decline in the proportion of test questions answered incorrectly. By this metric, high school graduates, college graduates, physics teachers, and PhDs were statistically indistinguishable.
- ¹⁵ Over the summer of 2020, well-resourced universities were able to provide support to faculty to help them modify their course designs to work more effectively online, but

such resources were readily available only in a small fraction of developed-country institutions, and not at all in most of the developing world's colleges and universities.

- ¹⁶ Lindsay McKenzie, "Students Want Online Learning Options Post-Pandemic," *Inside Higher Education*, April 27, 2021.
- ¹⁷ The McKinsey Global Institute has published several comprehensive reviews of the effect of automation or digitalization on jobs and the skills required for them. As a point of entry, see McKinsey Global Institute, "Jobs Lost, Jobs Gained: What the Future of Work Will Mean for Jobs, Skills, and Wages," November 28, 2017.
- ¹⁸ Fahim Ul Haq, "Five Reasons Why Online Learning Is the Future of Professional Development," *Forbes*, March 26, 2021.
- ¹⁹ A notable example is Merit America, a nonprofit that provides classroom mentoring and job placement services for students as they complete Google certificates in IT support and data analytics. In their first five years of operation, three thousand program completers were placed in new jobs at average annual salary gains of \$24,000. See Merit America, "Merit America Alumni Experience a \$24,000 Wage Increase 3+ Months Post-Program, According to University of Virginia Analysis," <https://meritamerica.org/blog/uva-2023>.
- ²⁰ William J. Baumol and William G. Bowen, "On the Performing Arts: The Anatomy of Their Economic Problems," *The American Economic Review* 55 (1/2) (1965): 495–502.
- ²¹ *Ibid.*