The Promises and Limits of Online Higher Education

UNDERSTANDING HOW DISTANCE EDUCATION AFFECTS ACCESS, COST, AND QUALITY

Di Xu and Ying Xu

MARCH 2019

AMERICAN ENTERPRISE INSTITUTE

Executive Summary

In the past two decades, one of the most important innovations in the US higher education system has been the steady increase in distance education through online courses. College administrators have expressed strong support for online education, signaling that the current online expansion will likely continue. Based on a national survey of college administrators, almost half of all postsecondary institutions now include expanding online learning as a crucial component in formal strategic plans. Almost two-thirds of college administrators believe that developing online courses is crucial for the long-term strategy of their institution. Today, more colleges are offering online education courses, and more students are taking them than ever before.

While the supply and demand for online higher education is rapidly expanding, questions remain regarding its potential impact on increasing access, reducing costs, and improving student outcomes. Does online education enhance access to higher education among students who would not otherwise enroll in college? Can online courses create savings for students by reducing funding constraints on postsecondary institutions? Will technological innovations improve the quality of online education?

This report finds that, to varying degrees, online education can benefit some student populations. However, important caveats and trade-offs remain. Existing experimental and quasi-experimental studies on semester-length college courses typically find negative effects on student course persistence and performance. Research suggests that students in online courses are between 3 percent and 15 percent more likely to withdraw, compared to similar students in face-to-face classes at community colleges. This report examines distance learning's effect on access, cost, and quality and concludes with a discussion about how strategies and policies can improve the effectiveness of online learning in higher education.

The Promises and Limits of Online Higher Education

UNDERSTANDING HOW DISTANCE EDUCATION AFFECTS ACCESS, COST, AND QUALITY

Di Xu and Ying Xu

Distance learning generally refers to education that is delivered to students in remote locations. It includes a wide variety of learning environments that are different from the traditional brick-and-mortar classroom setting, such as telecommunication courses (in which instruction is delivered on videotape or through cable distribution to students studying at home), correspondence study (in which the instructor mails or emails lessons to students who work independently), and online courses (in which course content is delivered via the internet, sometimes through modules or websites). However, with advances in technology, online courses have become the primary format of distance education at postsecondary institutions.

The growth of distance education was once intentionally constrained by the "50 percent rule" of the Higher Education Act (HEA) of 1992.[1] This rule denied federal funding for institutions with predominantly or exclusively distance education programs. Specifically, the rule dictated that institutions that offered more than 50 percent of their courses through distance education or enrolled more than half of their students in distance education courses would not be eligible for federal student aid programs such as Pell Grants, subsidized loans, and work-study funding. Since the 50 percent rule applied to institutions instead of programs, an education program could be composed entirely of traditional face-to-face courses and still lose its eligibility to federal student aid if it was offered at an institution that ran afoul of the 50 percent rule. Similarly, the HEA also denied access to certain types of federal financial aid and loans for students who took more than half their courses through distance courses.[2]

While all institutions and students were subject to the 50 percent rule when offering and enrolling in distance education, the rule particularly affected nontraditional students who often balance coursework with other job and family commitments. The rule substantially constrained the growth of for-profit institutions, which had pioneered distance learning to allow individuals to pursue further forms of education.[3] Since the for-profit sector disproportionately serves adult learners, women, underrepresented racial minority students, and low-income students, educational opportunities for the most disadvantaged populations were substantially compromised due to the 50 percent rule.[4]

To promote new advances in distance education and to address the increasing demand, the HEA was amended in 1998 to create the Distance Education Demonstration Program (DEDP), which granted colleges waivers from the 50 percent rule. The DEDP-granted waivers grew from 15 institutions or university systems in 1999 to 24 in 2003, and the number of off-site students enrolled in distance learning programs more than doubled during the same period.[5] In 2006, the HEA was amended again to discontinue

the 50 percent rule, thereby spurring the growth of dedicated online institutions.[6] The share of bachelor's degrees awarded by institutions that offered exclusively online courses grew from 0.5 percent in 2000 to over 6 percent in 2012.[7]

At the state level, funding for online education programs and students enrolled in online classes varies. In 2015, the Education Commission of the States, through its State Financial Aid Redesign Project, analyzed statutes and regulations for the largest 100 state financial aid programs across the country.[8] The report indicates that all states, except Pennsylvania, have eliminated the 50 percent rule from state-level policies. Several states have also explicitly promoted the growth of online education in their state budgets. For example, California committed $100 million in 2018 to create an online community college that will offer certificate and credentialing programs to primarily serve workers in need of new skills. The California state budget further committed another $20 million to expanding existing online offerings in the current brick-and-mortar campuses.[9]

Now that higher education institutions are generally unconstrained by state and federal policies from offering online and distance education courses, it is opportune to evaluate the benefits and drawbacks of online courses. How much has the expansion of online learning affected access to college, reduced costs, or improved student outcomes?

Expanding Access: How Many Students Take Online Courses and Why?

The literature on online learning identifies two primary reasons that students take online courses. First, the online delivery format provides greater flexibility and convenience, especially for students who have other work and family commitments.[10] The California Community College Chancellor's Office (CCCCO) conducted a distance education survey among all students who completed a distance education course in the 2016 fall term.[11] The survey asked distance education students to rank the importance of 16 reasons why they enrolled in a distance course.[12] Among the 6,625 survey respondents (a 9 percent response rate), the number one reason was convenience with their work schedule. (Seventy-four percent of the respondents rated it as important or very important.)

Second, individual student preferences about the course delivery drive enrollment in online education. Based on interviews with online course takers at two Virginia community colleges, Shanna Smith Jaggars found that students who prefer working independently and at their own pace are more likely to choose online courses.[13] In a similar vein, almost 60 percent of the CCCCO student survey respondents were enrolled in distance courses because they "enjoy learning on a computer."[14]

Jaggars also found that students make conscious decisions on a course-by-course basis based on three factors specific to a course: (1) suitability of the subject areas to the online context, (2) difficulty of the course, and (3) importance of the course. In general, the interviewed students seemed to have an implicit understanding that they would not learn the course materials as well when they took a course online rather than face-to-face.[15] As a result, students were comfortable taking online courses only when the course was easy (where "easy" was typically used to refer to humanities courses, whereas "difficult" referred to math and science courses), was less important to their academic career (such as courses not in their academic major), and was in a subject area they had less interest in.

A number of students directly pointed out that they would take a course online only when they felt competent to "teach themselves" strictly from a textbook or other readings, with little or no explicit instruction. In contrast, students explicated the need for the immediate question-and-answer context of a face-to-face course in a subject in which they would need stronger instructor guidance. These findings suggest that many online courses implemented at community colleges, at least as currently practiced, may not support student learning as effectively as traditional face-to-face classes and therefore need systematic efforts from both the institution and the course instructors to better facilitate teaching and learning in the online environment.

Due to the flexibility of online learning, online courses may be particularly appealing to students who assume working and family responsibilities and who would otherwise have to take fewer courses or not enroll in college at all. A Government Accountability Office report provided a comprehensive description of current online course takers based on data from the National Postsecondary Student Aid Study, a nationally representative survey covering more than 19 million postsecondary students.[16] The analyses indicate that 1.5 million of 19 million postsecondary students took at least one online course in 1999–2000. These 1.5 million students differ from other postsecondary students in a number of ways. Compared to students who did not take any online courses during their entire program, online course attempters tend to be older and are more likely to be employed full time and attending school part time. They also have higher incomes and are more likely to be married.

These patterns are also echoed in several studies using college administrative data. For example, based on data from California's Community College System, Hans Johnson and Marisol Cuellar Mejia found that students age 25 or older are much more likely than younger students to take online courses.[17] Specifically, 15.4 percent of older students take online courses, compared to 8.5 percent of their traditional college-aged peers (age 18–25).

Additionally, this report reveals a racial and ethnic difference in online enrollment, with Latino students having a substantially lower online enrollment rate than white, African American, or Asian students do. This disparity may partially reflect the broadband internet access divide, as research suggests that Latinos are typically less likely to have internet access at home.[18] Given the flexibility of online learning as the most important consideration students cited for enrolling in online courses and the demographic characteristics of the online course takers, it may seem self-evident that online courses provide an avenue to pursue higher education for individuals who otherwise would not enroll. However, there is surprisingly little causal evidence on whether the availability of online learning opportunities indeed increase access to higher education, especially for disadvantaged or underrepresented student groups.

The only quasi-experimental evidence in this regard came from a recent study that uses data from a new online master's of science in computer science (OMSCS) offered by the Georgia Institute of Technology, in which all courses are delivered exclusively online.[19] The researchers found a significant difference in the age of students applying for the online program and its in-person equivalent. Specifically, the average in-person applicant is a 24-year-old student recently out of college, whereas the average online applicant is a 34-year-old mid-career worker.

A 2014 survey with OMSCS applicants also revealed that geographic and temporal flexibility is the primary appeal of online education to those whose jobs, families, or residential situations do not allow for enrollment in traditional programs. Eighty percent of those admitted to the online program accept those offers and enroll, suggesting that the online program expanded access to education for mid-career or older populations that would not otherwise enroll. Based on a regression discontinuity approach,[20] the researchers find that access to this online option substantially increased overall enrollment by about 20 percentage points and that such effects are fairly consistent across different demographic subgroups, such as by gender, ethnicity, age, and citizenship. Importantly, among applicants who fell right below the cutoff score and were therefore not admitted into the online program, few enrolled in other non-OMSCS programs, supporting the claim that the online option indeed increases access to higher education.

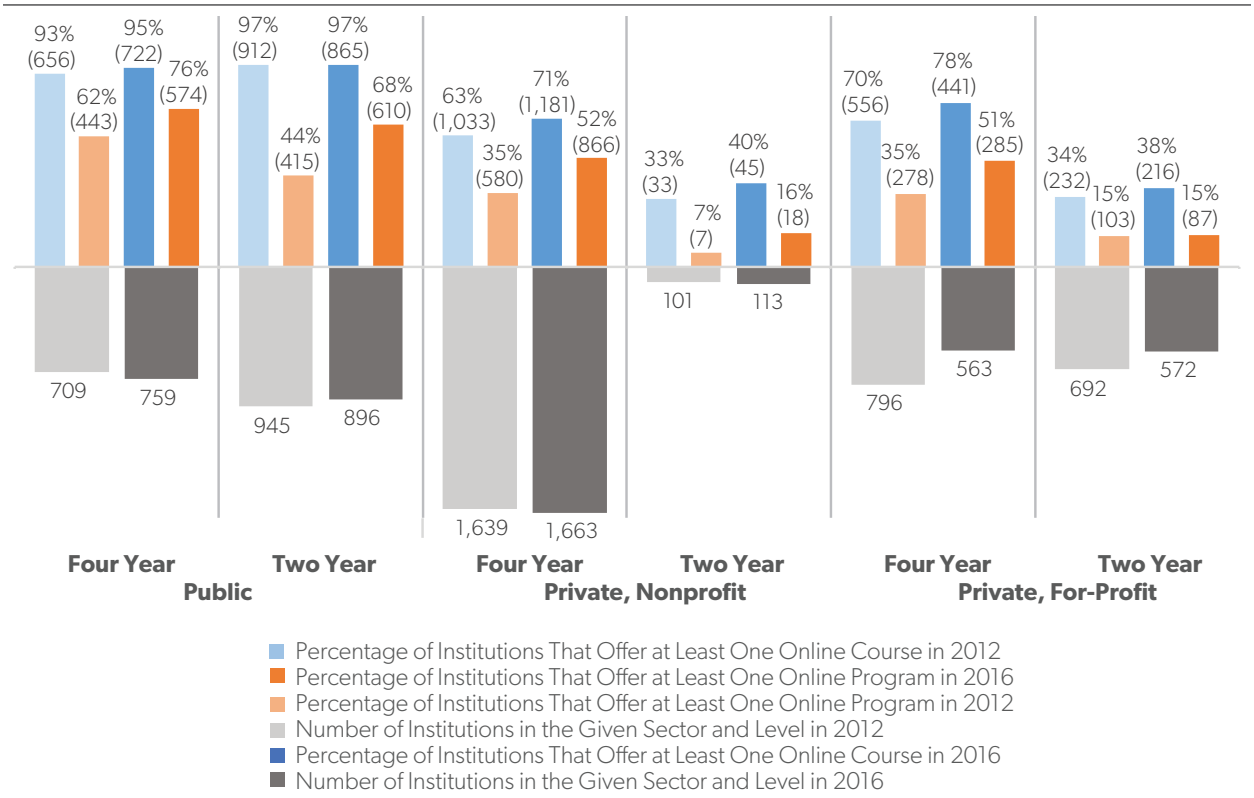
The Supply and Demand of Online Education. With the added convenience of online classes and their potential ability to expand access to higher education, it should be no surprise that the supply of and demand for online courses has increased throughout the past decade. That is, more colleges are now offering online courses than ever before (more *supply*), and more students are now enrolling in those courses than ever before (more *demand*). How large is this increase? The Department of Education's Integrated

Postsecondary Education Data System (IPEDS) provides comprehensive national statistics on postsecondary education, and since 2012, IPEDS has reported data regarding online education offerings and enrollment for degree-seeking students.

IPEDS defines online education as a credit-bearing course or program in which the instructional content is delivered exclusively online.[21] IPEDS data from 2016–17 are used to show the overall increase in supply of online education courses and the increase in demand for those courses by students. The data represent more than 7,000 postsecondary institutions across the US, among which almost 5,000 are degree-granting institutions.

The Supply Side: Increases in Online Courses and Programs. In 2016–17, approximately 3,500, or 76 percent, of all degree-granting institutions reported offering online courses. This number has increased steadily since 2012, when 70 percent of those institutions reported to offer online courses. Among institutions that offered any online course, almost all offered online courses at the undergraduate level, whereas only half offered online courses at the graduate level. While online courses provide flexibility to students in general, programs offered *entirely* online allow students to attain a higher education credential remotely and thus could expand access to higher education among individuals who do not live near a physical college campus, such as those serving in the Army. According to IPEDS, more than half

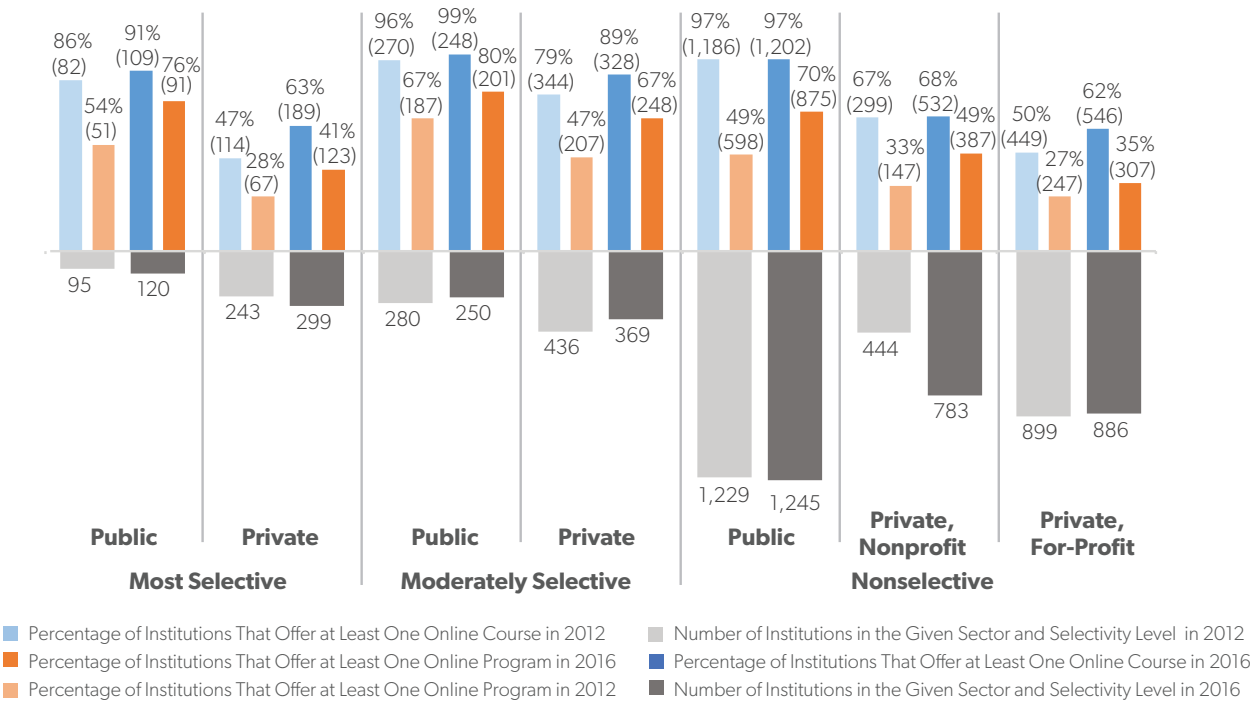
Figure 1. Number of Postsecondary Institutions That Offer Online Courses or Programs by Sector and Level, 2012 and 2016



Note: The numbers reported in the figure are calculated based on data from active degree-granting institutions with valid enrollment data in each year (n = 4,566 in 2016; n = 4,882 in 2012). The numbers in parentheses represent the total number of institutions in a specific category.

Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012 and 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 2. Number of Postsecondary Institutions That Offer Online Courses or Programs by Selectivity and Sector, 2012 and 2016



Note: These numbers were calculated based on active degree-granting institutions with valid enrollment data and valid selectivity scores in a given year. The sample includes 3,952 institutions in 2016 and 3,626 institutions in 2012. Selectivity is derived from the Carnegie Classification of Institutions of Higher Education (variable "C15UGPRF" in the IPEDS 2016 database and variable "CCUGPROF" in the IPEDS 2012 database, respectively). Based on the 15 categories,[23] we coded all institutions into three selectivity levels: nonselective, moderately selective, and most selective. For the most selective and moderately selective categories, "private" includes both nonprofit and for-profit institutions. However, 99 percent of private for-profit institutions were categorized as nonselective, so for-profit and nonprofit institutions are grouped together in the most selective and moderately selective categories.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012 and 2016, https://nces.ed.gov/ipeds/use-the-data.

of degree-granting institutions offered at least one exclusively online program in 2016–17.

Figure 1 shows the percentage of degree-granting postsecondary institutions that offer any online course and at least one exclusively online program, broken out by sector (public, private nonprofit, and private) and level (two year versus four year). Online learning is most prevalent in the public sector, where more than 95 percent of public institutions offered at least one course online in 2016 and more than two-thirds of the institutions offered at least one program that can be pursued exclusively online. Online course and online program offerings are less prevalent in both the private nonprofit sector and the for-profit sector, especially at two-year institutions.

Comparing data between 2012 and 2016 also reveals noticeable increases in the availability of exclusively online programs at both two-year and four-year institutions in all three sectors. Among two-year public institutions, for example, only 415 (44 percent) institutions offered an exclusive online program in 2012. By 2016, this number increased to 610, or 68 percent, of all degree-granting two-year public institutions. The only exceptions are for-profit two-year institutions, where only 15 percent of these institutions offered exclusively online programs in both 2012 and 2016.

Figure 2 further takes into account an institution's selectivity and displays online course and program offering by sector among institutions with similar levels of selectivity. The selectivity measure is created by IPEDS based on several admission-related factors, such as college admission test scores, the number of applicants, and the number of students admitted.[22] In general, more selective institutions have lower acceptance rates and tend to admit students with higher average entrance test scores (such as the SAT or ACT), suggesting that they predominantly admit the most academically qualified students.

While online education offering is most prevalent among public institutions across the board, the gap in online course and program offering is particularly pronounced among the most selective institutions: During 2016–17, 91 percent of more selective public institutions offered at least one online course, compared to 63 percent of more selective private nonprofit institutions. Similarly, whereas 76 percent of the more selective public institutions offered exclusively online programs, only 41 percent of the more selective nonprofit private institutions did so.

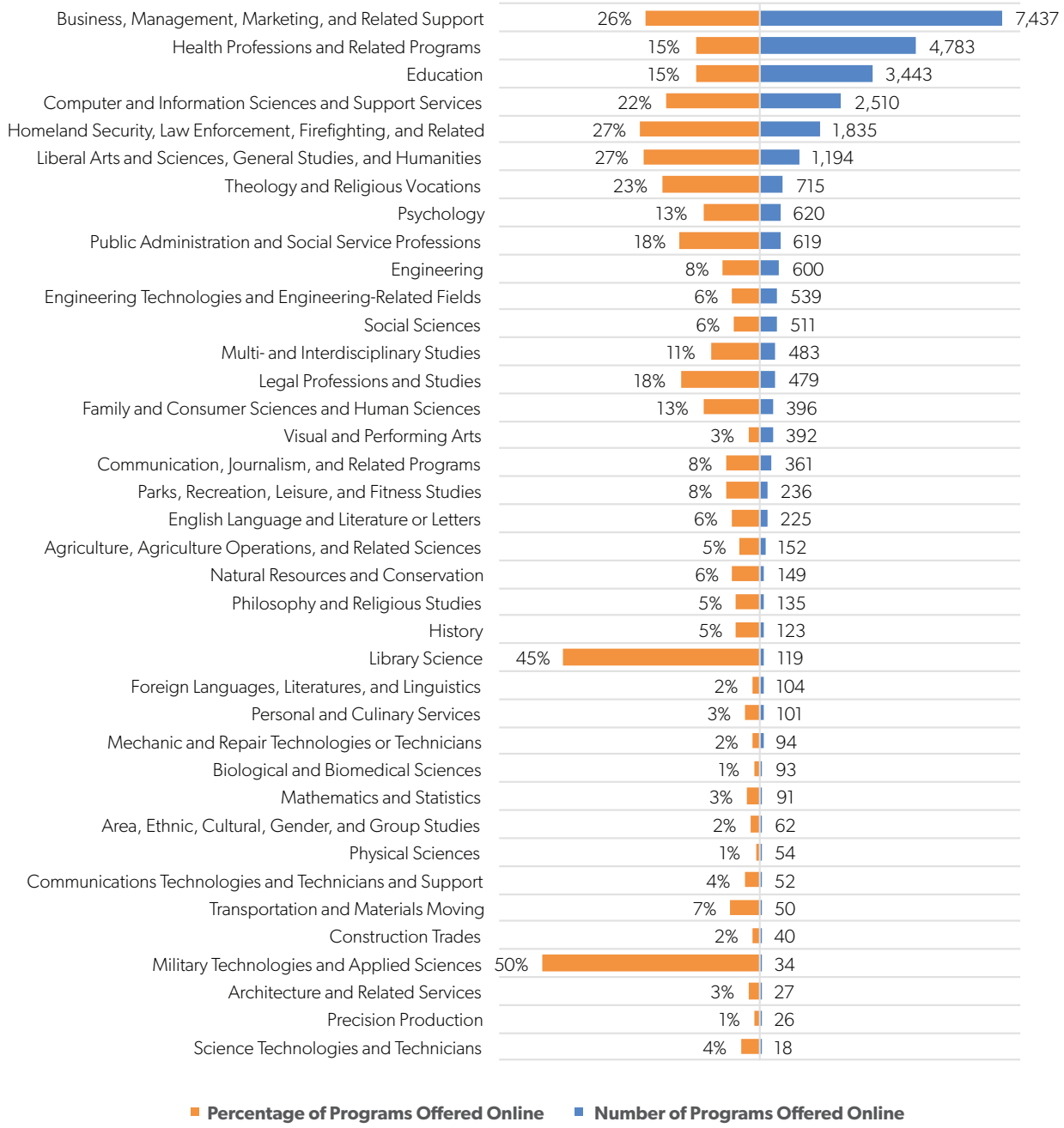
IPEDS further divides exclusively online programs by Classification of Instructional Programs (CIP) code, thus enabling a more detailed examination of fully online programs by academic subject areas. Figure 3 presents the total number of education programs that can be pursued exclusively online at degree-granting institutions in each field of study. Due to variations in demand and the suitability of the online format in delivering the course content, the supply of fully online programs shows substantial variations across subject areas. Business and marketing top the list, where 7,437 programs can be pursued exclusively online and represent one-quarter of all programs in this area, followed by health (4,783 programs) and education (3,443 programs).

To examine the possibility that the availability of fully online programs in each field may vary by the type of credential, we further break down the distribution of programs for associate and bachelor's degrees (Figure 4), graduate degrees (Figure 5), and certificates (Figure 6). It seems that business, health, and education are among the top three programs for all three types of credentials, with one exception: Relatively fewer associate and bachelor's degree programs in education can be fully pursued online (569 programs, representing only 6 percent of all associate and bachelor's programs in education).

Finally, Figure 7 shows the distribution of programs by sector and selectivity of institutions for the top five fields with the largest number of exclusively online programs.[24] Two interesting patterns emerge from the findings. First, except for education, fully online programs are overwhelmingly offered by nonselective public and private for-profit institutions. In particular, three-quarters of exclusively online computer science programs were offered by institutions from these two categories. Second, a relatively small percentage of exclusively online programs can be pursued at selective institutions. (Education is a notable exception, in which more than half of the programs are offered at selective institutions.)

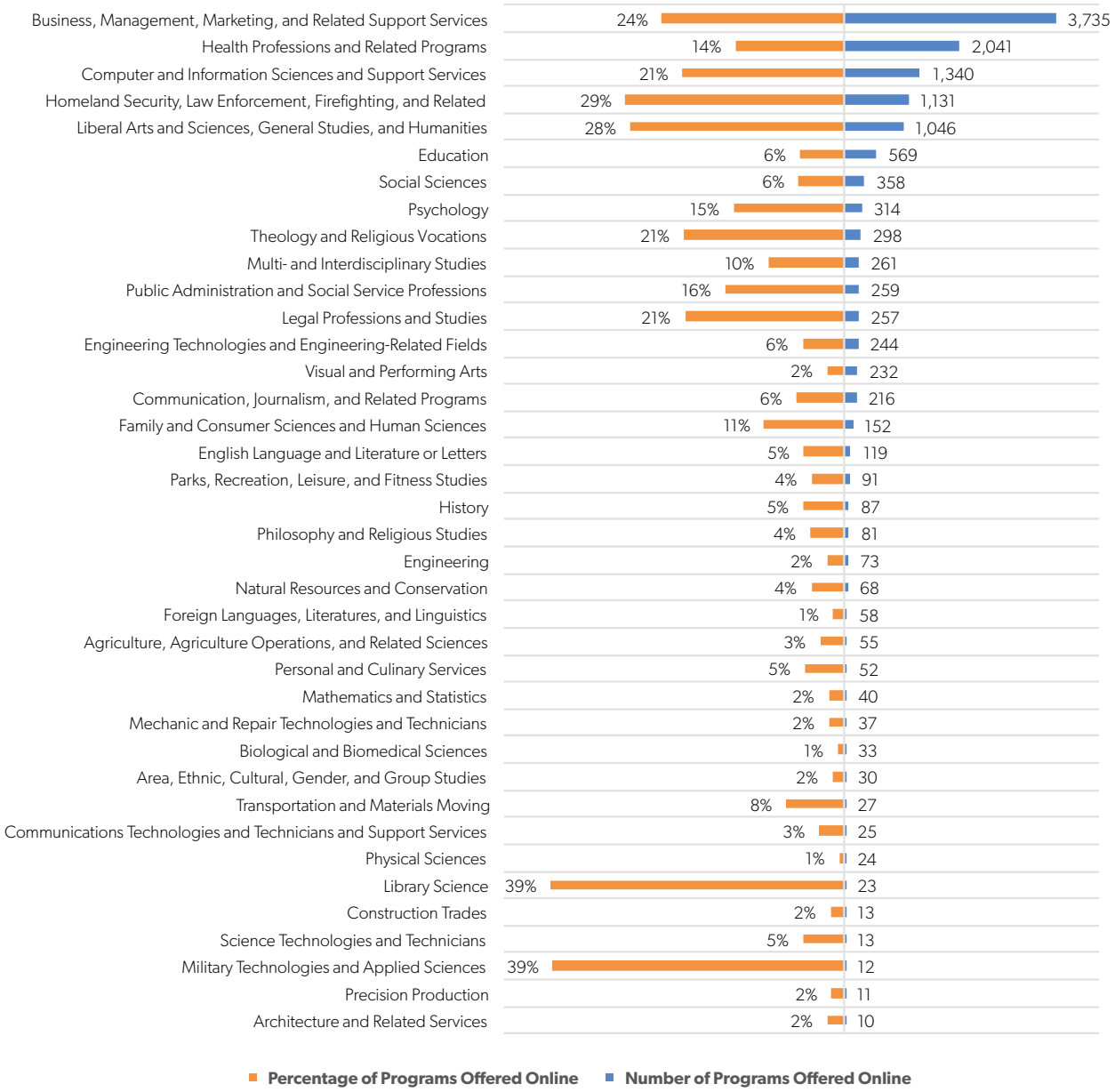
The Demand Side: Increases in Online Enrollment. Among all postsecondary degree-granting institutions, 15 percent of all degree-seeking students were exclusively enrolled in online courses during 2016–17, and approximately one-third of degree-seeking students were enrolled in at least one course through online learning (referred to as "any-online student" hereafter). There are substantial variations in student enrollment in online education across sectors: Private for-profit institutions, particularly for-profit four-year institutions, had the highest online enrollment rate, in which 68 percent of students enrolled in this sector during 2016–17 took at least one online class. Among these students, the majority (85 percent) were enrolled online exclusively (referred to as "only-online students" hereafter). Institutions in the public sector and private nonprofit sector had a much lower online enrollment rate, in which 30 percent and 27 percent of students took at least one online class, respectively. Compared with any-online students enrolled in the for-profit sector, any-online students in the public and private nonprofit sectors were more likely to take face-to-face classes simultaneously, in which approximately one-third (35 percent) in the public

Figure 3. Availability of Exclusive Online Programs by Academic Subject Areas, 2016



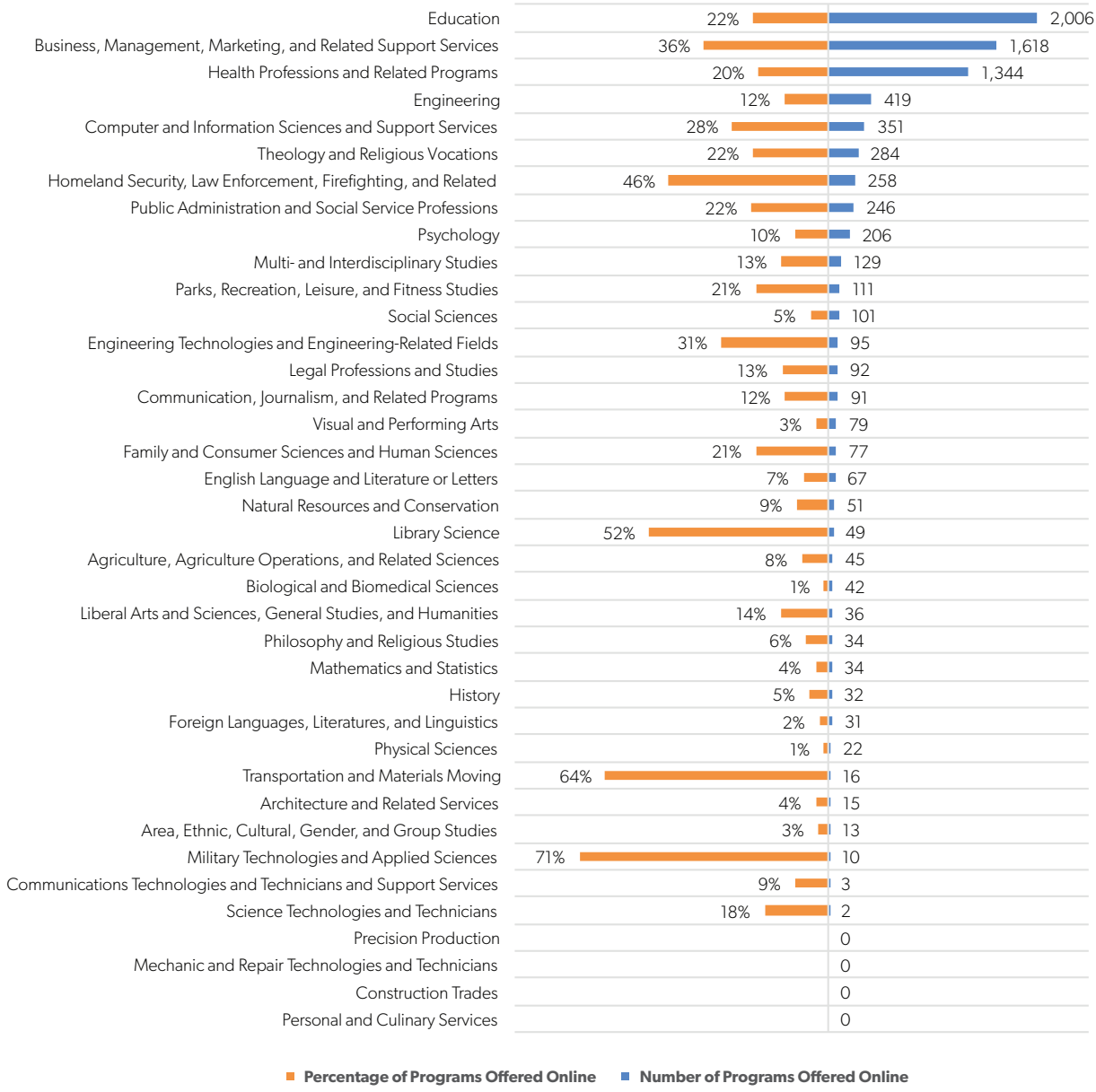
Note: These numbers were calculated based on active degree-granting institutions that reported valid data regarding online education offering in 2016 (n = 4,566). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 4. Availability of Exclusive Online Associate or Bachelor's Degree Programs by Academic Subject Areas, 2016



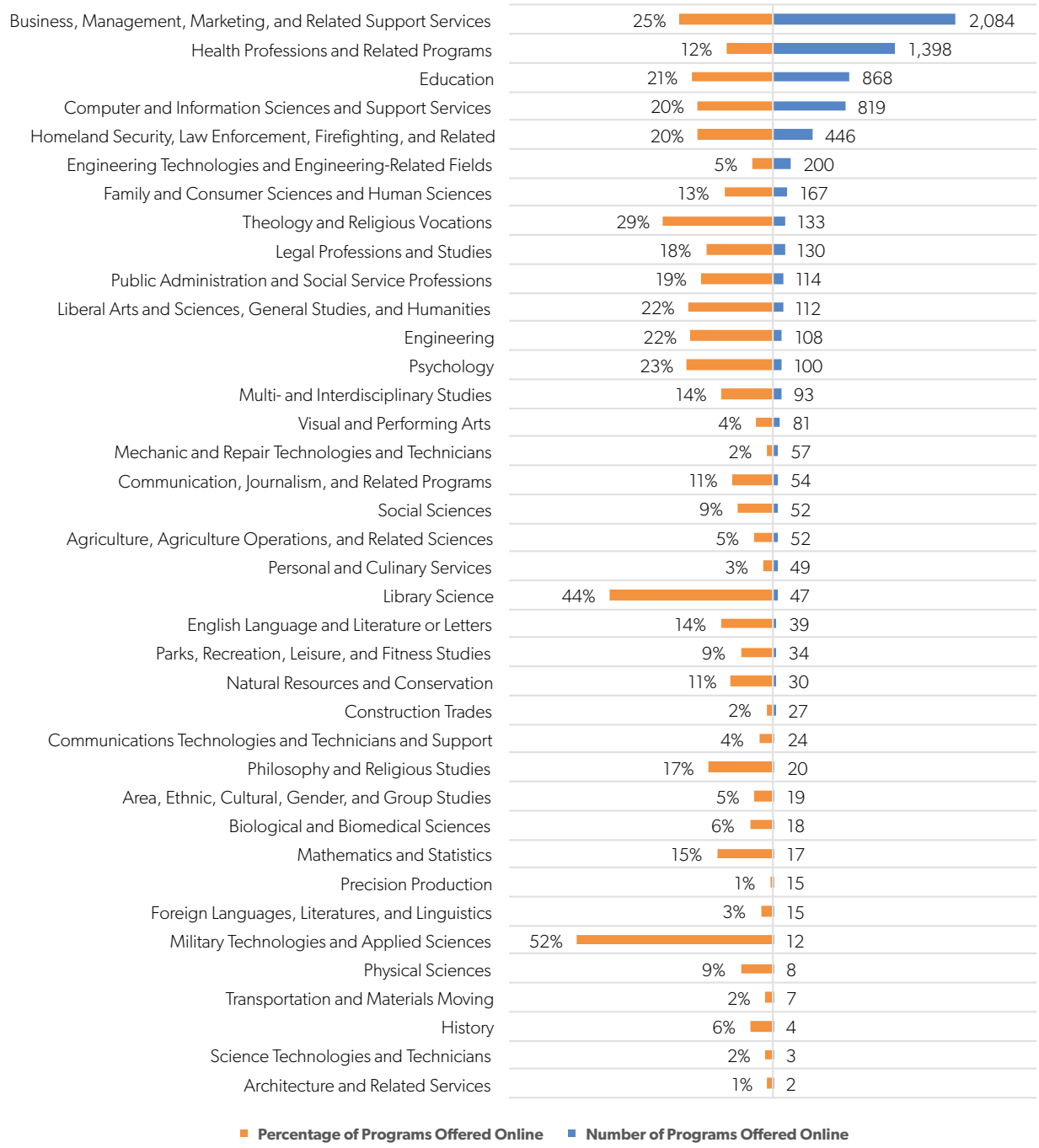
Note: These numbers were calculated based on active degree-granting institutions that reported valid data regarding online education offering in 2016 (n = 4,566). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 5. Availability of Exclusive Online Graduate Degree Programs by Academic Subject Areas, 2016



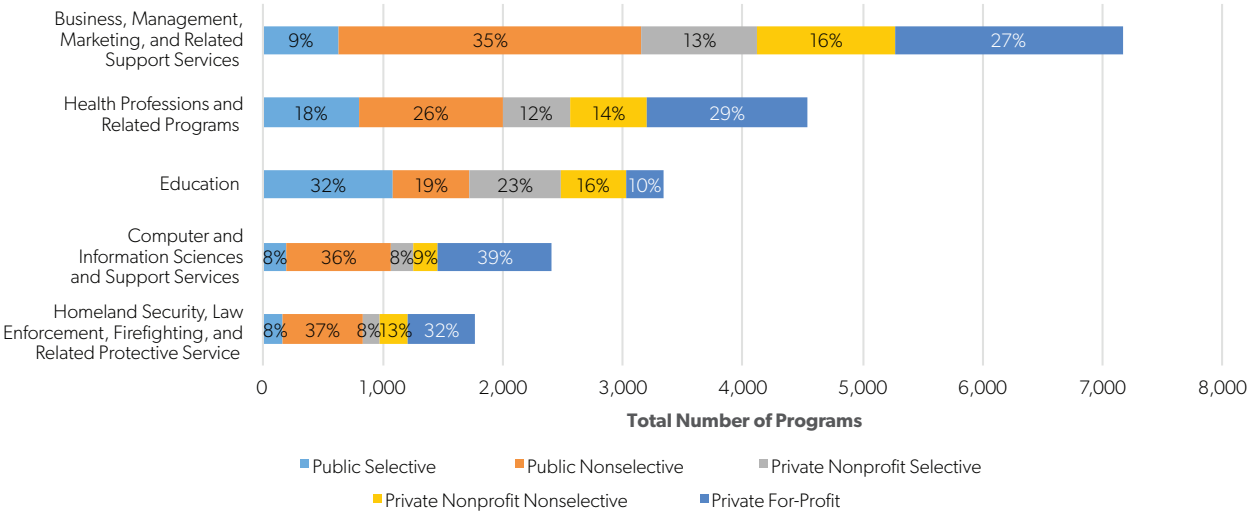
Note: These numbers were calculated based on active degree-granting institutions that reported valid data regarding online education offering in 2016 (n = 4,566). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 6. Availability of Exclusive Online Certificate Programs by Academic Subject Areas, 2016



Note: These numbers were calculated based on active degree-granting institutions that reported valid data regarding online education offering in 2016 (n = 4,566). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 7. Top Five Fields with the Largest Number of Online Programs by Sector and Selectivity, 2016



Note: These numbers were calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity scores (n = 3,952). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database. Selectivity is derived from the Carnegie Classification of Institutions of Higher Education (variable "C15UGPRF" in the IPEDS 2016 database and variable "CCUGPROF" in the IPEDS 2012 database, respectively). Given that over 99 percent of the institutions in the private for-profit sector were categorized as nonselective institutions, this figure did not break out institutions in this category between selective and nonselective.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2016, https://nces.ed.gov/ipeds/use-the-data.

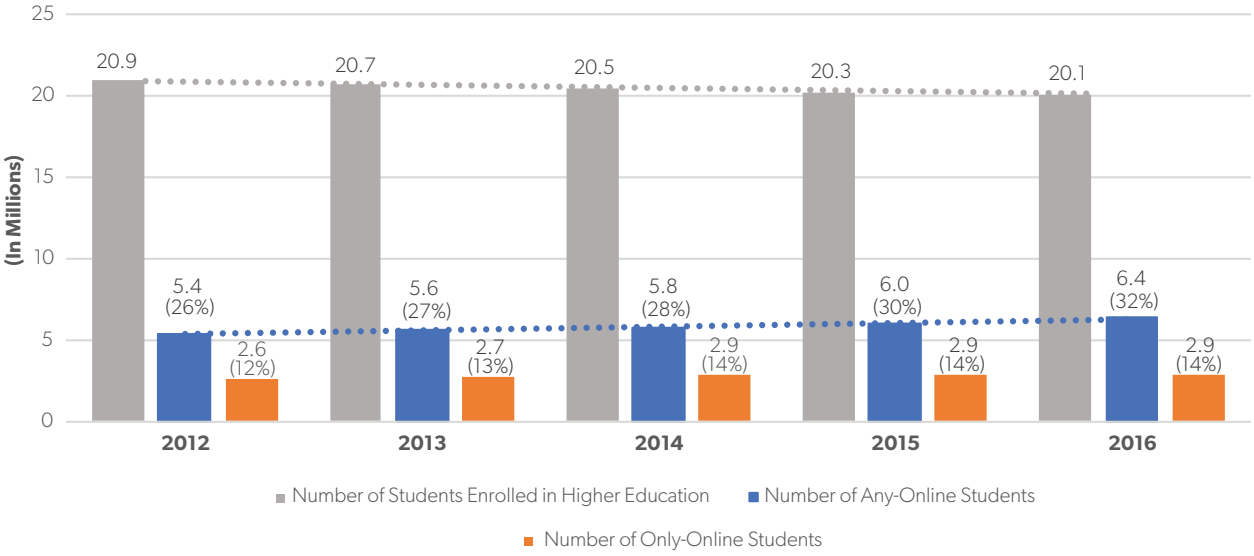
sector and 65 percent in the private nonprofit sector were enrolled in online courses exclusively.

Figure 8 shows the overall changes in student enrollment in online courses between 2012 and 2016 across all degree-granting postsecondary institutions. The number of any-online students increased by one million, representing a 19 percent increase overall. The number of only-online students also increased by 0.3 million during this period, or a 12 percent increase. The nationwide increase in online enrollment displayed in IPEDS is also evident in state and local reporting. At California Community Colleges (the largest community college system in the US) online course enrollment increased by almost 850,000 between 2002 and 2012. Meanwhile, enrollment in face-to-face classes declined by almost 285,000. Consequently, the proportion of online course enrollment surged from 1.4 percent to 10.7 percent over this period.[25]

Figure 9 further displays the trends of any-online and only-online students by institutional sector. Overall, the shares of online students (both any-online and only-online students) increased steadily across all three sectors between 2012 and 2016. While the total number of online students slightly increased during the five-year period in both the public and private nonprofit sectors, the number of online students at private for-profit colleges declined, which seems to be primarily driven by the overall shrinkage of total student enrollment in this sector during this period.

To examine possible differences in online enrollment between two-year and four-year colleges, Figure 10 further differentiates between four-year and two-year institutions in each sector and shows the percentage of students enrolled in any online course in 2012 and 2016, respectively. Overall, the percentage of any-online and only-online students increased in both two-year and four-year colleges across all sectors. In the public sector, two-year institutions had slightly higher online enrollment rates than did four-year institutions in both 2012 (27 percent vs. 22 percent for any-online and 10 percent vs.

Figure 8. Number of Students Enrolled in Postsecondary Degree-Granting Institutions and Online Courses, 2012–16



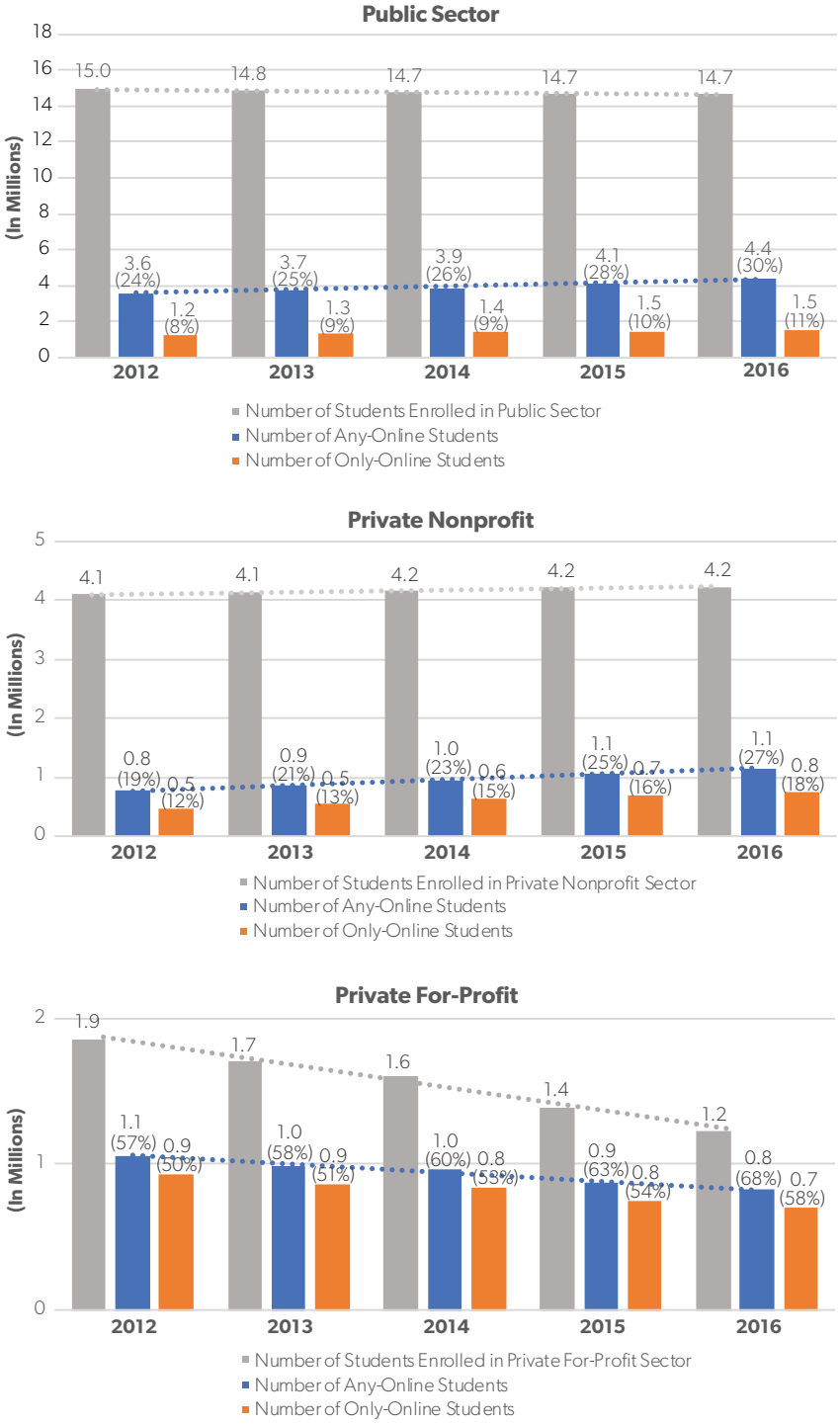
Note: The numbers reported in the figure were calculated based on data from active degree-granting institutions in each year. The numbers in parentheses represent the percentage of any-online or only-online students among those enrolled in higher education in a given year.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012, 2013, 2014, 2015, and 2016, https://nces.ed.gov/ipeds/use-the-data.

7 percent for only-online) and 2016 (31 percent vs. 29 percent for any-online and 12 percent vs. 10 percent for only-online). In the private nonprofit sector, two-year institutions showed a dramatic increase in online enrollment rate between 2012 and 2016 (from 7 percent to 40 percent for any-online and from 2 percent to 34 percent for only-online), although these two-year institutions only accounted for less than 1 percent of the total postsecondary enrollment. In the private for-profit sector, four-year institutions had an extremely high online enrollment rate (80 percent for any-online and 69 percent for only-online in 2016), while the rate was fairly low at two-year, private for-profit institutions (13 percent for any-online and 4 percent for only-online in 2016).

Figure 11 displays the percentage of any-online and only-online students by institutional selectivity. The patterns across institutions are strikingly consistent: the more selective an institution, the less likely the students would attempt any online course. For example, only 16 percent of the students enrolled in most-selective institutions attempted any online course during 2016–17, which is half the rate compared to students enrolled at nonselective institutions (39 percent).

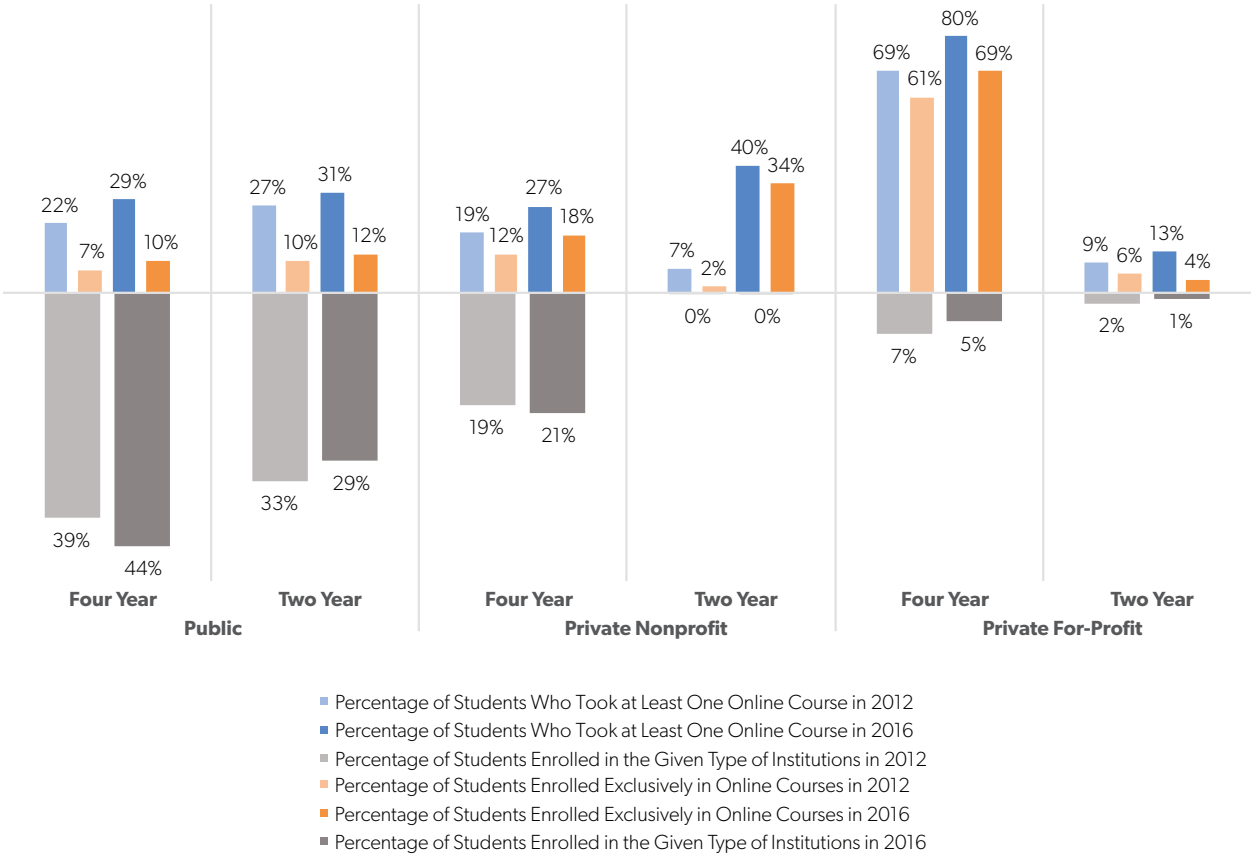
The higher rate of online enrollment among nonselective institutions shown in Figure 11 might be primarily driven by a large share of students enrolled at private for-profit institutions. To address this possibility, Figure 12 shows the percentage of students enrolled in online courses broken out by sector in each category of selectivity. After disaggregating the data by both sector and selectivity level, the pattern of higher online enrollment rate in nonselective institutions holds in the public sector and the private nonprofit sector. For example, in the private nonprofit sector, only 10 percent of the students at more selective institutions took any online course in 2016–17. The percentage of any-online students almost tripled at moderately selective nonprofit institutions and increased by about half at nonselective nonprofit institutions.

Figure 9. Number of Students Enrolled in Postsecondary Institutions and Online Courses by Sector, 2012–16



Note: The numbers reported in the figure were calculated based on data from active degree-granting institutions in each year. The numbers in parentheses represent the percentage of any-online or only-online students among all enrollees in higher education in a given year.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012, 2013, 2014, 2015, and 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 10. Higher Education and Online Enrollment by Sector and Level, 2012 and 2016



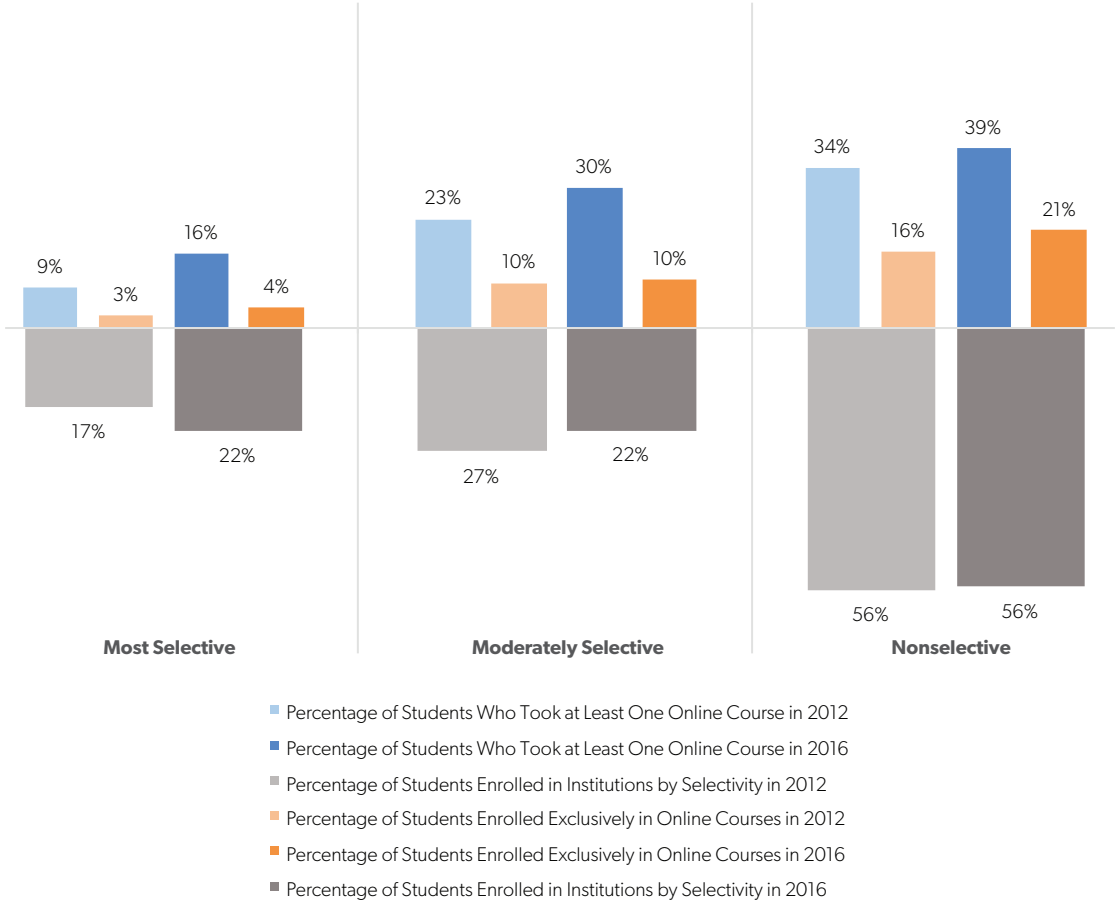
Note: These numbers were calculated based on active degree-granting institutions with valid enrollment data in the current year (n = 4,566 in 2016; n = 4,822 in 2012). Institutional sector was retrieved from variable "CONTROL," and institutional level was retrieved from variable "ICLEVEL" in the IPEDS database. Total enrollment rate in private, nonprofit two-year institutions in 2012 is 0.18 percent. The total enrollment rate in two-year, private nonprofit institutions in 2016 was 0.26 percent.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012 and 2016, https://nces.ed.gov/ipeds/use-the-data.

Finally, considering that state-level policies may shape online learning in unique ways, Figure 13 shows online enrollment by state in the 2016–17 school year. Unsurprisingly, the most populated states, such as California, Florida, and Texas, also had the largest number of online course takers. Once accounting for between-state differences in overall higher education enrollment, four states have the largest share of students who enrolled in at least one online course in 2016: Arizona (61 percent), Idaho (52 percent), New Hampshire (58 percent), and West Virginia (57 percent). At the other end of the spectrum, three states—Connecticut, New York, and Rhode Island—had less than 20 percent of students enrolled in at least one online course.

The Cost of Online Education: Can Distance Learning "Bend the Cost Curve"?

One reason for the support behind online education and distance learning is that it can help address funding insufficiencies in higher education

Figure 11. Higher Education and Online Enrollment by Selectivity, 2012 and 2016



Note: These numbers were calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity scores in a given year. The sample includes 3,955 institutions in 2016 and 3,626 institutions in 2012. Selectivity was retrieved from the Carnegie Classification of Institutions of Higher Education (variable "C15UGPRF" and variable "CCUGPROF" in the IPEDS 2016 and IPEDS 2012 database, respectively).
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012 and 2016, https://nces.ed.gov/ipeds/use-the-data.

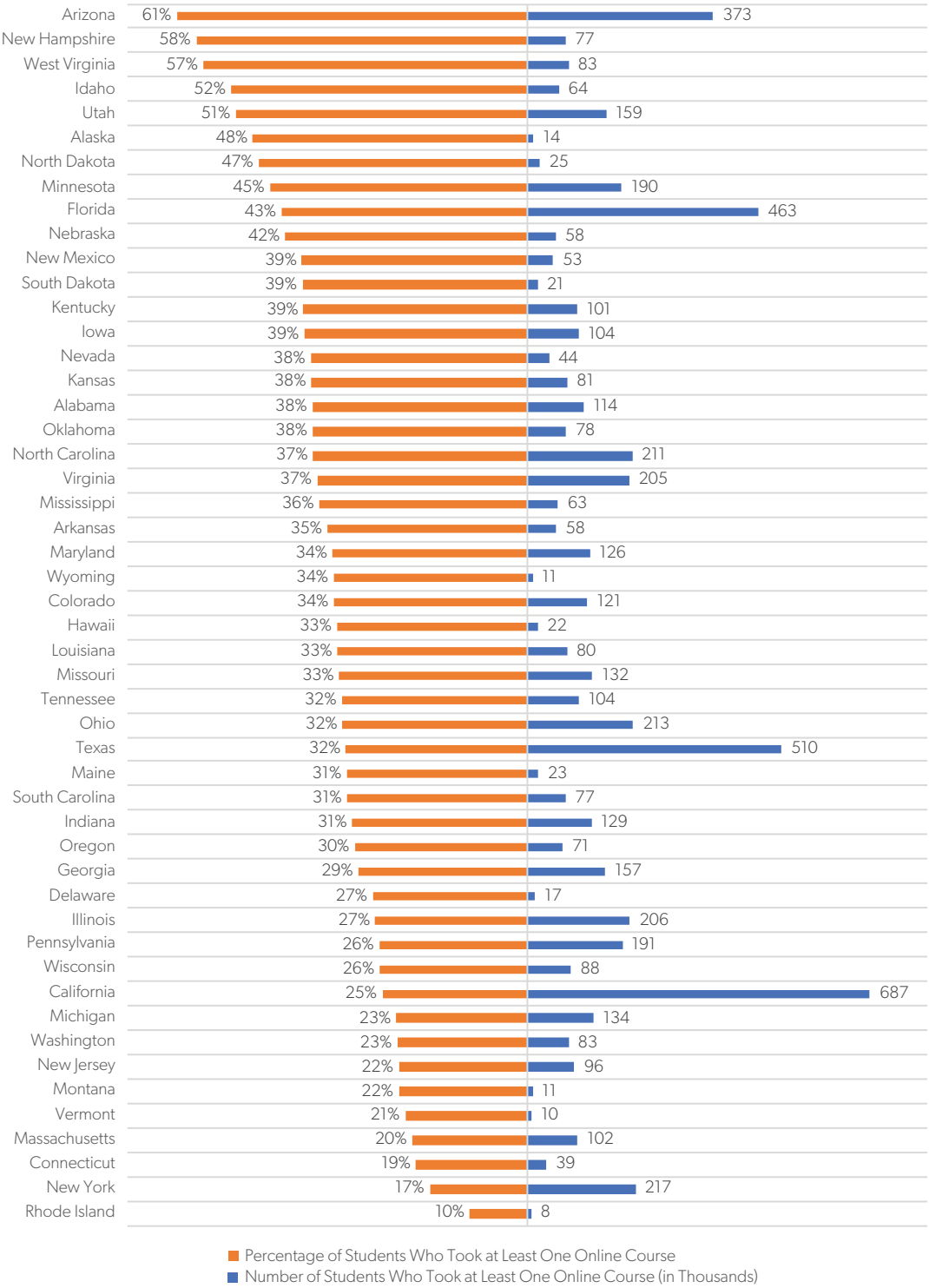
by reconfiguring the use of highly paid faculty and reducing the demand for brick-and-mortar construction and maintenance.[26] Since online courses do not have physical space limitations on enrollment, colleges can increase class sizes in online courses as a response to changes in demand relatively easily compared to brick-and-mortar classrooms. Moreover, the consequence associated with increased class size on student learning may also differ substantially by course delivery format: While larger class sizes can negatively influence student-learning outcomes through increased classroom disruptions in the traditional face-to-face setting, these mechanisms would be largely muted if an online course has limited synchronous student-instructor interactions and peer interactions.[27]

Eric Bettinger and his coauthors directly assess the effects of increasing class size on student-learning outcomes in online courses at a large for-profit university.[28] The authors exploit a field experiment in which more than 4,000 course sections of 111 courses were randomly assigned to either

Figure 12. Higher Education and Online Enrollment by Sector and Selectivity, 2012 and 2016

Note: These numbers were calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity scores in a given year. The sample includes 3,955 institutions in 2016 and 3,626 institutions in 2012. Selectivity was retrieved from the Carnegie Classification of Institutions of Higher Education (variable "C15UGPRF" and variable "CCUGPROF" in the IPEDS 2016 and IPEDS 2012 database, respectively). For the most selective and moderately selective categories, "private" includes both nonprofit and for-profit institutions. However, 99 percent of private for-profit institutions were categorized as nonselective, so for-profit and nonprofit institutions are grouped together in the most selective and moderately selective categories.
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2012 and 2016, https://nces.ed.gov/ipeds/use-the-data.

Figure 13. Percentage of Students Enrolled in Any Online Course by State, 2016



Note: These numbers were calculated based on active degree-granting institutions that reported valid data regarding online education offering (n = 4,566).

Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2016, https://nces.ed.gov/ipeds/use-the-data.

regular-sized classes of 31 students or slightly larger classes with an average 10 percent increase in class size. They estimate the effect of online class size on a variety of student outcomes. The authors find, after addressing potentially endogenous student sorting into different classes, that increasing the online class size by 10 percent has no statistically significant effect on either current course grade or subsequent course enrollment. The null results suggest that online courses have the potential to reduce the cost of providing education by increasing online class size without affecting student outcomes.

If online course offerings can indeed serve as cost-saving innovations for institutions, colleges may also charge lower tuition for their online programs and courses, therefore lowering the costs for students to pursue postsecondary education. Indeed, using IPEDS, David Deming and his coauthors found that institutions with higher shares of students enrolled online charge lower prices, providing some suggestive evidence that online education might be able to "bend the cost curve" in traditional higher education.[29]

Caveats Against Online Courses as a Cost-Saving Strategy. At first, these results seem to provide evidence that online courses present a promising opportunity to reduce higher education costs for both institutions and students. A caveat against this promise, however, is the extent to which online courses and programs compromise the quality of education received compared with traditional face-to-face instruction. If the primary reason why online class size can be increased without degrading learning outcomes is that interpersonal interactions are muted enough in online classrooms, it is reasonable to question whether the reduced interpersonal interactions and social presence may compromise the quality of education received by students. In fact, in a separate paper that uses the same data set from a large for-profit university, Bettinger and his coauthors find that online courses do significantly less to promote student academic success than similar in-person courses do.[30] The negative association between online learning and student-learning outcomes, which is discussed in detail below, indicates that college online courses do not currently support student learning equally as well as face-to-face classes. Thus, perhaps a more compelling question is whether online technology has the potential to deliver *similar* quality of education in a less expensive way relative to brick-and-mortar instruction.

Another important caveat to the promise of online education is the large upfront cost of developing high-quality online courses. The complexities involved in making generalizations about costs across different types of courses and institutions make it extremely difficult, if not entirely impossible, to provide a clear-cut answer as to whether online courses are indeed cheaper in terms of both upfront costs in course development and recurring costs in course delivery.[31] For example, Russell Poulin and Terri Taylor Straut noted substantial variations in how an online course is designed and implemented, ranging from a set of slides with little student-instructor interaction to a highly interactive course with well-designed videos of lectures.[32] As a result, development costs for online courses can vary widely across institutions from $10,000 to $60,000 per course, depending on a variety of factors such as specific online course design features, student services, and faculty compensation.[33]

Based on expenditure data from the University of North Carolina (UNC) system, a recent report provides suggestive evidence that well-designed online courses with technologically enabled interaction between students and instructors are *more* expensive than traditional on-campus courses in terms of both startup expenditures in course development and recurring expenditures in delivering the course.[34] More specifically, based on the cost information on a sample of 92 courses (46 on-campus and 46 distance courses) from 15 UNC campuses,[35] the report indicates that the average cost for developing a distance course ($5,387) is 6 percent higher than the average cost for developing an on-campus course ($5,103).[36] The higher costs associated with developing online courses are primarily driven by higher expenses for staff or consultants that assist faculty in course development. In terms of course delivery,

the cost for delivering an online course ($17,564) is also higher than the average cost for delivering an on-campus course ($16,433), which is due to distance education courses often having other costs associated with delivery that on-campus courses do not incur, such as special software or hardware needed for content delivery or technologically enabled interaction between students and instructors.[37]

Most interestingly, the average class size for distance education courses was significantly smaller than the average size for on-campus courses (18 vs. 23), and faculty in follow-up campus interviews emphasized the need to maintain smaller class sizes for online courses specifically because "teaching online courses is more time consuming for faculty" and "due to the amount of work necessary to engage students in the online environment."[38] That faculty might need to spend more time to ensure the quality of instruction and interaction in an online course than in face-to-face classes raises questions on the potential of online courses to serve as a cost-saving strategy through larger class size.

If cost saving is not the primary reason for institutions to offer online courses, then why do postsecondary institutions generally agree on the importance of expanding online learning? Interviews conducted by Lawrence Bacow and his coauthors identified two major reasons for providing online learning opportunities. First, many institutions view online education as an important new revenue source, as it may generate new revenue streams by reaching students who would not otherwise enroll in traditional degree programs.[39] Second, most institutions intend to use online learning as a way to improve students' learning experience.

Specifically, several administrators noted online learning as an effective way to address space constraints, particularly in low-division, high-demand introductory courses—an issue many institutions are facing due to the increasing demand for higher education. Freedom from the constraint of physical classroom space allows administrators to create as many course sections as they can find qualified instructors for, which could address the availability barrier. In addition, online learning may also expand access to better educational resources: While small colleges do not always have the resources to offer a wide range of courses to their students, shared online courses allow these campuses to offer students a wider variety of courses. Finally, college administrators are also optimistic about online courses potentially reforming the traditional learning process through technology, such as enabling a greater level of learning flexibility, achieving strong computer-mediated student-to-student interaction and collaboration, and providing immediate personalized feedback on student learning.

Online Education and Student Outcomes

With the rapid growth of online education and its potential benefits to address the needs of diverse student populations, questions remain regarding its effectiveness.[40] Do online courses effectively prepare students with the knowledge and skills needed to succeed in college and later in their careers? Earlier observational studies attempted to compare student-learning outcomes between online and face-to-face formats, and the findings are mixed.[41] Such discrepancies in research findings might be partially explained by the issue of "self-selection": Most of these observational studies simply made comparisons between students who opted to take the course online and those who self-selected into the traditional face-to-face format and, therefore, did not control for the possibility that a common set of personal characteristics and school circumstances may jointly influence decisions on online course enrollment and course outcomes. As a result, the extent to which these statistical findings are attributable to cause-effect relationships remains uncertain.

To provide an overview of the causal link between course delivery format and student-learning outcomes, we reviewed the literature that uses experimental or quasi-experimental research design to control for student sorting by course delivery format. Appendix A summarizes the key information of each study discussed below.

Online Delivery Format Improves Learning Outcomes. The strongest support for the optimism around online learning comes from a meta-analysis by the US Department of Education.[42] Based on only randomized experiments or quasi-experiments, the meta-analysis suggests that, on average, students in online learning conditions performed better than did those receiving face-to-face instruction.[43] However, a thorough review by Jaggars and Thomas Bailey of the 45 experimental studies included in the meta-analysis raises concerns regarding whether the findings from the Department of Education report could be generalizable to typical college courses.[44]

First, the majority of the studies included in this meta-analysis focused on only one specific topic, in which the duration of the intervention could be as short as only 15 minutes. Results from these short interventions may not speak to the challenging issues inherent in maintaining student attention and motivation over a course of several months. Among all the 45 studies included, only seven were relevant to typical online semester-length college courses.[45] Overall, these seven studies showed no strong advantage or disadvantage in terms of learning outcomes among students who stayed in the course throughout the entire semester.[46] However, all seven studies were conducted at midsize or large universities, with five rated as "selective" or "highly selective" by *US News and World Report,* and all seemed to involve relatively well-prepared students.

These results may not speak to academically underprepared students who may struggle more in online learning environments due to poor time-management and independent-learning skills, which are thought to be crucial to success in online education, or due to technical difficulties, such as slowness of typing, problems navigating the course management system, and difficulty following material on the screen. These are all problems that may be more common among students with weak educational backgrounds.[47] Only one of the studies examined the impacts of the course delivery format on lower-performing students. Cynthia Peterson and Nathan Bond performed a descriptive analysis suggesting that the lowest third of academically prepared students performed substantially better in the face-to-face setting than in the online setting.[48]

In addition, the studies included in the meta-analysis almost exclusively focus on course grade and do not study attrition as an outcome. While course attrition rates might be low and ignorable in a selective institution with an academically well-prepared student population, a large proportion of students enrolled in open-access public institutions, especially at two-year community colleges, are academically underprepared. These underprepared students withdraw from courses and drop out of college at a higher rate.[49] Indeed, studies consistently identify higher course attrition rates in online courses compared to similar face-to-face courses at two-year colleges.[50] If less academically prepared students are more likely to withdraw due to the online nature of the delivery format, it may not be surprising, then, that students who *stayed* in the online course were more likely to earn a good grade than were students who took face-to-face courses.

Finally, several studies in the meta-analysis were conducted by professors who taught the course in subjects likely to be especially well-suited to online learning, such as computer programming. These professors were either online course advocators or potentially highly motivated professors teaching unusually high-quality online classes. The classes often involved synchronous sessions, timely instructor feedback, effective technical support, a clear grading rubric, and a well-organized course structure with intuitive navigation. Yet, the quality of the courses designed and offered by these online advocates may not represent typical online courses offered at colleges. Indeed, studies that examine the design features of online courses currently offered at postsecondary institutions, especially open-access public colleges, noted that many instructors simply transfer their in-person pedagogy to the online format and include a minimal level of synchronous interpersonal interaction opportunities.[51]

Online Delivery Format Hinders Learning Outcomes. Aside from the meta-analysis, all other experimental and quasi-experimental studies on

semester-length college courses find negative effects on student course performance, course persistence, and other downstream learning outcomes such as course repetition and subject persistence. The effect of taking online courses on these outcome metrics is explored in detail below.

Course Performance. Nearly all causal studies find negative effects of online course taking on student course performance or, at best, null results.[52] The outcome measures include course grades, course completion with a passing grade, and standardized posttest scores.[53]

Four experimental studies are conducted in relatively selective four-year institutions and randomly assign students into different delivery formats in a single course in economics or statistics with a total enrollment ranging between 312 and 725 students.[54] David Figlio, Mark Rush, and Lu Yin compare between a purely online and face-to-face classroom setting in teaching microeconomics principles, in which students assigned to the online format watch videos of the lectures online.[55] Ted Joyce and his coauthors also conducted the study in principles of microeconomics, but the online instruction in their study instead takes the form of blended learning that included an online component and reduced the weekly face-to-face meeting time by half.[56]

William Bowen and his coauthors compare an online delivery format with one hour per week of instructor contact time to a purely face-to-face delivery format with three hours per week of contact time in a statistics course by randomly assigning students on six public university campuses.[57] The online instruction in their study is the most sophisticated among the four studies, which includes an interactive learning system that provides students with customized machine-guided instruction and timely information about student performance to course instructors for more targeted and effective guidance from the instructor. Additionally, the blended group is also accompanied by one hour of face-to-face instruction each week. William Alpert and his coauthors compared student-learning outcomes in a microeconomic principle course delivered through three formats—face-to-face, blended, and fully online—at a public university.[58] Both the blended and the online formats provide students with online lectures; additionally, students in the blended format attend a weekly in-person discussion session, whereas students in the fully online format attend a weekly online synchronous discussion session.

Except for Bowen and his coauthors who identify no significant difference in learning outcomes between the blended and face-to-face instruction, the other three all find negative effects of online instruction on course grades.[59] Bowen and his coauthors point out that one potential explanation for the null effects in their study versus more negative impacts in other studies may be due to the form of online instruction: The online course examined in their study uses an advanced, less commonly used interactive learning system with machine-guided protocols, whereas the online instruction in the rest of the studies is mainly through videotaped lectures that do not enable student-faculty interactions.[60]

While well identified, all the experimental studies focus on a small number of students in a specific course and therefore shed limited insights on the impacts of online learning in the broad set of college courses. A handful of studies address this issue by using college administrative data that include a large swath of online and face-to-face courses at one college or multiple colleges in an entire state.[61] The majority of these quasi-experimental studies examine online learning at two-year community colleges, which is a population of particular interest for policy on online learning.[62] Four state community college systems have been examined thus far (California, North Carolina, Virginia, and Washington), and all states demonstrate rapid growth of enrollment in fully online courses during the past decade.[63]

Using different quasi-experimental methods to address student sorting into online courses and drawing on data from different states and settings, the results from the quasi-experimental studies find patterns that are strikingly similar: Students in fully online delivery formats had learning outcomes that were substantially worse than those in the face-to-face section of the same course.[64] The current

evidence on the negative effects of online delivery format are primarily based on data from a large swath of courses at nonselective institutions, such as for-profit four-year colleges or two-year community colleges.[65] In contrast, all the studies conducted at selective four-year institutions involve only a few hundred students enrolled in one specific course. As a result, it is uncertain whether the consistent and substantial performance decrement observed at the nonselective institutions also speaks to online courses at four-year colleges. We do know, however, compared to the robust and sizable negative impacts of online learning identified across all studies conducted at nonselective institutions, the studies conducted at relatively selective four-year institutions yield mixed findings; even among studies that identified a negative association between online delivery and student-learning outcomes, the magnitude of the negative effects also tend to be smaller compared with those based on student course performance at two-year or for-profit colleges.

One concern that is often raised about comparisons between the online and face-to-face sections of a course without randomized controlled trials is that there might be systematic differences between instructors teaching the online and face-to-face sections. For example, if more experienced and high-quality instructors avoid teaching courses online, the negative effects identified by these quasi-experimental studies might be partly attributable to teacher productivity. Cassandra Hart and her coauthors directly assessed the extent of this problem by including a rich set of instructor characteristics into the fixed effects model.[66] Their analyses indicate that including observable instructor characteristics does little to alter the negative relationship between online course taking and student performance.[67]

Course Persistence. While course persistence—measured as making it through the entire semester of a class—is generally high at four-year colleges, course attrition is a serious issue at open-access institutions, particularly at two-year community colleges, where a large proportion of students withdraw before the end of a course at a high rate.[68] This particular retention problem in community colleges is even worse with online courses. Indeed, most community colleges acknowledge that online course dropout rates are higher, although it is not clear whether these dropout rates are due to the online course format or the characteristics of students who choose that course format based on simple raw comparisons.

Four quasi-experimental studies explicitly examine the causal impacts of online delivery format on course persistence at the four state community college systems mentioned above, and all identified sizable negative impacts of online course taking on course persistence. The research finds that students in online courses are between 3 percentage points and 15 percentage points more likely to withdraw from the course, compared to similar students taking face-to-face classes, depending on the state examined and the statistical method used.[69] Students who withdraw during the add and drop period were not included in the analysis. As a result, midsemester course withdrawal penalizes students not only academically—students do not obtain any credit from the course and a grade of "W" also appears on their permanent record—but also economically, since students who withdraw after the add and drop period pay full tuition for the course and do not receive any refund for the course.

Downstream Outcomes. A handful of studies examined whether online delivery format influences students' downstream outcomes, including course repetition, defined as whether a student retakes the same course; subject persistence, defined as future enrollment in other classes in the same subject area; follow-up course grades; and college persistence—as opposed to dropping out of college after that term.[70]

Using a multi-way fixed effects model, Hart and her coauthors find that online course taking is positively associated with course repetition and negatively associated with subject persistence at the California Community Colleges.[71] Based on transcript records from nearly 40,000 students at a large comprehensive university over a 10-year period, John Krieg and Steven Henson match each course with all subsequent courses for which it is a prerequisite and used an instrumental variable approach to control for

student sorting by course delivery format.[72] They find that students taking online prerequisite courses earn lower grades compared to students who took the prerequisite face-to-face.

The sizable negative impacts of online learning on subject persistence into the next course may be driven by two distinct sources: An uninspiring experience in a course may reduce the student's probability of either taking another course in a particular field or dropping out from college completely. While both are undesirable, the latter is particularly worrisome, since completing college—not just enrolling in it—is imperative with economic opportunity, especially among disadvantaged populations.

Regression analyses also find that taking online courses has a negative effect on college persistence. After controlling for multiple observable covariates, numerous studies find that students who take online courses are less likely to persist in college and attain a degree.[73] For example, based on data from Washington community colleges, Nick Huntington-Klein and his coauthors find a negative effect of 2 percentage points of taking an online course on the probability of earning a degree. Based on data from Virginia Community College System, Jaggars and Xu also find that students who took at least one online course in their first semester at college were 5 percentage points less likely to return for the subsequent semester and students who took a higher proportion of credits online were significantly less likely to attain any credential or transfer to a four-year college.[74]

Given the robust negative impacts of online learning on concurrent and subsequent course performance, the question then is whether the expansion of online learning may negatively influence a student's eventual labor market performance, such as average employment rate and income level. Unfortunately, experimental or quasi-experimental studies that can estimate the causal impact of exposure to online learning and labor market outcomes are still missing from the literature.

Heterogeneous Impact by Student and Course Characteristics. A handful of experimental and quasi-experimental studies compared the size of the online performance decrement by a number of student characteristics and found strikingly consistent patterns.[75] Specifically, the performance gaps between online and face-to-face learning seem to be particularly strong among underrepresented racial minority students, younger students, students with lower levels of academic preparation, students with part-time enrollment, and students who do not intend to transfer to a four-year institution. Since most of these subgroups already tend to have poorer academic outcomes overall, the achievement gaps that existed among these subgroups in face-to-face courses became even more pronounced in online courses. For example, in California Community Colleges, among online course takers, the average gap between white and African American students in course completion with a passing grade increased by 5 percentage points, from 13 percentage points to 18 percentage points, representing an almost 40 percent increase.[76]

In addition to online performance gaps by student subpopulations, a number of studies also found that the online performance gap varied across academic subject areas.[77] For example, based on data from the Washington community college system, Xu and Jaggars found that some of the variability in the online performance gap across academic subject areas seemed due to peer effects: Regardless of their own characteristics, students experienced stronger online performance decrement when they took courses in subject areas in which a larger proportion of peers are at risk for performing poorly online.[78] Perhaps in online courses with a high proportion of students who are struggling in the online environment, interpersonal interactions and group projects are more challenging than they would be with the same group of students in the face-to-face setting. Or perhaps instructors need to respond to highly demanding students, thereby decreasing the support to other students enrolled in the class.

After removing the effects of measurable individual and peer characteristics, the authors further identified two subject areas that demonstrated significant online performance gaps: the social sciences (e.g., anthropology, philosophy, and psychology) and the applied professions (business, law, and nursing).

These subject areas may require a high degree of hands-on demonstration and practice or require intensive interactions between faculty and students, which studies have suggested are more difficult to effectively implement in the online context.[79]

The results regarding the relative impact of online learning across subject areas are less consistent across studies, partly due to the different ways that researchers categorize courses. For example, using data from California Community Colleges, Hart and her coauthors divide all courses into five broad disciplines (social sciences, business and management, humanities, information technology, and math) and find that the online performance decrement is particularly pronounced in math and humanities classes.[80] Also using data from California Community Colleges, Johnson and Mejia provide a much more detailed subject categorization that includes 17 subject areas in total.[81] They find that students enrolled in public and protective services, engineering, and media and communications suffer from the largest online performance penalty. Despite the variations in effect sizes, the online performance gaps are observed consistently across student subgroups and by different subject areas.

What Explains Online Performance Decrement? Why do students struggle more in fully online courses? Practitioners and scholars increasingly acknowledge two crucial challenges to successful learning in an online environment: requirement of higher-level self-directed learning skills and greater difficulties in enabling effective human interactions. On top of these challenges, individual differences in technology literacy and unequal access to computers and internet may also hinder some students' online learning effectiveness. For example, in 2010, only 55 percent of African Americans and 57 percent of Hispanics had high-speed internet access at home, compared to 72 percent of Caucasian and 81 percent of Asians.[82]

Unlike face-to-face courses in which students attend course lectures at a fixed time, students working in a fully virtual environment are required to plan out when they will watch the course lectures and work on corresponding assignments. Even in high-quality online courses, students must learn course materials independently, manage time wisely, keep track of progress on course assignments, overcome technical difficulties and the feeling of isolation, and take the initiative to communicate with instructors and peers for questions and group assignments.[83] As such, online learning has been recognized as a highly "learner-autonomous" process that requires high levels of self-motivation, self-direction, and self-discipline to succeed.[84]

Granted, these skills are important to success in any learning environment, but they are more crucial to effective online education. A recent national report on online learning finds that more than two-thirds of academic leaders believe that "students need more discipline to succeed in an online course than in a face-to-face course."[85] Thus, while we would expect students with lower self-directed learning skills to fare more poorly in any course compared to their more-prepared peers, students with insufficient time management and self-directed learning skills may struggle particularly in an online learning environment.

Similarly, the lack of interpersonal connections in online courses imposes at least two additional challenges on students. First, due to the absence of physically present peers and their behaviors, social comparisons are limited. Extensive research from psychology indicates that making comparisons to peers is one of the fundamental ways through which students adjust and regulate their behaviors during the learning process.[86] In traditional classrooms, peer comparisons happen naturally with the physical presence and visibility of classmates. However, such affordance of social comparison is missing in most online courses. With sparse social and normative signals, online learners need to regulate their learning process independently, which can affect learning outcomes.

Second, computer-mediated communications are often criticized as inherently impersonal since nonverbal and relational cues—common in face-to-face communication—are generally missing. Despite the high potential of leveraging advanced technology to facilitate peer-peer and student-instructor interactions, most of the online courses, particularly those

offered at public open-access institutions, involve limited peer interactions and student-faculty interactions.[87] Low levels of social presence may lead to increased feelings of loneliness and isolation, which has negative effects on course persistence and learning performance.[88]

The evidence reviewed above indicates that most students tend to perform worse in online settings compared to face-to-face classes, but the performance decrement is particularly strong among certain subpopulations. Literature suggests that female students, white students, older students, and individuals with high prior educational attainment on average have a higher level of self-directed readiness than do male students, black students, and individuals with lower educational attainment.[89] As Michael Zastrocky, research director for academic strategies for the Gartner Group, stated, "There are some students who really do not do well outside a traditional classroom. There are some who do very well."[90]

Strategies to Improve Online Education

Based on the growing knowledge regarding the specific challenges of online learning and possible course design features that could better support students, several potential strategies have emerged to promote student learning in semester-long online courses. The teaching and learning literature has a much longer list of recommended instructional practices. However, research on improving online learning focuses on practices that are particularly relevant in virtual learning environments. These include strategic course offering, student counseling, interpersonal interaction, warning and monitoring, and the professional development of faculty.

Strategic Online Course Offering. Above all, given students' differential ability to successfully learn in an online environment, colleges may need to be more strategic in online course offerings. Considering that the convenience of online learning is most valuable to adults with multiple responsibilities and that older students typically have a higher level of self-directed learning skills, colleges may be able to expand online learning more drastically in courses or programs enrolling a large proportion of adult learners.[91] In contrast, in lower-division courses in which the majority of students are fresh high school graduates, colleges may need to provide more face-to-face interaction opportunities and support to the students. To combine the benefits from both delivery formats, one popular approach many colleges have adopted is replacing part of the traditional face-to-face time with online learning or a hybrid course. This strategy could partly address issues of resource constraints but will also largely overcome the challenges associated with learning in a fully virtual environment.

Student Counseling. When students struggle academically, they may benefit from institutional resources and supports, such as counseling and tutoring services.[92] However, since online students often choose the format to accommodate work and family responsibilities, they may face challenges accessing these supports if they are delivered exclusively on campus.[93] To better address the need of the growing online student population, especially those who enroll exclusively online, many colleges have started to provide comprehensive counseling and tutoring through the online format.

For example, the California Community College System established the Online Education Initiative (OEI) in 2014 to coordinate efforts in online education across campuses and has developed a series of services to support online learning.[94] These services include 24/7 online tutoring in high-volume subjects, an online counseling platform that connects students to counselors from their own campus, and a set of online readiness tutorials. These help students evaluate their readiness for online learning and provide students with information that may help them identify barriers to success in online learning and make plans to address those barriers. A recent report on the pilot testing of OEI supports suggests that students in OEI pilot courses outperformed their peers in non-pilot courses.[95] Although the evaluation was purely descriptive, it provides suggestive evidence that online learners may benefit from institutional

resources and services tailored for online learning specifically. Of course, providing additional resources alone will do little to improve online course performance if students do not use them. For resources to be most effective, colleges should ensure that services are clear, easy to use, and accessible to all students.

Promoting Interpersonal Interactions. Interpersonal interactions are key to successful learning in any environment. Researchers have proposed a number of ways to strengthen interpersonal communication in fully online courses, including assigning students to peer groups and incorporating small-group problem-solving activities to facilitate student-to-student interactions and providing synchronous online discussion sessions to improve instructor-student interaction by mimicking traditional classroom interactions.[96] Researchers also agree that creating opportunities for students to meet face-to-face with their instructors could substantially improve student-instructor relationships and student motivation, although this can be challenging for some students since they may have enrolled in online courses due to work schedules, family commitments, and other obligations.[97]

In current online courses, the most common form of face-to-face meetings takes place through office hours. However, studies suggest that many students are uncomfortable seeking assistance from instructors through individual meetings and that office hour visits are often brief and underused.[98] Based on these observations, some researchers suggest providing structured group face-to-face meeting sessions as a substitute for office hours for answering student questions.[99]

Warning and Monitoring. One great advantage of the virtual learning environment is its potential to identify at-risk students in a timely way, based on individual online learning behaviors that might otherwise go unnoticed in face-to-face lectures with large class sizes.[100] Based on student click stream and learning analytics data, online platforms can closely record when and how students access online materials and complete assignments. Colleges could incorporate early warning systems into online courses to identify and intervene in helping struggling students before they withdraw from the course. For example, Kimberly Arnold and Matthew Pistilli used local course data to build predictive models that correlate disparate types of measures (such as online learning patterns, student surveys, and online learning diagnostics) with student course performance to identify students who are at risk of negative academic outcomes.[101] Early identification of at-risk learning behaviors can enable course instructors or counselors to take more proactive steps to determine whether a student is experiencing problems and to discuss potential supports or solutions. Yet, the extent to which this strategy helps students succeed in online learning environments largely depends on the quality of follow-up supports that instructors and advisers provide.

Faculty Professional Development. Online courses require students to assume greater responsibility for their learning; thus, a successful online student may need high levels of self-regulation and self-discipline.[102] Given the crucial importance of self-directed learning skills and time management in online success, researchers argue that students, especially those from disadvantaged backgrounds, may need additional support or scaffolding to build those skills.[103] For example, some researchers argue that it would be beneficial to provide online learners with the opportunity to pre-commit to studying course materials at a specific day and time, which in turn may provide students with a self-control mechanism to avoid procrastination.[104]

It is not clear whether most online courses incorporate such skill development or scaffolds when they are offered. However, a recent qualitative study at two community colleges found that many faculty expected their online students to begin courses already equipped with self-directed learning skills and did not believe that faculty should be responsible for helping students develop those skills.[105] Colleges therefore may consider offering faculty professional development opportunities that inform online instructors of the challenges faced by students in online courses and ways to scaffold self-directed learning skills effectively.

Conclusion

Online education is a growing industry, and students are choosing online learning in ever-greater numbers. But is online education simply a substitute for in-person education, or can it instead expand access to students who would not otherwise have enrolled in an educational program? A review of the existing research on this topic provides suggestive evidence that online education can indeed expand access to college. The convenience of online learning is particularly valuable to adults with multiple responsibilities and highly scheduled lives; thus, online learning can be a boon to workforce development, helping adults return to school and complete additional education that could otherwise not fit into their daily routines. From an institutional perspective, online courses allow colleges to offer additional classes or programs, increasing student access to required courses. Given the value of these benefits, online courses are likely to become an increasingly important feature of postsecondary education.

Yet, the reasons students give for selecting online versus face-to-face delivery format seem to suggest that students suspected compromised learning experiences in a fully online course. If students indeed learn less well on average in online courses than in face-to-face courses, the current online expansion at higher education institutions may be at the cost of worse academic outcomes. A comprehensive review of the research literature reveals that, on average, students learn less well in online courses compared to similar students in face-to-face classes—particularly at two-year and nonselective institutions. Research finds that online learning can even exacerbate education inequality among different demographic groups, since online courses are substantially more prevalent at nonselective institutions that disproportionately enroll students from underrepresented groups and lower socioeconomic backgrounds.

While some students may benefit substantially from a well-organized online course with high levels of peer interactions and student-faculty interactions, maintaining these high-level interactions requires instructors to devote a substantial amount of time throughout the course. Students in high-interaction online courses report that instructors posted announcements on a regular basis to remind students about requirements and deadlines, responded to questions in a timely manner (typically, within 24 hours), provided multiple ways for students to communicate with the instructor, offered personal feedback on students' assignments, responded to individual student postings on the discussion forum, and were also more likely to ask for student feedback and were responsive to that input. All these activities require strong time commitments from the instructor. As a result, colleges that contemplate benchmarking online course quality will need to take into account the workload on instructors in delivering a high-touch online class and the cost of supporting instructors in using sophisticated technology infrastructure and instructional platforms.

About the Authors

Di Xu is an assistant professor of educational policy and social context at the University of California Irvine and a visiting fellow at AEI.

Ying Xu is a Ph.D. candidate at the School of Education at the University of California Irvine.

Acknowledgments

The authors are extremely grateful to Cody Christensen for his valuable comments and suggestions on this report. They also thank the AEI staff for their support during this research project. The opinions expressed are those of the authors and do not represent views of AEI.

Appendix A

Table A1. Experimental and Quasi-Experimental Evidence on the Impact of Online Learning on Student Outcomes

Study	Setting	Sample	Experiment Conditions	Description of Online Format	Methodology	Outcome Measures	Key Findings
	Experiment Studies						
US Department of Education (2009)	K–12 and Higher Education	45 Studies	Face-to-Face; Bended; Fully Online	Unspecified	Meta-Analysis	Unspecified	1. Positive Effects of Fully Online and Blended Format on Learning Outcomes
Figlio, Rush, and Yin (2013)	Research Universities	N = 312	Face-to-Face; Fully Online	Online Lecture with Access to Face-to-Face Meeting with Instructor and Graduate Student Teaching Assistants	Random Assignment	1. Course Grade	1. Negative Effects of Fully Online Format on Course Grade
Bowen et al. (2014)	Public Universities	N = 605	Face-to-Face; Blended	Interactive Online Learning System with Some Face-to-Face Instruction	Random Assignment	1. Course Grade 2. Comprehensive Assessment of Outcomes in Statistics (CAOS) 3. Course Completion with a Passing Grade	1. No Format Effects on Course Grade 2. No Format Effects on CAOS Posttest Scores 3. No Format Effects on Course Completion
Joyce et al. (2015)	Public Universities	N = 725	Face-to-Face; Blended	Online Learning System with One 75-Minute Face-to-Face Lecture Each Week	Random Assignment	1. Course Grade 2. Course Persistence 3. Class Attendance 4. Study Time	1. Negative Effects on Blended Format on Course Grade 2. No Format Effects on Course Persistence 3. No Format Effects on Class Attendance 4. No Format Effects on Study Time

(continued on the next page)

Study	Setting	Sample	Experiment Conditions	Description of Online Format	Methodology	Outcome Measures	Key Findings
Alpert, Couch, and Harmon (2016)	Public Universities	N = 323	Face-to-Face; Blended; Fully Online	Blended Format: Online Lectures with a Weekly Face-to-Face Discussion Session Fully Online: Online Lectures with Online Synchronous Discussion	Random Assignment	1. Course Grade	1. Negative Effects of Fully Online Format on Course Grade Compared to Face-to-Face Format; No Difference Between Blended vs. Face-to-Face Format
	Quasi-Experimental Studies						
Coate et al. (2004)	Public Universities	N = 126	Face-to-Face with Online Assignments; Fully Online	Online Lecture with Online Synchronous or Asynchronous Discussion	Two-Stage Least Squares Correction	1. Course Grade	1. Negative Effects of Fully Online Format on Course Grade
Xu and Jaggars (2011)	Community Colleges	N = 22,279	Face-to-Face; Fully Online	Unspecified	Propensity Score Matching	1. Course Grade 2. Course Persistence	1. Negative Effects of Fully Online Format on Course Grade 2. Negative Effects of Fully Online Format on Course Persistence
Xu and Jaggars (2013)	Community Colleges	N = 22,624	Face-to-Face (Less Than 50 Percent Online); Online (over 51 Percent Online)	Unspecified	Instrumental Variable	1. Course Grade 2. Course Persistence	1. Negative Effects of Online Format on Course Grade 2. Negative Effects of Online Format on Course Persistence
Johnson and Mejia (2014)	Community Colleges	N = 126,509	Face-to-Face; Online (over 80 Percent Online)	Online Lecture with Either Asynchronous or Synchronous Interaction	Instrumental Variable	1. Course Completion with Passing Grade	1. Negative Effects of Fully Online Format on Course Completion
Streich (2014)	Community Colleges	N = 112,566	Face-to-Face; Blended; Fully Online	Unspecified	Instrumental Variable	1. Course Grade 2. Course Persistence	1. Negative Effects of Fully Online and Blended Format on Course Grade 2. Negative Effects of Fully Online and Blended Format on Course Persistence

(continued on the next page)

Study	Setting	Sample	Experiment Conditions	Description of Online Format	Methodology	Outcome Measures	Key Findings
Xu and Jaggars (2014)	Community Colleges	N = 498,613	Face-to-Face; Fully Online	Unspecified	Individual Fixed Effects	1. Course Grade 2. Course Persistence	1. Negative Effects of Fully Online Format on Course Grade 2. Negative Effects on Fully Online Format on Course Persistence
Krieg and Henson (2016)	Regional Comprehensive Universities	N = 38,652	Face-to-Face; Online (over 75 Percent Online)	Unspecified	Fixed Effects with Instrumental Variable	1. Subsequent Course Grade	1. Negative Effects of Online Format on Subsequent Course Grade
Bettinger et al. (2017)	Private For-Profit Universities	N = 230,484	Face-to-Face; Fully Online	Online Lecture with Online Discussion and Group Projects	Instrumental Variable	1. Course Grade 2. Subsequent Course Grade 3. Subsequent Enrollment	1. Negative Effects of Fully Online Format on Course Grade 2. Negative Effects of Fully Online Format on Subsequent Course Grade 3. Negative Effects of Fully Online Format on Subsequent Enrollment
Hart, Friedmann, and Hill (2018)	Community Colleges	N = 440,405	Face-to-Face; Fully Online	Online Lecture with Either Asynchronous or Synchronous Interaction	Student and Course Fixed Effects	1. Course Grade 2. Course Persistence 3. Course Completion with a Passing Grade 4. Course Repetition 5. Subsequent Course Enrollment	1. Negative Effects of Fully Online Format on Course Grade 2. Negative Effects of Fully Online Format on Course Persistence 3. Negative Effects of Fully Online Format on Course Completion 4. Fully Online Format Increases Likelihood of Same-Course Repetition 5. Fully Online Format Decreases Likelihood of Subsequence Course Enrollment in the Same Subject

Source: Authors.

Notes

1. Higher Education Amendments of 1992, Pub. L. No. 102-325.
2. Higher Education Amendments of 1992, Pub. L. No. 102-325.
3. David J. Deming, Claudia Goldin, and Lawrence F. Katz, "The For-Profit Postsecondary School Sector: Nimble Critters or Agile Predators?," *Journal of Economic Perspectives* 26, no. 1 (2012): 139–64.
4. Deming, Goldin, and Katz, "The For-Profit Postsecondary School Sector."
5. Jeffrey J. Kuezi, Rebecca R. Skinner, and David P. Smole, "Distance Education and Title IV of the Higher Education Act: Policy, Practice, and Reauthorization," Domestic Social Policy Division, January 21, 2005, https://dmi.illinois.edu/nca/2134.pdf.
6. Basmat Parsad and Laurie Lewis, *Distance Education at Degree-Granting Postsecondary Institutions: 2006–07*, Institute of Education Sciences, National Center for Education Statistics, December 2008, https://nces.ed.gov/pubs2009/2009044.pdf.
7. David J. Deming et al., "The Value of Postsecondary Credentials in the Labor Market: An Experimental Study" (working paper, National Bureau of Economic Research, Cambridge, MA, 2014).
8. Lauren Sisneros, "Distance Education Students and Their Access to State Financial Aid Programs," Ed Note, April 29, 2016, https://ecs.org/distance-education-students-and-their-access-to-state-financial-aid-programs/.
9. Budget Act of 2018, S. 840, California Legislature (2018).
10. California Community College Chancellor's Office, *2017 Distance Education Report*, 2017, http://californiacommunitycolleges.cccco.edu/Portals/0/Reports/2017-DE-Report-Final-ADA.pdf; Thomas Daymont, Gary Blau, and Deborah Campbell, "Deciding Between Traditional and Online Formats: Exploring the Role of Learning Advantages, Flexibility, and Compensatory Adaptation," *Journal of Behavioral and Applied Management* 12, no. 2 (2011): 156–75; Rudy Hirschheim, "The Internet-Based Education Bandwagon: Look Before You Leap," *Communications of the ACM* 48, no. 7 (2005): 97–101; Shanna Smith Jaggars, "Choosing Between Online and Face-to-Face Courses: Community College Student Voices," *American Journal of Distance Education* 28, no. 1 (2014): 27–38; Carol B. Aslanian and David L. Clinefelter, *Online College Students 2012: Comprehensive Data on Demands and Preferences*, Learning House, 2012; and Maureen Hannay and Tracy Newvine, "Perceptions of Distance Learning: A Comparison of Online and Traditional Learning," *Journal of Online Learning and Teaching* 2, no. 1 (2006): 1–11.
11. California Community College Chancellor's Office, *2017 Distance Education Report*.
12. Since the survey did not ask students the motivation for choosing a particular delivery format, some of the top-rated reasons are general motivation for course enrollment. More specifically, the top seven reasons students took a distance education course were (1) the course was convenient with their work schedule, (2) the course met requirements for the associate degree, (3) the course met requirements for transfer to a four-year college or university, (4) the course would improve their job skill, (5) they had a personal interest in the subject, (6) they had success with a previous distance education course, and (7) they enjoy learning on a computer.
13. Jaggars, "Choosing Between Online and Face-to-Face Courses."
14. California Community College Chancellor's Office, *2017 Distance Education Report*.
15. Jaggars, "Choosing Between Online and Face-to-Face Courses."
16. US Government Accountability Office, *Growth in Distance Education Programs and Implications for Federal Education Policy*, 2002, https://gao.gov/assets/110/109607.pdf.
17. Hans Johnson and Marisol Cuellar Mejia, "Online Learning and Student Outcomes in California's Community Colleges," Public Policy Institute of California, 2014, http://ppic.org/content/pubs/report/R_514HJR.pdf.
18. Mark Baldassare et al., "California's Digital Divide," Public Policy Institute of California, 2013, https://www.ppic.org/publication/californias-digital-divide/.
19. Joshua Goodman, Julia Melkers, and Amanda Pallais, "Can Online Delivery Increase Access to Education?," *Journal of Labor Economics* 37, no. 1 (2019): 1–34.
20. Specifically, the researchers exploited an arbitrary undergraduate GPA cutoff of 3.26 for admission into the online program that

is unknown to applicants and employed a regression discontinuity design to examine the extent to which the quasi-random variation in admission among applicants just above and below that threshold lead to differential higher education enrollment outcomes based on the National Student Clearinghouse data.

21. Hybrid courses that include traditional face-to-face time do not count as online course per IPEDS's definition. Therefore, IPEDS uses a relatively more strict definition of online course compared with other national surveys. For example, Babson Survey Research Group and the Instructional Technology Council define online courses as those in which at least 80 percent of instruction is delivered online. Abby Miller, Amela M. Topper, and Samantha Richardson, "Suggestions for Improving IPEDS Distance Education Data Collection," National Postsecondary Education Cooperative, 2017, https://nces.ed.gov/ipeds/pdf/NPEC/data/NPEC_Paper_IPEDS_Distance_Education_2017.pdf. Despite the disparity in definition, however, the trends and descriptive statistics regarding the growth of online courses are fairly consistent across these reports. This is probably due to fully online courses dominating online education at the higher education sector and a relatively small proportion of courses being provided through a hybrid format. See Francie E. Streich, "Online Education in Community Colleges: Access, School Success, and Labor-Market Outcomes" (doctoral dissertation, University of Michigan, Ann Arbor, MI, 2014); and Di Xu and Shana Smith Jaggars, "The Effectiveness of Distance Education Across Virginia's Community Colleges: Evidence from Introductory College-Level Math and English Courses," *Educational Evaluation and Policy Analysis* 33, no. 3 (2011): 360–77.

22. Alisa F. Cunningham, *Changes in Patterns of Prices and Financial Aid*, US Department of Education, National Center for Education Statistics, 2005.

23. The 15 subcategories are (1) two year, higher part time; (2) two year, mixed part and full time; (3) two year, medium full time; (4) two year, higher full time; (5) four year, higher part time; (6) four year, medium full time, inclusive, lower transfer in; (7) four year, medium full time, inclusive, higher transfer in; (8) four year, medium full time, selective, lower transfer in; (9) four year, medium full time, selective, higher transfer in; (10) four year, full time, inclusive, lower transfer in; (11) four year, full time, inclusive, higher transfer in; (12) four year, full time, selective, lower transfer in; (13) four year, full time, selective, higher transfer in; (14) four year, full time, more selective, lower transfer in; and (15) four year, full time, more selective, higher transfer in.

24. The five largest programs are (1) business, management, marketing, and related support services; (2) health professions and related programs; (3) education; (4) computer and information sciences and support services; and (5) homeland security, law enforcement, firefighting, and related protective service. We combined "most selective" with "moderately selective" into one category (as opposed to "nonselective") in Figure 4.

25. Most of the California Community College students who take online courses also take face-to-face classes simultaneously. For more information, see Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges."

26. Carol A. Twigg, "Improving Learning and Reducing Costs: New Models for Online Learning," *Educause Review* 38, no. 5 (2003): 28–38; and Gregory L. Waddoups, Gary L. Hatch, and Samantha Butterworth, "Case 5: Blended Teaching and Learning in a First-Year Composition Course," *Quarterly Review of Distance Education* 4, no. 3 (2003): 271–78.

27. Synchronous online education refers to two-way video conferencing or internet chat, while asynchronous online education includes delivering course materials through prerecorded video lectures. For more information, see Edward P. Lazear, "Educational Production," *Quarterly Journal of Economics* 16, no. 3 (2001): 777–803.

28. Eric Bettinger et al., "Virtual Classrooms: How Online College Courses Affect Student Success," *American Economic Review* 107, no. 9 (2017): 2855–75.

29. David J. Deming et al., "Can Online Learning Bend the Higher Education Cost Curve?," *American Economic Review: Papers & Proceedings* 105, no. 5 (2015): 496–501.

30. Bettinger et al., "Virtual Classrooms."

31. Greville Rumble, "Modeling the Costs and Economics of Distance Education," in *Handbook of Distance Education*, ed. Michael Grahame Moore and William G. Anderson (Mahwah, NJ: Lawrence Erlbaum Associates, 2003).

32. Russell Poulin and Terri Taylor Straut, *Distance Education Price and Cost Report*, WICHE Cooperative for Educational Technologies, February 2017, https://wcet.wiche.edu/sites/default/files/Price-and-Cost-Report-2017_0.pdf.

33. Stephan Schiffman, "Business Issues in Online Education," in *Elements of Quality Education: Engaging Communities*, ed. John

Bourne and Janet C. Moore (Needham, MA: Sloan Consortium, 2005).

34. The differences in costs to deliver a distance course and an on-campus course does not reach statistical significance though. For more information, see North Carolina General Assembly, *University Distance Courses Cost More to Develop Overall but the Same to Deliver as On-Campus Courses*, April 28, 2010, https://ncleg.net/PED/Reports/documents/DE/DE_Report.pdf.

35. A total of 1,979 new courses were developed since 2004 at the University of North Carolina. The evaluation team further limited the sample to 801 courses developed between 2008–09 and 2009–10 to determine the most recent costs for course development. Finally, the evaluation team stratified the sample by funding category and type (distance vs. on campus) and randomly selected courses for each category and type. The report includes a more detailed explanation of the sampling methodology in Appendix A. See North Carolina General Assembly, *University Distance Courses Cost More to Develop Overall but the Same to Deliver as On-Campus Courses.*

36. The University of North Carolina (UNC) defines "distance education" as "a coherent course of study in which the student is at a distance from the campus and the instructor may or may not be in the same place as the student." Therefore, UNC definition of distance education includes a broader range of courses than the typical definition of online course in which course content is delivered fully online. See North Carolina General Assembly, *University Distance Courses Cost More to Develop Overall but the Same to Deliver as On-Campus Courses.*

37. The report indicates that UNC faculty use a variety of technology platforms, in which the instruction may be delivered either synchronously (such as through two-way video conferencing or internet chat) or asynchronously (such as providing course materials via video). Faculty-in-focus group interviews generally agreed that instructors can "get to know their distance students better than their on-campus students because mandatory posting requirements for online courses increase student-instructor interaction." See North Carolina General Assembly, *University Distance Courses Cost More to Develop Overall but the Same to Deliver as On-Campus Courses,* 6.

38. North Carolina General Assembly, *University Distance Courses Cost More to Develop Overall but the Same to Deliver as On-Campus Courses*.

39. Lawrence S. Bacow et al., *Barriers to Adoption of Online Learning Systems in US Higher Education*, Ithaka S+R, 2012, https://sr.ithaka.org/publications/barriers-to-adoption-of-online-learning-systems-in-u-s-higher-education/.

40. Steven R. Aragon and Elaine S. Johnson, "Factors Influencing Completion and Noncompletion of Community College Online Course," *American Journal of Distance Education* 22, no. 3 (2008): 146–58.

41. Gary A. Berg, "Distance Learning Best Practices Debate," *WebNet Journal* 3, no. 2 (2001): 5–17; Russell R. Paden, "A Comparison of Student Achievement and Retention in an Introductory Math Course Delivered in Online, Face-to-Face, and Blended Modalities" (doctoral dissertation, ProQuest Dissertations Publishing, Minneapolis, MN, 2006); and Gary Ury, "A Comparison of Undergraduate Student Performance in Online and Traditional Courses," *Journal of Computing Sciences in Colleges* 19, no. 4 (2004): 99–107.

42. US Department of Education, *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*, 2009, https://ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf.

43. The meta-analysis defines online learning as "learning that takes place partially or entirely over the Internet," which excludes purely print-based correspondence education, videoconferencing, or broadcast television that do not have significant internet-based instruction. The specific practices of online learning vary substantially across studies though, such as the inclusion of computer-mediated asynchronous communication with instructor or peers, video or audio to deliver course content, opportunity for face-to-face time with instructor or peers, etc. The duration of the instruction examined in these studies also varies substantially, ranging from as short as 15 minutes to a semester-long college course.

44. Shanna Smith Jaggars and Thomas Bailey, *Effectiveness of Fully Online Courses for College Students: Response to a Department of Education Meta-Analysis,* Columbia University, 2010, https://files.eric.ed.gov/fulltext/ED512274.pdf.

45. Elvira R. Caldwell, "A Comparative Study of Three Instructional Modalities in a Computer Programming Course: Traditional Instruction, Web-Based Instruction, and Online Instruction" (doctoral dissertation, ProQuest Dissertations Publishing, 2006); Nadire Cavus, Huseyin Uzunboylu, and Dogan Ibrahim, "Assessing the Success Rate of Students Using a Learning Management System Together with a Collaborative Tool in Web-Based Teaching of Programming Languages," *Journal of Educational Computing Research* 36, no. 3 (2007): 301–21; John D. Davis et al., "Developing Online Courses: A Comparison of Web-Based Instruction with Traditional

Instruction" (presentation, Society for Information Technology and Teacher Education International Conference, Chesapeake, VA, 1999); Cynthia L. Peterson and Nathan Bond, "Online Compared to Face-to-Face Teacher Preparation for Learning Standards-Based Planning Skills," *Journal of Research on Technology in Education* 36, no. 4 (2004): 345–60; Robert LaRose, Jennifer Gregg, and Matt Eastin, "Audiographic Telecourses for the Web: An Experiment," *Journal of Computer-Mediated Communication* 4, no. 2 (1998); Gale Mentzer, John Cryan, and Berhane Teclehaimanot, "Two Peas in a Pod? A Comparison of Face-to-Face and Web Based Classrooms," *Journal of Technology and Teacher Education* 15, no. 2 (2007): 233–46; and Regina Schoenfeld-Tacher, Sherry McConnell, and Michele Graham, "Do No Harm—A Comparison of the Effects of On-Line vs. Traditional Delivery Media on a Science Course," *Journal of Science Education and Technology* 10, no. 3 (2001): 257–65.

46. The meta-analysis reports the effect sizes for six of these studies as positive for online learning, while one was reported as negative. See US Department of Education, *Evaluation of Evidence-Based Practices in Online Learning*, Exhibit 4a. However, the reexamination of the studies suggests that three should be classified as negative, one as mixed, two as positive, and one as unclassifiable based on information provided in the published article. See Jaggars and Bailey, *Effectiveness of Fully Online Courses for College Students*; Davis et al., "Developing Online Courses"; Peterson and Bond, "Online Compared to Face-to-Face Teacher Preparation for Learning Standards-Based Planning Skills"; Mentzer, Cryan, and Teclehaimanot, "Two Peas in a Pod?"; Caldwell, "A Comparative Study of Three Instructional Modalities in a Computer Programming Course"; Cavus, Uzunboylu, and Ibrahim, "Assessing the Success Rate of Students Using a Learning Management System Together with a Collaborative Tool in Web-Based Teaching of Programming Languages"; Schoenfeld-Tacher, McConnell, and Graham, "Do No Harm"; and LaRose, Gregg, and Eastin, "Audiographic Telecourses for the Web."

47. Cynthia S. Bambara et al., "Delicate Engagement: The Lived Experience of Community College Students Enrolled in High-Risk Online Courses," *Community College Review* 36, no. 3 (2009): 219–38; Madeline Ehrman, "Psychology: Psychological Factors and Distance Education," *American Journal of Distance Education* 4, no. 1 (1990): 10–24; Eli Eisenberg and Tony Dowsett, "Student Drop-Out from a Distance Education Project Course: A New Method of Analysis," *Distance Education* 11, no. 2 (1990): 231–53; James R. Aman and Sheida Shirvani, "Dick and Jane Online: Considering Online Course," *Journal of Computing Sciences in Colleges* 21, no. 3 (2006): 131–38; and Bambara et al., "Delicate Engagement."

48. Peterson and Bond, "Online Compared to Face-to-Face Teacher Preparation for Learning Standards-Based Planning Skills."

49. Thomas Bailey, Dong Wook Jeong, and Sung-Woo Cho, "Referral, Enrollment, and Completion in Developmental Education Sequences in Community Colleges," *Economics of Education Review* 29 (2010): 255–70.

50. M. M. Bendickson, "The Impact of Technology on Community College Students' Success in Remedial/Developmental Mathematics" (doctoral dissertation, Scholar Commons, 2004); Sarah Carr, "As Distance Education Comes of Age, the Challenge Is Keeping the Students," *Chronicle of Higher Education*, February 11, 2000; Alfred P. Rovai and Mervyn J. Wighting, "Feelings of Alienation and Community Among Higher Education Students in a Virtual Classroom," *Internet and Higher Education* 8, no. 2 (2005): 97–110; and Xu and Jaggars, "The Effectiveness of Distance Education Across Virginia's Community Colleges."

51. Rebecca Cox, "Virtual Access," in *Defending the Community College Equity Agenda*, eds. Thomas Bailey and Vanessa Smith Morest (Baltimore, MD: Johns Hopkins, 2006); and Shanna Smith Jaggars and Di Xu, "How Do Online Course Design Features Influence Student Performance?," *Computers & Education* 95 (2016): 270–84.

52. A much broader literature used randomized assignments to compare between online and face-to-face training sessions across a variety of settings. For example, see Giuseppe Bello et al., "Online vs Live Methods for Teaching Difficult Airway Management to Anesthesiology Residents," *Intensive Care Medicine* 31, no. 4 (April 2005): 547–52; LaRose, Gregg, and Eastin, "Audiographic Telecourses for the Web"; Katrina A. Meyer, "Face-to-Face Versus Threaded Discussions: The Role of Time and Higher-Order Thinking," *Journal of Asynchronous Learning Networks* 7, no. 3 (September 2003): 55–65; Rosalie Ocker and Gayle Yaverbaum, "Asynchronous Computer-Mediated Communication Versus Face-to-Face Collaboration: Results on Student Learning, Quality and Satisfaction," *Group Decision and Negotiation* 8, no. 5 (September 1, 1999): 427–40; Yara Padalino and Heloisa Helena Ciqueto Peres, "E-Learning: A Comparative Study for Knowledge Apprehension Among Nurses," *Revista Latino-Americana de Enfermagem* 15, no. 3 (2007): 397–403; and Peterson and Bond, "Online Compared to Face-to-Face Teacher Preparation for Learning Standards-Based Planning Skills." The majority of these studies suggest that student course grades do not differ between the online and face-to-face context. However, results from these studies cannot address the challenging issues inherent in maintaining student attention and motivation over a course of several

months, and we therefore focus on studies on semester-length college courses only. For more information, see Cassandra M. Hart, Elizabeth Friedmann, and Michael Hill, "Online Course-Taking and Student Outcomes in California Community Colleges," *Education Finance and Policy* 13, no. 1 (2018): 42–71; and William G. Bowen et al., "Interactive Learning Online at Public Universities: Evidence from a Six-Campus Randomized Trial," *Journal of Policy Analysis and Management* 33, no. 1 (2014): 94–111.

53. David Figlio, Mark Rush, and Lu Yin, "Is It Live or Is It Internet? Experimental Estimates of the Effects of Online Instruction on Student Learning," *Journal of Labor Economics* 31, no. 4 (2013): 763–84; Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges"; and Bowen et al., "Interactive Learning Online at Public Universities."

54. William T. Alpert, Kenneth A. Couch, and Oskar R. Harmon, "A Randomized Assessment of Online Learning," *American Economic Review* 106, no. 5 (2016): 378–82; Bowen et al., "Interactive Learning Online at Public Universities"; Figlio, Rush, and Yin, "Is It Live or Is It Internet?"; and Ted Joyce et al., "Does Classroom Time Matter?," *Economics of Education Review* 46 (2015): 64–77.

55. Figlio, Rush, and Yin, "Is It Live or Is It Internet?"

56. Joyce et al., "Does Classroom Time Matter?"

57. Bowen et al., "Interactive Learning Online at Public Universities."

58. Alpert, Couch, and Harmon, "A Randomized Assessment of Online Learning."

59. Bowen et al., "Interactive Learning Online at Public Universities."

60. Bowen et al., "Interactive Learning Online at Public Universities."

61. Bettinger et al., "Virtual Classrooms"; and Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges."

62. Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges"; Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges"; Streich, "Online Education in Community Colleges"; Xu and Jaggars, "The Effectiveness of Distance Education Across Virginia's Community Colleges"; Di Xu and Shanna Smith Jaggars, "The Impact of Online Learning on Students' Course Outcomes: Evidence from a Large Community and Technical College System," *Economics of Education Review* 37 (2013): 46–57; and Di Xu and Shanna Smith Jaggars, "Performance Gaps Between Online and Face-to-Face Courses: Differences Across Types of Students and Academic Subject Areas," *Journal of Higher Education* 85, no. 5 (2014): 633–59.

63. Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges"; Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges"; Streich, "Online Education in Community Colleges"; Xu and Jaggars, "The Effectiveness of Distance Education Across Virginia's Community Colleges"; Xu and Jaggars, "The Impact of Online Learning on Students' Course Outcomes"; and Xu and Jaggars, "Performance Gaps Between Online and Face-to-Face Courses."

64. Without randomly assigning students into online and face-to-face delivery formats, the key challenge to identifying the causal impacts of online learning on student outcomes is that online takers and face-to-face takers may differ from each other in a variety of ways that could also be related to one's potential learning outcomes. In addition, online enrollment may be concentrated in either more or less challenging courses. Researchers have used two primary identification strategies to address possible between-course and within-course selection: (1) an instrumental variable approach and (2) a multiple fixed effects model. For the first identification strategy, Xu and Jaggars used distance from home to campus as an instrument for a student's probability of taking a specific course through the online delivery format, based on the assumption that students who live relatively further away from college are more likely to take advantage of the flexibility of online learning. Streich instead instrumented for whether a student enrolled in the online or hybrid format of a course with the share of seats offered online or hybrid for that course in a specific term. Bettinger et al. combined the two instruments together, in which their instrument is the interaction between term-by-term changes in in-person seats at a student's local campus and the distance each student must travel to attend an in-person course at that local campus, thus substantially weakening identifying assumptions underlying either of the two instruments on its own. The other identification strategy used in the current study is a multi-way fixed effects model that controls for any observed or unobserved selection at both the student and course level simultaneously. Xu and Jaggars, "The Impact of Online Learning on Students' Course Outcomes"; Streich, "Online Education in Community Colleges"; Bettinger et al., "Virtual Classrooms"; Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in

California Community Colleges"; and Xu and Jaggars, "Performance Gaps Between Online and Face-to-Face Courses."

65. Bettinger, "The Effects of Class Size in Online College Courses"; and Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges."

66. Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges."

67. Specifically, four types of instructor characteristics are included in the model: (1) the contract status of the instructor (temporary adjuncts, tenure track, nontenured, or tenured), (2) years of experience, (3) whether the instructor is teaching any courses as an overload, and (4) whether the course is team taught.

68. Course persistence is defined as persisting to the end of the course or completing a course regardless of whether the students have received a passing grade. In other words, students are considered to have persisted if they receive any letter grade (A–F) or a pass or no pass designation from a course. Almost all the studies conducted at four-year institutions did not study course persistence as an outcome, probably because course persistence at four-year institutions, particularly relatively selective ones, is fairly high regardless of which delivery format is used. For more information, see Bailey, Jeong, and Cho, "Referral, Enrollment, and Completion in Developmental Education Sequences in Community Colleges."

69. Xu and Jaggars, "Performance Gaps Between Online and Face-to-Face Courses"; and Di Xu and Shanna Smith Jaggars, "Online and Hybrid Course Enrollment and Performance in Washington State Community and Technical Colleges" (working paper, Columbia University, 2011).

70. College persistence does not necessarily imply that students matriculate continuously. For example, a student could skip a term and then return to college and still be counted as persisting. For more information, see Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges"; John M. Krieg and Steven E. Henson "The Educational Impact of Online Learning: How Do University Students Perform in Subsequent Courses?," *Education Finance and Policy* 11, no. 4 (2016): 426–48; Nick Huntington-Klein, James Cowan, and Dan Goldhaber, "Selection into Online Community College Courses and Their Effects on Persistence," *Research in Higher Education* 58, no. 3 (2017): 244–69; Shanna Smith Jaggars and Di Xu, *Online Learning in the Virginia Community College System,* Columbia University, 2010, https://academiccommons.columbia.edu/doi/10.7916/D80V89VM; and Peter Shea and Temi Bidjerano, "Online Course Enrollment in Community College and Degree Completion: The Tipping Point," *International Review of Research in Open and Distributed Learning* 19, no. 2 (2018): 283–93.

71. Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges."

72. Krieg and Henson "The Educational Impact of Online Learning."

73. Huntington-Klein, Cowan, and Goldhaber, "Selection into Online Community College Courses and Their Effects on Persistence," *Research in Higher Education* 58, no. 3 (2017): 244–69; Jaggars and Xu, *Online Learning in the Virginia Community College System*; and Shea and Bidjerano, "Online Course Enrollment in Community College and Degree Completion."

74. Jaggars and Xu, *Online Learning in the Virginia Community College System*.

75. Figlio, Rush, and Yin, "Is It Live or Is It Internet?"; Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges"; Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges"; Krieg and Henson, "The Educational Impact of Online Learning"; and Xu and Jaggars, "Performance Gaps Between Online and Face-to-Face Courses."

76. Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges."

77. Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges"; Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges"; and Xu and Jaggars, "Performance Gaps Between Online and Face-to-Face Courses."

78. The authors created an indicator, online at risk, defined as students who are academically less prepared (with a first-term face-to-face GPA below 3.0) and who also have at least one of the other demographic characteristics indicating greater risk of poor online performance (i.e., being male, younger, or black). For more information, see Xu and Jaggars, "Performance Gaps Between Online and Face-to-Face Courses."

79. Bambara et al., "Delicate Engagement."

80. Hart, Friedmann, and Hill, "Online Course-Taking and Student Outcomes in California Community Colleges."

81. Johnson and Mejia, "Online Learning and Student Outcomes in California's Community Colleges."

82. Lee Rainie, *Internet, Broadband, and Cell Phone Statistics*, Pew Research Center, 2010, http://www.pewinternet.org/2010/01/05/internet-broadband-and-cell-phone-statistics/.

83. Ehrman, "Psychology"; Eisenberg and Dowsett, "Student Drop-Out from a Distance Education Project Course"; Bambara et al., "Delicate Engagement"; and Ido Roll and Philip H. Winne, "Understanding, Evaluating, and Supporting Self-Regulated Learning Using Learning Analytics," *Journal of Learning Analytics* 2, no. 1 (2015): 7–12.

84. Joseph Rene Corbeil, "Online Technologies Self-Efficacy, Self-Directed Learning Readiness, and Locus of Control of Learners in a Graduate-Level Web-Based Distance Education Program" (doctoral dissertation, ProQuest Dissertations Publishing, Houston, TX, 2003); and Lucy M. Guglielmino and Paul J. Guglielmino, "Identifying Learners Who Are Ready for E-Learning and Supporting Their Success," in *Preparing Learners for E-Learning*, ed. G. Piskurich (San Francisco, CA: Jossey-Bass, 2003).

85. I. Elaine Allen and Jeff Seaman, *Grade Level: Tracking Online Education in the United States*, Babson Survey Research Group, 2015, http://onlinelearningsurvey.com/reports/gradelevel.pdf.

86. Hart Blanton et al., "When Better-Than-Others Compare Upward: Choice of Comparison and Comparative Evaluation as Independent Predictors of Academic Performance," *Journal of Personality and Social Psychology* 76, no. 3 (1999): 420–30; and Pascal Huguet et al., "Social Comparison Choices in the Classroom: Further Evidence for Students' Upward Comparison Tendency and Its Beneficial Impact on Performance," *European Journal of Social Psychology* 31, no. 5 (2001): 557–78.

87. Cox, "Virtual Access"; and Jaggars and Xu, "How Do Online Course Design Features Influence Student Performance?"

88. A. Grubb and M. Hines, "Tearing Down Barriers and Building Communities," in *Issues in Web-Based Pedagogy: A Critical Primer*, ed. R. A. Cole (Westport, CT: Greenwood Press, 2000); P. Robinson, "Where Is Every-Body?," in *Issues in Web-Based Pedagogy: A Critical Primer*, ed. R. A. Cole (Westport, CT: Greenwood Press, 2000); and Chun-Wang Wei, Nian-Shing Chen, and Kinshuk, "A Model for Social Presence in Online Classrooms," *Educational Technology Research and Development* 60, no. 3 (2012): 529–45.

89. Sherria L. Hoskins and Johanna C. Van Hooff, "Motivation and Ability: Which Students Use Online Learning and What Influence Does It Have on Their Achievement?," *British Journal of Educational Technology* 36, no. 2 (2005): 177–92; Jusung Jun, "Understanding Dropout of Adult Learners in E-Learning" (doctoral dissertation, University of Georgia, Athens, GA, 2005); H. E. Muse, "A Persistence Issue: Predicting the At-Risk Student in Community College Web-Based Classes" (doctoral dissertation, Nova Southeastern University, Fort Lauderdale, FL, 2003); Cynthia Stewart, Christine Bachman, and Ruth Johnson, "Student Characteristics and Motivation Orientation of Online and Traditional Degree Program Student," *Journal of Online Learning and Teaching* 6, no. 2 (2010): 367–79; Marilyn K. Wiggam, "Predicting Adult Learner Academic Persistence: Strength of Relationship Between Age, Gender, Ethnicity, Financial Aid, Transfer Credits, and Delivery Methods" (doctoral dissertation, Ohio State University, Columbus, OH, 2004); and Thomas G. Reio and W. Davis, "Age and Gender Differences in Self-Directed Learning Readiness: A Developmental Perspective," *International Journal of Self-Directed Learning* 2, no. 1 (2005): 40–49.

90. Paula B. Doherty, *Success Factors Among Community College Students in an Online Learning Environment* (dissertation, Nova Southeastern University, Fort Lauderdale, FL, April 15, 2000).

91. Jaggars, "Choosing Between Online and Face-to-Face Courses."

92. Mark Schneider and Kim Clark, *Completion Reforms That Work*, American Enterprise Institute, 2018, http://aei.org/spotlight/completion-reforms-that-work/; and Mesmin Destin, *Leveraging Psychological Factors*, American Enterprise Institute, 2018, http://aei.org/spotlight/leveraging-psychological-factors/.

93. Jaggars, "Choosing Between Online and Face-to-Face Courses."

94. Online Education Initiative, "College Participation," 2018, http://ccconlineed.org/about-the-oei/college-participation/.

95. Alyssa Nguyen, "The Online Education Initiative: Access and Quality of Online Education in California's Community Colleges 2015–2016," RP Group, 2017, http://ccconlineed.org/wp-content/uploads/2015/09/2015-16OEIDisseminationBriefFINAL.pdf.

96. Andrew Walker and Heather Leary, "A Problem Based Learning Meta Analysis: Differences Across Problem Types, Implementation Types, Disciplines, and Assessment Levels," *Interdisciplinary Journal of Problem-Based Learning* 3, no. 1 (2009): 12–43.

97. Linda Acitelli, Beverly Black, and Elizabeth Axelson, "Learning and Teaching During Office Hours," Center for Research on Learning and Teaching, 2003, http://crlt.umich.edu/gsis/p4_5.

98. Moon-Heum Cho and B. Joon Kim, "Students' Self-Regulation for Interaction with Others in Online Learning Environments," *Internet and Higher Education* 17 (2013): 69–75; Stefan Hrastinski, "Introducing an Informal Synchronous Medium in a Distance Learning Course: How Is Participation Affected?," *Internet and Higher Education* 9, no. 2 (2006): 117–31; Marjorie A. Jaasma and Randall J. Koper, "The Relationship of Student-Faculty Out-of-Class Communication to Instructor Immediacy and Trust and to Student Motivation," *Communication Education* 48, no. 1 (1999): 41–47; and Marjorie K. Nadler and Lawrence B. Nadler, "Out of Class Communication Between Faculty and Students: A Faculty Perspective," *Communication Studies* 51, no. 2 (2000): 176–88.

99. Nadler and Nadler, "Out of Class Communication Between Faculty and Students."

100. Cristóbal Romero and Sebastián Ventura, "Educational Data Mining: A Review of the State of the Art," *IEEE Transactions on Systems, Man, and Cybernetics, Part C* (*Applications and Reviews*) 40, no. 6 (2010): 601–18.

101. Kimberly E. Arnold and Matthew D. Pistilli, "Course Signals at Purdue: Using Learning Analytics to Increase Student Success," in *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (New York: ACM, 2012).

102. Roger Azevedo, Jennifer G. Cromley, and Diane Seibert, "Does Adaptive Scaffolding Facilitate Students' Ability to Regulate Their Learning with Hypermedia?," *Contemporary Educational Psychology* 29, no. 3 (2004): 344–70; and Corbeil, "Online Technologies Self-Efficacy, Self-Directed Learning Readiness, and Locus of Control of Learners in a Graduate-Level Web-Based Distance Education Program."

103. Roger Azevedo, "Using Hypermedia as a Metacognitive Tool for Enhancing Student Learning? The Role of Self-Regulated Learning," *Educational Psychologist* 40, no. 4 (2005): 199–209; and Chris Quintana, Melian Zhang, and Joseph Krajcik, "A Framework for Supporting Metacognitive Aspects of Online Inquiry Through Software-Based Scaffolding," *Educational Psychologist* 40, no. 4 (2005): 235–44.

104. Xavier Giné, Dean Karlan, and Jonathan Zinman, "Put Your Money Where Your Butt Is: A Commitment Contract for Smoking Cessation," *American Economic Journal: Applied Economics* 2, no. 4 (2010): 213–35; and Supreet Kaur, Michael Kremer, and Sendhil Mullainathan, "Self-Control at Work," *Journal of Political Economy* 123, no. 6 (2015): 1227–77.

105. Rachel Hare Bork and Zawadi Rucks-Ahidiana, "Role Ambiguity in Online Courses: An Analysis of Student and Instructor Expectations" (working paper, Columbia University, New York, NY, 2013).