The Ambivalence About Distance Learning in Higher Education

7

Challenges, Opportunities, and Policy Implications

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Contents

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Abstract

In the past two decades, one of the most important trends 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. 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 chapter provides a comprehensive review of existing research on online learning's impact on access, cost, and student performance in higher education. Our review suggests that online education has the potential to expand access to college, especially among adult learners with multiple responsibilities. Yet, the online delivery format imposes additional challenges to effective instruction and learning. Indeed, existing studies on college courses typically find negative effects of online delivery on course outcomes and the online performance decrement is particularly large among academically less-prepared students. As a result, online courses without strong support to students may exacerbate educational inequities. We discuss a handful of practices that could better support students in online courses, including strategic course offering, student counseling, interpersonal interaction, warning and monitoring, and the professional development of faculty. Yet, college administrative data suggests that high-quality online courses with high degrees of instructor interaction and student support cost more to develop and administer than do face-to-face courses.

Keywords

Online learning · Access to higher education · Degree-granting institutions · Cost · Quality · "50 percent rule" · Funding for online education · Reasons for taking online courses · Characteristics of online course takers · Supply of online courses and programs · Demand for online coursework · Exclusive online degree programs · Student learning outcomes · Challenges to effective online learning · Community colleges · Heterogeneous impact of online learning by student characteristics · Design features of online courses · Strategies to improve online education

Introduction

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 (where 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 the advancement in technology, online course has become the primary format of distance education at postsecondary institutions nowadays.[1]

The growth of distance education was once intentionally constrained by the "50 percent rule" of the Higher Education Act (HEA) of 1992.[2] 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% 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 Title IV if it is offered at an institution that ran afoul of the 50 percent rule.

While 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 need to balance coursework with other job and family commitments, and therefore may benefit substantially from the flexibility of distance learning. The rule also substantially constrained the growth of for-profit institutions, which had originally pioneered distance learning to allow individuals to pursue further forms of education (Deming et al. 2012). Since the for-profit sector disproportionately serves adult learners, women, underrepresented racial minority students, and low-income students (Deming et al. 2012), educational opportunities for the most disadvantaged populations were substantially compromised due to the 50 percent rule.

To promote new advances in distance education and to address the increasing demand for it, the HEA was amended in 1998 to create the Distance Education Demonstration Program (DEDP), which granted waivers to colleges 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 offsite students enrolled in distance learning programs more than doubled during the same period (Domestic Social Policy Division 2005). In 2006, the HEA was amended again to discontinue the 50 percent rule. The discontinuation of the 50 percent rule, together with other trends, such as the rapid advancement of technology, increasing demand for higher education, and growing population of nontraditional students, has spurred the growth of dedicated online institutions (U.S. Department of Education 2006). The share of bachelor's degrees awarded by institutions that offered exclusively online courses grew from 0.5% in 2000 to over 6% in 2012 (Deming et al. 2015).

At the state level, funding for online education programs and students enrolled in online classes varies. In 2015, 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 (Education Commission of the States 2015). The report indicates that all states, except for Pennsylvania, had eliminated the

[1]In this chapter, we will use "online course," and "online learning" interchangeably to refer to semester-length college courses where more than 80% of the course content is delivered online.

[2]Higher Education Amendments of 1992, Pub. L. No. 102–325.

50 percent rule from state-level policies. Several states have also explicitly promoted the growth of online education in their state budgets. In 2018, for example, California committed $100 million 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 (SB-840 2018).

The strong support for online education is also explicitly stated by college administrators in their long-term strategic plan, indicating that the current online expansion is likely to continue. For example, based on a national survey of college administrators in all degree-granting institutions of higher education, Allen and Seaman (2016) found that in the academic year of 2015, almost half of all postsecondary institutions have included expanding online learning as a critical component in their formal strategic plan, and almost two thirds of the institutions believed that development of online courses is critical for their long-term strategy.

While online enrollment has been increasing rapidly at postsecondary institutions, questions remain regarding its impact on access to college, costs, and student outcomes. Can the advancement of technology bend the cost curve for postsecondary institutions and students? Does online education enhance access to higher education among students who would not otherwise be enrolled in college or have to take fewer courses without online learning? Does online course offering and enrollment vary across state, and by school sector and selectivity? How does the expansion of online learning affect student learning outcomes? What are some potential strategies to better support students in college online courses? This chapter reviews existing research on these important topics and discusses the benefits and challenges associated with online learning in higher education.

The rest of the chapter includes six sections and will begin with a general overview of the demand and supply of online courses in higher education and the characteristics of students taking online courses and online programs. Section "The Cost of Online Education" reviews existing evidence on the costs associated with developing online courses, compared with face-to-face courses. Section "Online Education and Student Outcomes" summarizes key findings from existing studies on the impacts of online learning on student learning outcomes, with a focus on studies using experimental or quasi-experimental research design that would deliver a causal interpretation. Section "What Explains Online Performance Decrement?" discusses the challenges typically faced by students in online learning. Section "Strategies to Improve Online Education" examines potential strategies to improve the effectiveness of online learning, and the final section concludes the chapter.

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

Why Do Students Take Online Courses?

The literature on online learning identifies two primary reasons that students take online courses. First, the online delivery format provides greater flexibility and convenience (e.g., CCCCO 2017; Daymont et al. 2011; Hirschheim 2005; Jaggars

2014), especially for students who have other work and family commitments (Aslanian and Clinefelter 2012; Hannay and Newvine 2006). The California Community College Chancellor's Office conducted a distance education survey among all students who completed a distance education course in the fall term of 2016 (CCCCO 2017). The survey asked distance education students to rank the importance of 16 reasons why they enrolled in a distance course.[3] Among the 6,625 survey respondents (a 9% response rate), the number one reason was convenience with their work schedule (74% 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 community colleges in Virginia, Jaggars (2014) found that students who prefer working independently and at their own pace are more likely to choose online courses. In a similar vein, almost 60% of the California Community Colleges Chancellor's Office (CCCCO) student survey respondents were enrolled in distance courses because they "enjoy learning on a computer" (CCCCO 2017, p. 32).

Jaggars (2014) also found that students make conscious decision on a course-by-course basis based on three factors specific to a course: (i) suitability of the subject areas to the online context; (ii) difficulty of the course; and (iii) 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. As a result, students were only comfortable taking online courses when the course is easy (where "easy" was typically used to refer to humanities courses whereas "difficult" to math and science courses), is less important to their academic career (such as courses not in their academic major), and is in subject areas which they have less interest in. A number of students directly pointed out that they would only take a course online 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 where 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.

[3]It should be noted that 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: (i) the course was convenient with my work schedule; (ii) the course met requirements for the associate degree; (iii) the course met requirements for transfer to a 4-year college or university; (iv) the course would improve my job skill; (v) I had a personal interest in the subject; (vi) I had success with a previous distance education course; and (vii) I enjoy learning on a computer.

Characteristics of Online Students

Due to the flexibility of online learning, online course may be particularly appealing to students who assume working and family responsibilities and would otherwise have to take fewer courses or not enroll in college at all. Indeed, based on the 2015–2016 National Postsecondary Student Aid Study (NPSAS) that surveyed approximately 113,000 postsecondary students (89,000 undergraduate and 24,000 graduate students), our calculation suggests that 46% of undergraduate students and 45% of graduate students took at least one course that was taught exclusively online in the 2015–2016 school year. There students differed from other postsecondary students in a number of ways. Compared with students who did not take any online courses in the 2015–2016 school year, online course takers were older (28-year-old versus 25-year-old), more likely to be married (24% versus 13%),[4] more likely to be employed full time (36% versus 20%) and had higher average income.

These patterns are also echoed in several studies using college administrative data. For example, based on data from California's Community College System, Johnson and Mejia (2014) found that students aged 25 or older are much likely than younger students to take online courses. Specifically, 15.4% of older students take online courses as compared to 8.5% of their traditional college-aged peers (aged 18–25 years). Additionally, this report also reveals a racial and ethnic difference in online enrollment, with Latino students having a substantially lower online enrollment rate than the White, African American, or Asian students. 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 (Baldassare et al. 2013). Given the flexibility of online learning as the most important consideration cited by students 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 utilizes data from a new Online Master of Science in Computer Science (OMSCS) offered by the Georgia Institute of Technology (Goodman et al. 2019), in which all courses are delivered exclusively online. 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 24-year-old student recently out of college, whereas the average online applicant is 34-year-old mid-career worker. A survey with OMSCS applicants in 2014 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

[4]Individuals who were separated are counted as married; those who were divorced were counted as single.

offers and enroll, suggesting that the online program expanded access to education for mid-career or older populations who would not otherwise enroll. Based on a regression discontinuity approach,[5] the researchers find that access to this online option substantially increased overall enrollment by about 20 percentage points, and such effects are fairly consistent across different demographic subgroups, such as by gender, ethnicity, age, or citizenship. Importantly, among applicants who fell right below the cutoff score and were therefore not admitted into the online program, very few enrolled in other non-OMSCS programs, providing support to the claim that the online option indeed increases access to higher education.

Supply and Demand of Online Education

With the added convenience of online classes and their potential ability to expand access to higher education, the supply of and demand for online courses has increased throughout the last decade. That is, more colleges are now offering online courses than ever before (more *supply*) and more students are now enrolling in those courses (more *demand*) than ever before. 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. Therefore, hybrid courses that include traditional face-to-face time do not count as online course per IPEDS's definition.[6] Below, IPEDS data from the 2016–2017 school year is used to show the overall increase in supply of online education courses, along with the increase in demand for those courses by students. The data represents more than 7,000 postsecondary institutions across the USA, among which almost 5,000 are degree-granting institutions. IPEDS defines online education as a credit-bearing course or program in which the instructional content is delivered exclusively online.

[5]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.

[6]It should be noted that the 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 (ITC) define online courses as those in which at least 80% of instruction is delivered online (Miller et al. 2017). 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 the fact that fully online course has been dominating online education at the higher education sector and a relatively small proportion of courses are provided through a hybrid format (Streich 2014; Xu and Jaggars 2011).

The Supply Side: Increases in Online Courses and Programs

In the 2016–2017 academic year, approximately 3,500, or 76%, of all degree-granting institutions reported to offer online courses. This number has increased steadily since 2012, when 70% of those institutions reported to offer online courses. Among institutions that offered any online course, almost all of them 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 have the potential to 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 of degree-granting institutions offered at least one exclusively online program in the 2016–2017 academic year.

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 (2-year versus 4-year). Online learning is most prevalent in the public sector, where more than 95% 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 exclusive online program 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 2-year and 4-year institutions in all three sectors. Among 2-year public institutions, for example, only 415 (44%) institutions offered an exclusive online program in 2012. By 2016, this number increased to 610, or 68%, of all degree-granting 2-year public institutions. The only exception are for-profit 2-year institutions, where only 15% of these institutions offered exclusively online programs in both 2012 and 2016.[7]

Figure 2 further takes into account the selectivity of an institution 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 (Cunningham 2005). 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 board, the gap in online course and program offering is particularly pronounced among the most selective institutions: during the academic year of 2016–2017, 91% of more selective public institutions offered at least one online

[7]It is worth noting that some universities have multiple campuses. Each campus is treated as an independent institution in IPEDS with unique institution ID, selectivity, and program and enrollment information. Taking DeVry University as an example, all campuses offer at least one online course and nine campuses offer at least one exclusively online program.

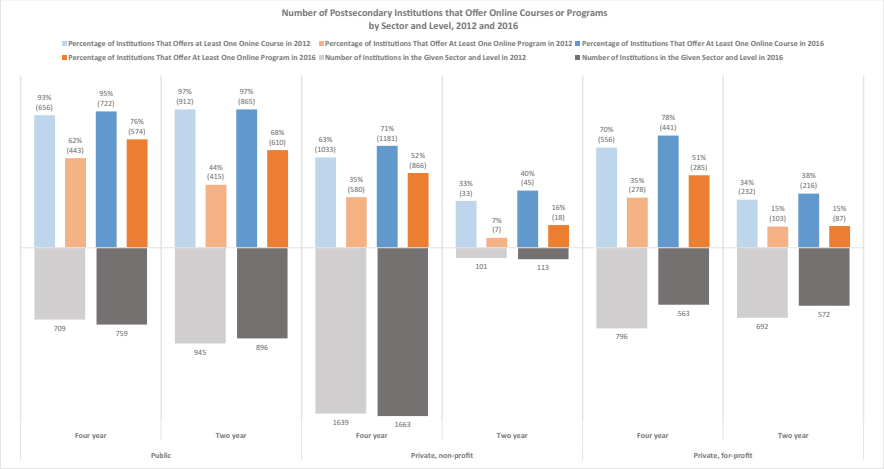


Fig. 1 Percent of postsecondary institutions that offer online courses or programs in 2012 and 2016 by sector and level. **Note**. The numbers reported in the figure are calculated based on data from active degree-granting institutions with valid enrollment data in each year (n = 4,566 in 2016; n = 4,882 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)

course compared to 63% of more selective private nonprofit institutions; similarly, whereas 76% of the more selective public institutions offered exclusively online programs, only 41% 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 3a presents the total number of education programs that can be pursued completely online at degree-granting institutions in each field of study. Due to both 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 AA and BA (3b), for graduate degree (3c), and for certificates (3d), respectively. It seems that business, health, and education are among the top three programs for all three types of credentials, with one exception: there are relatively fewer AA and BA programs in the field of education that can be fully pursued online (569 programs, representing only 6% of all AA and BA programs in education).

Finally, Fig. 4 shows the distribution of programs by sector and selectivity of institutions for the top five fields with the largest number of exclusively online

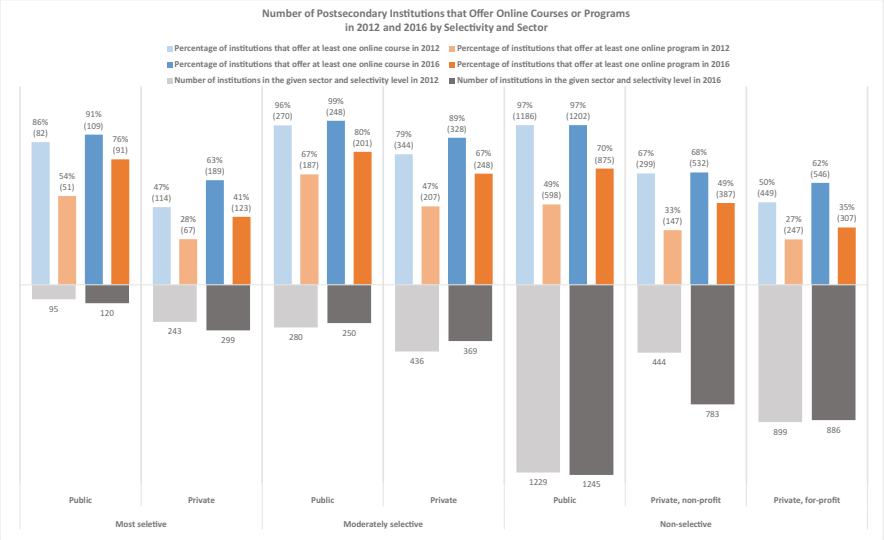


Fig. 2 Percent of postsecondary institutions that offer online courses or programs in 2012 and 2016 by selectivity and sector. **Note**. These numbers are calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity score in a given year. The sample includes 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 and variable "CCUGPROF" in the IPEDS 2012 database, respectively). Based on the 15 subcategories: (1) 2-year, higher part-time, (2) 2-year, mixed part/full-time, (3) 2-year, medium full-time, (4) 2-year, higher full-time, (5) 4-year, higher part-time, (6) 4-year, medium full-time, inclusive, lower transfer-in, (7) 4-year, medium full-time, inclusive, higher transfer-in, (8) 4-year, medium full-time, selective, lower transfer-in, (9) 4-year, medium full-time, selective, higher transfer-in, (10) 4-year, full-time, inclusive, lower transfer-in, (11) 4-year, full-time, inclusive, higher transfer-in, (12) 4-year, full-time, selective, lower transfer-in, (13) 4-year, full-time, selective, higher transfer-in, (14) 4-year, full-time, more selective, lower transfer-in, and (15) 4-year, full-time, more selective, higher transfer-in, we coded all institutions into three selectivity levels: (i) nonselective, (ii) moderately selective, and (iii) most selective. (**Source**: IPEDS 2012 and 2016 https://nces.ed.gov/ipeds/use-the-data)

programs.[8] Two interesting patterns emerge from the findings. First, except for the field of education, fully online programs are overwhelmingly offered by non-selective 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

[8]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 Fig. 4.

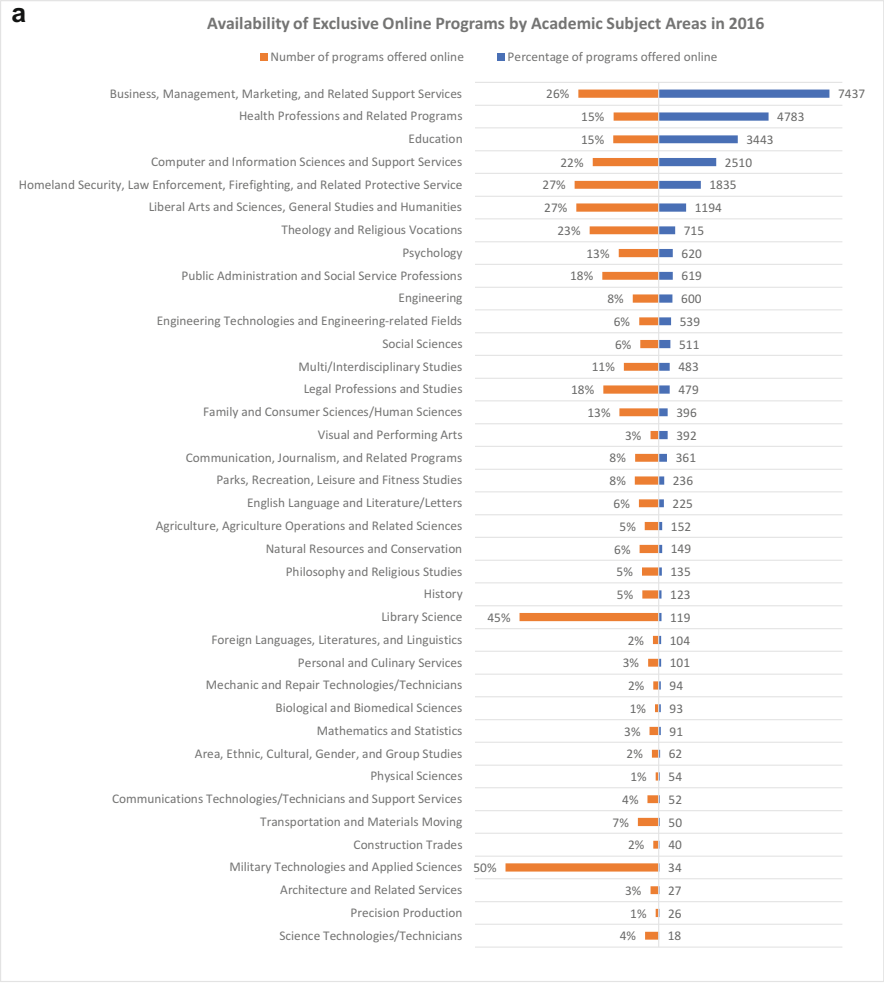
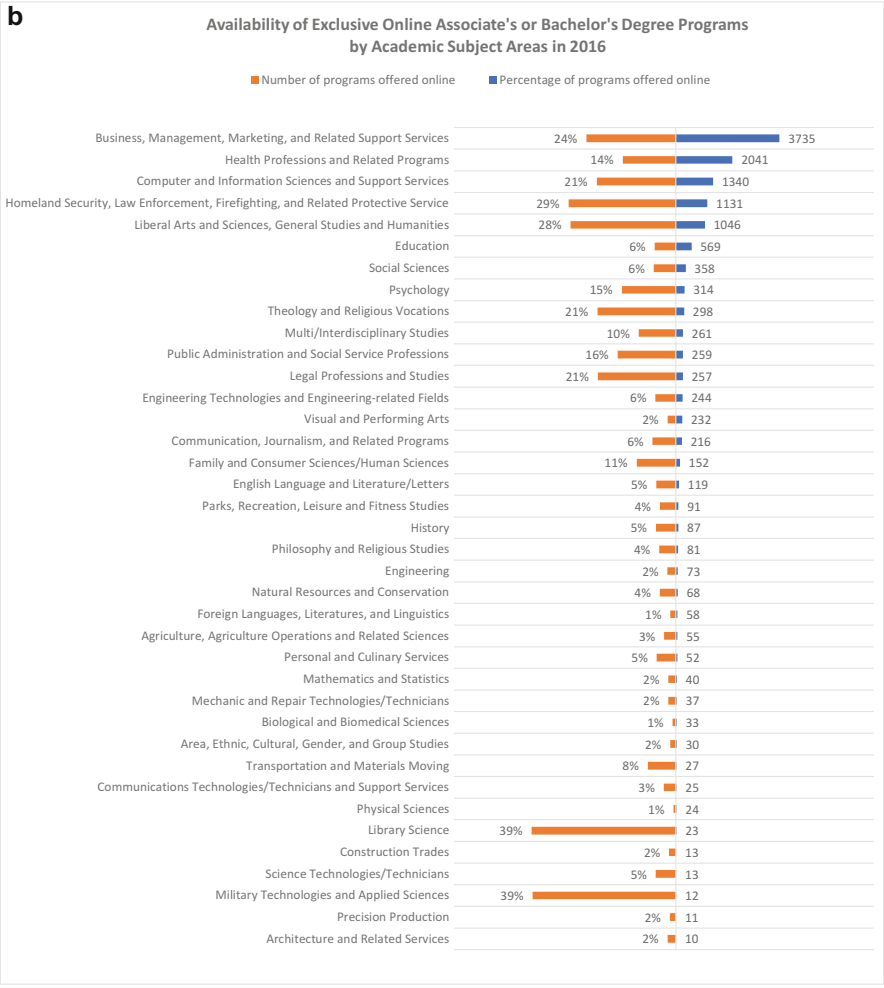


Fig. 3 (continued)

programs can be pursued at selective institutions. (Education is a notable exception, where 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% of all degree-seeking students were exclusively enrolled in online courses during the 2016–2017 academic year, 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



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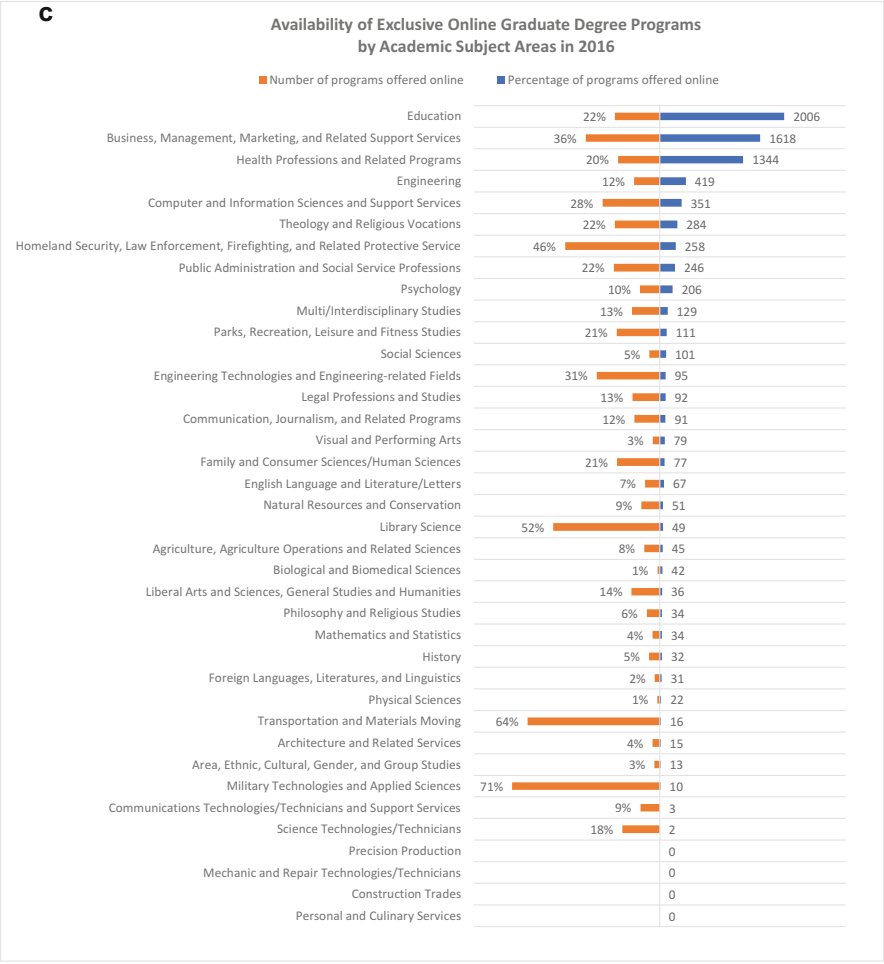
institutions had the highest online enrollment rate, where 68% of students enrolled in this sector during 2016–2017 academic year took at least one online class; among these students, the majority (85%) were enrolled online exclusively (referred to as "only-online students" hereafter). Institutions in the public sector and private nonprofit sector had a much lower online enrollment rate, where 30% and 27% 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, where approximately one third (35%) in the public sector and 65% in the private nonprofit sector were enrolled online courses exclusively.

Figure 5 shows the overall changes in student enrollment in online courses between 2012 and 2016 across all degree-granting postsecondary institutions. The number of



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any-online students increased by 1 million, representing a 19% increase overall. The number of only-online students also increased by 0.3 million during this period, or a 12% 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 USA) online course enrollment increased by almost 850,000 between 2002 and 2012; in the meanwhile, enrollment in face-to-face classes has declined by almost 285,000. Consequently, the proportion of online course enrollment surged from 1.4% to 10.7% over this period (Johnson and Mejia 2014).[9]

[9]Most of the California community college students who take online courses also take face-to-face classes simultaneously.

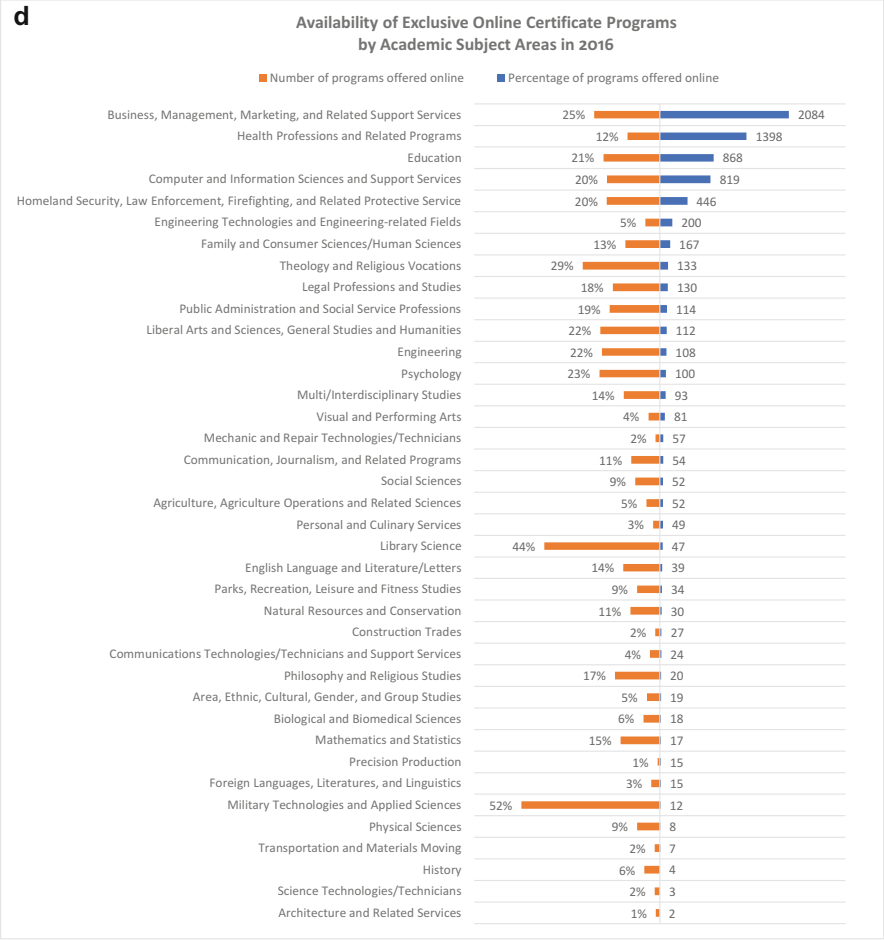

Fig. 3 (**a**) Availability of exclusive online programs by academic subject areas in 2016. **Note**. These numbers are calculated based on active degree-granting institutions that reported valid data regarding online education offering in 2016 (n = 4,566). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database. (**Source**: IPEDS 2016 https://nces.ed.gov/ipeds/use-the-data). (**b**) Availability of exclusive online AA or BA degree programs by academic subject areas in 2016. **Note**. These numbers are 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**: IPEDS 2016 https://nces.ed.gov/ipeds/use-the-data). (**c**) Availability of exclusive online graduate degree programs by academic subject areas in 2016. **Note**. These numbers are 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**: IPEDS 2016 https://nces.ed.gov/ipeds/use-the-data). (**d**) Availability of exclusive online certificate programs by academic subject areas in 2016. **Note**. These numbers are 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**: IPEDS 2016 https://nces.ed.gov/ipeds/use-the-data)

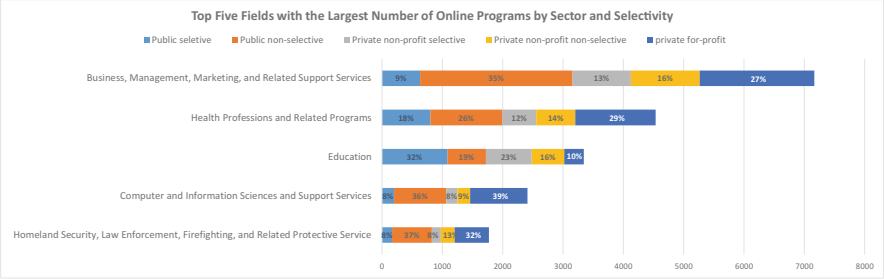

Fig. 4 Top five fields with the largest number of online programs by sector and selectivity. **Note**. These numbers are calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity score (n = 3,952). Academic subject areas were retrieved from variable "CIPCODE" in the IPEDS database. Selectivity is derived from the Carnegie Classification of Institutions of Higher Education (variable "C15UGPRF" in the IPEDS 2016 and variable "CCUGPROF" in the IPEDS 2012 database, respectively). Given that over 99% of the institutions in private for-profit sector were categorized as nonselective institution, this chart did not break out institutions in this category between selective and nonselective. (**Source**: IPEDS 2016 https://nces.ed.gov/ipeds/use-the-data)

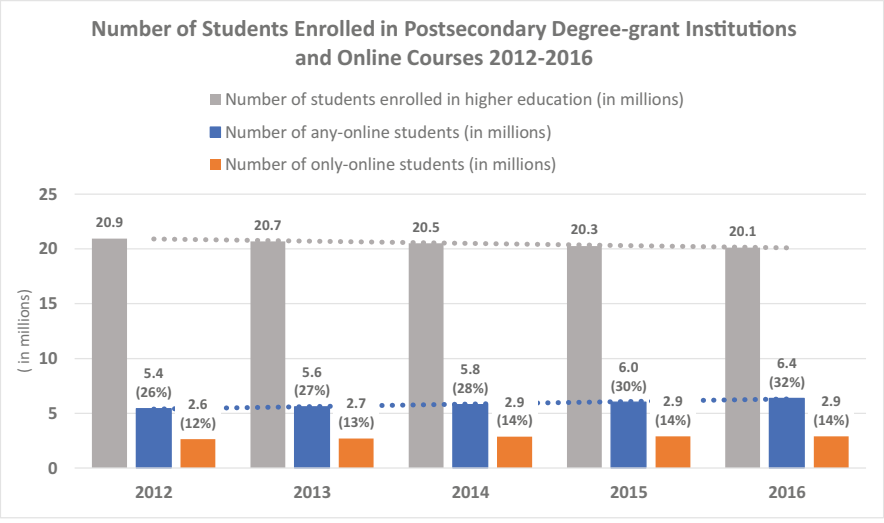

Fig. 5 Number of students enrolled in postsecondary degree-grant institutions and online courses 2012–2016. **Note**. The numbers reported in the figure are calculated based on data from active degree-granting institutions in each year. Numbers in parentheses represent the percentage of any-online or only-online students among those enrolled in higher education in a given year. (**Source**: IPEDS 2012, 2013, 2014, 2015, and 2016 https://nces.ed.gov/ipeds/use-the-data)

Figure 6 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 the 2012 and 2016

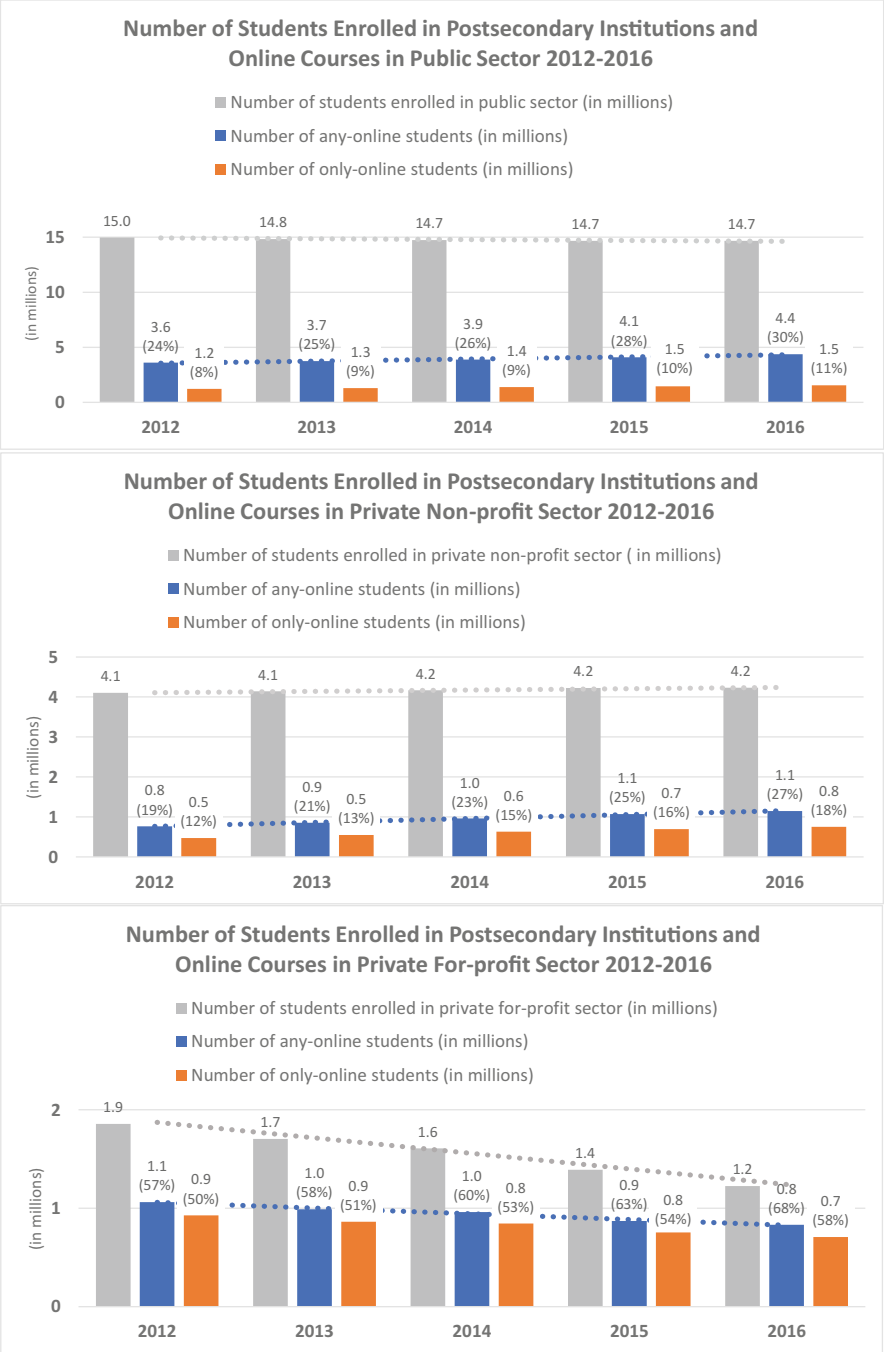

Fig. 6 (continued)

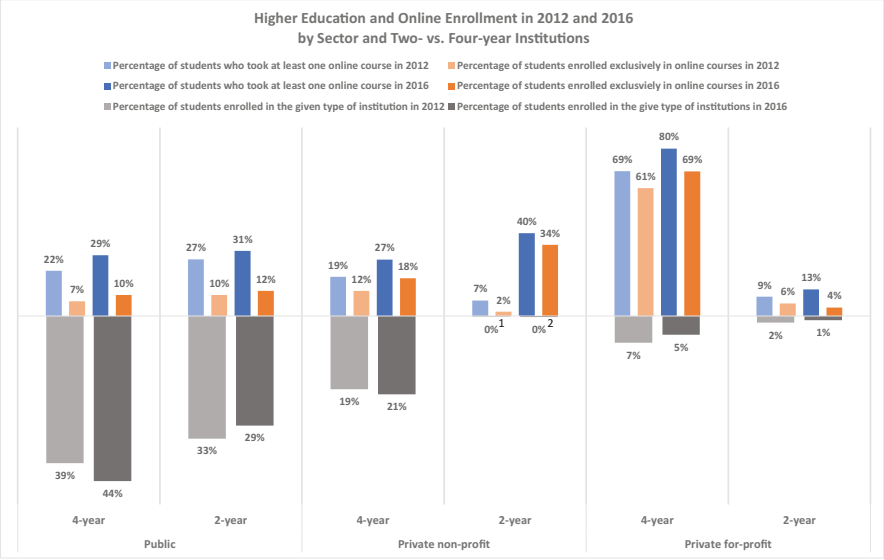

Fig. 7 Higher education and online enrollment in 2012 and 2016 by sector and 2- vs. 4-year institutions. **Note**. These numbers are calculated based on active degree-granting institutions with valid enrollment data in the current year (n = 4,566 in 2016; n = 4,882 in 2012). Institutional sector is retrieved from variable "CONTROL" and institutional level is retrieved from variable "ICLEVEL" in the IPEDS database. 1. Total enrollment rate in private, nonprofit 2-year institutions in 2012 is 0.18%. 2. Total enrollment rate in private, nonprofit 2-year institutions in 2016 is 0.26%. (**Source**: IPEDS 2012 and 2016 https://nces.ed.gov/ipeds/use-the-data)

academic year. While the total number of online students slightly increased during the 5-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 2-year and 4-year colleges, Fig. 7 further differentiates between 4-year and 2-year institutions within each sector and shows the percentage of students enrolled in any online course in 2012 and in 2016, respectively. Overall, the percentage of any-online and only-online students increased in both 2-year and 4-year colleges across all sectors. In the public sector, 2-year institutions had slightly higher online enrollment rate than 4-year institutions in both 2012 (27% vs. 22% for any-online; 10% vs. 7% for only-online) and 2016 (31% vs. 29% for any-online; 12% vs. 10% for only-online). In the

Fig. 6 Number of students enrolled in postsecondary institutions and online courses 2012–2016 by sector. **Note**. The numbers reported in the figure are 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**: IPEDS 2012, 2013, 2014, 2015, and 2016 https://nces.ed.gov/ipeds/use-the-data)

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

Figure 8 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% of the students enrolled in most-selective institutions attempted any online course during the 2016–2017 academic year, which is half the rate compared to students enrolled at nonselective institutions (39%).

The higher rate of online enrollment among nonselective institutions shown in Fig. 8 might be primarily driven by large share of students enrolled at private for-profit institutions. To address this possibility, Fig. 9 shows the percent of students enrolled in online courses broken out by sector within 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 within the public sector and the private nonprofit sector. In the private nonprofit sector, for example, only 10% of the students at more selective institutions took any online course in 2016–2017. The percent of any-online students almost tripled at moderately selective nonprofit institutions and also increased by about half at nonselective nonprofit institutions.

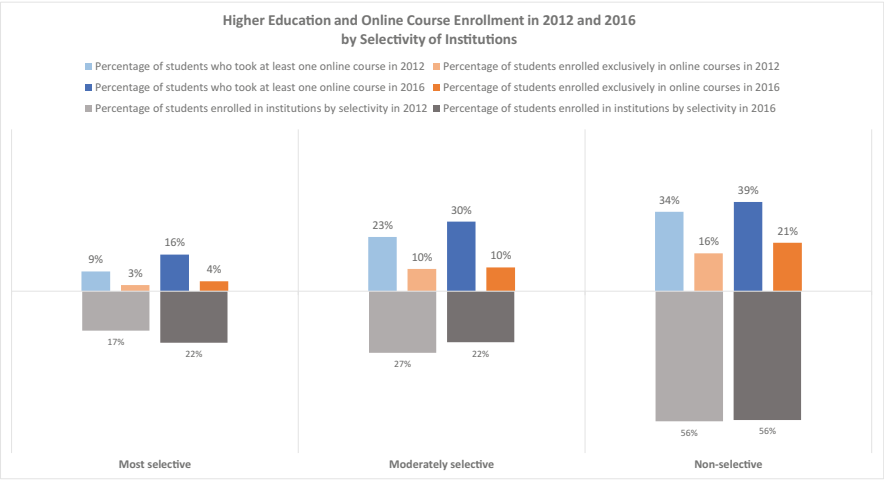

Fig. 8 Higher education and online enrollment in 2012 and 2016 by selectivity of institutions. **Note**. These numbers are calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity score in a given year. The sample includes 3,955 institutions in 2016 and 3,626 institutions in 2012. Selectivity is derived 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**: IPEDS 2012 and 2016 https://nces.ed.gov/ipeds/use-the-data)

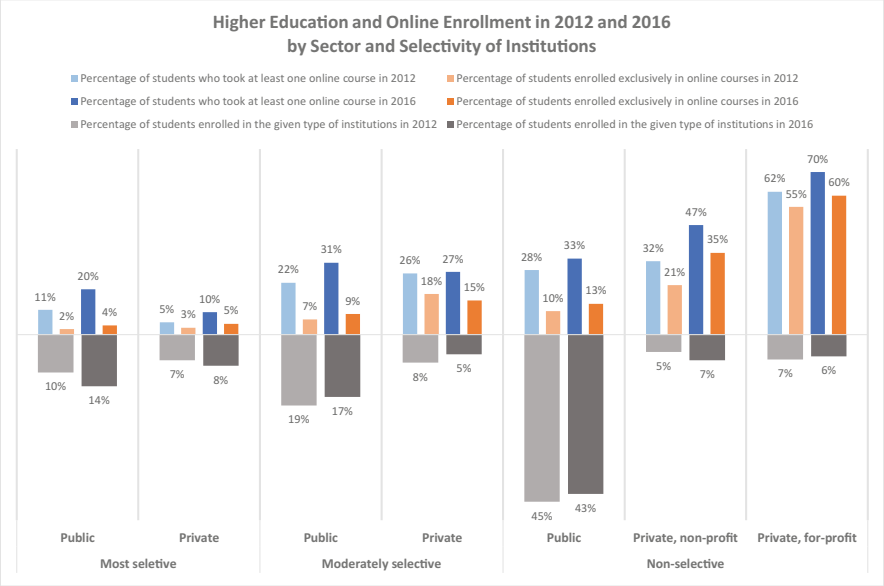

Fig. 9 Higher education and online enrollment in 2012 and 2016 by sector and selectivity of institutions. **Note**. These numbers are calculated based on active degree-granting institutions with valid enrollment data and with valid selectivity score in a given year. The sample includes 3,955 institutions in 2016 and 3,626 institutions in 2012. Selectivity is derived 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**: IPEDS 2012 and 2016 https://nces.ed.gov/ipeds/use-the-data)

Finally, considering that state-level policies may shape online learning in unique ways, Fig. 10 shows online enrollment by state. Unsurprisingly, the most populated states, such as California, Texas, and Florida also had the largest number of online course takers. Once accounting for between-state differences in overall higher education enrollment, four states has the largest share of students who enrolled in at least one online course in 2016: Arizona (61%), New Hampshire (58%), West Virginia (57%), and Idaho (52%); at the other end of the spectrum, three states – Rhode Island, New York, and Connecticut – had less than 20% 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 has the potential to help address funding insufficiencies in higher education by reconfiguring the use of highly paid faculty and reducing the demand for brick-and-mortar construction and maintenance (Twigg 2003; Waddoups et al. 2003),

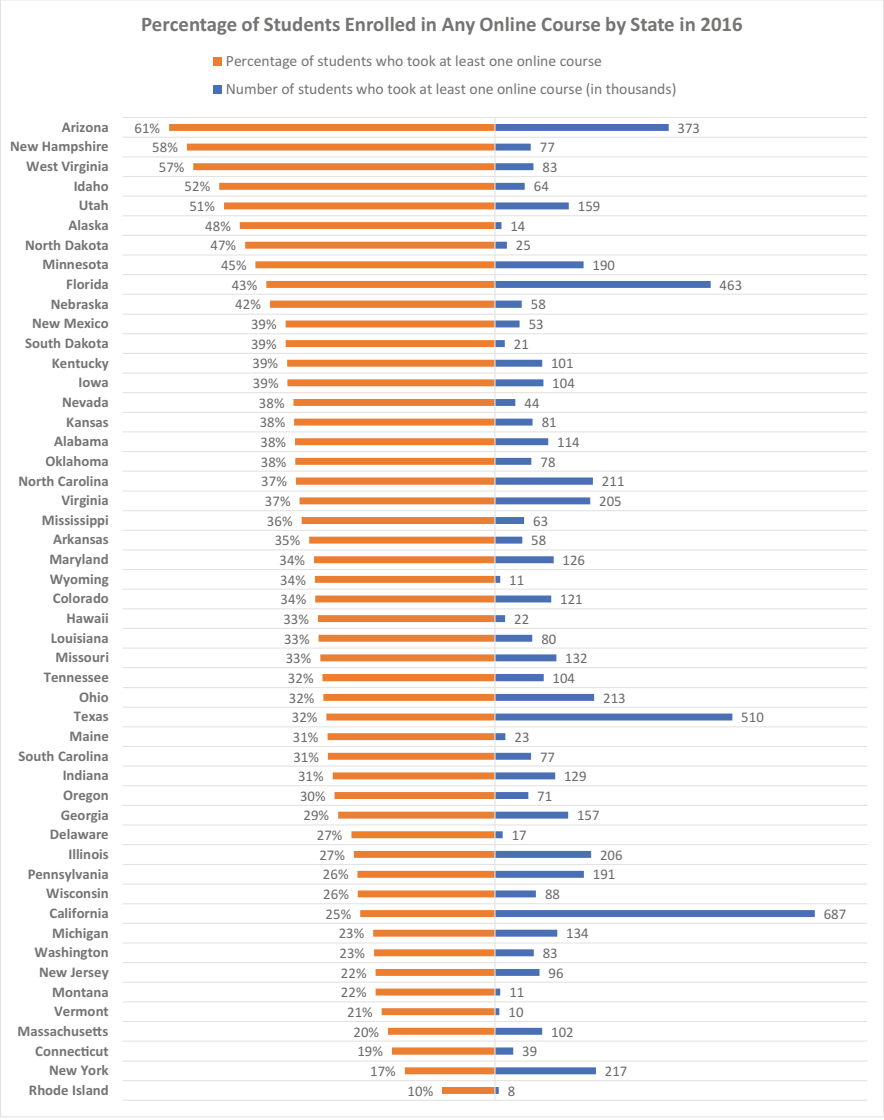

Fig. 10 Percentage of students enrolled in any online course by state. **Note**. These numbers are calculated based on active degree-granting institutions that reported valid data regarding online education offering (n = 4,566). (**Source**: IPEDS 2016 https://nces.ed.gov/ipeds/use-the-data)

which some scholars refer to as "bend the higher education cost curve" (Deming et al. 2015). 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 (Lazear 2001), these mechanisms would be largely muted if an online course has limited synchronous student-instructor interactions and peer interactions. Bettinger et al. (2017a) directly assess the effects of increasing class size on student learning outcomes in online courses at DeVry University, one of the nation's largest for-profit postsecondary institutions. The authors exploit a field experiment where more than 4,000 course sections of 111 courses were randomly assigned to either regular-sized classes of 31 students or slightly larger classes with an average 10% increase in class size, and 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% 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 offering can indeed serve as cost-saving innovations for institutions, colleges may also charge lower tuitions for their online programs and courses, therefore lowering the costs for students to pursue postsecondary education. Indeed, using the IPEDS of the US Department of Education, Deming et al. (2015) find 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.

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 data from a large for-profit university, Bettinger et al. (2017b) find that online courses do significantly less to promote student academic success than similar in-person courses. 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 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 (Rumble 2003). For example, Poulin and Straut (2017) 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 (Poulin and Straut 2017). 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 (Schiffman 2005).

Based on expenditure data from the University of North Carolina (UNC) system, a 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 start-up expenditures in course development and in recurring expenditures in delivering the course (North Carolina General Assembly 2010).[10] More specifically, based on the cost information on a sample of 92 courses (46 on-campus and 46 distance courses) from 15 UNC campuses,[11] the report indicates that the average cost for developing a distance course ($5,387) is 6% higher than the average cost for developing an on-campus course ($5,103).[12] 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 the fact that distance education courses often had other costs associated with delivery that on-campus courses did not incur, such as special software or hardware needed for content delivery or technologically enabled interaction between students and instructors.[13]

[10]The differences in costs to deliver a distance course and an on-campus course do not reach statistical significance though.

[11]A total of 1,979 new courses were developed since 2004 at UNC. The evaluation team further limits the sample to 801 courses developed between 2008–2009 and 2009–2010 academic years 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.

[12]It should be noted that 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, the 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.

[13]The report indicates that UNC faculty use a variety of technology platforms, where 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 are able to "get to know their distance students better than their on-campus students because mandatory posting requirements for online courses increase student-instructor interaction" (p. 6).

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" (p.11, North Carolina General Assembly 2010). The possibility that faculty may need to spend more time to ensure the quality of instruction and interaction in an online course than 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 Bacow et al. (2012) 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. 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 the potential of online courses to reform the traditional learning process through technology, such as enabling 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 (Aragon and Johnson 2008). Do online courses effectively prepare students with the knowledge and skills needed to succeed in college and later in their careers? Earlier observational studies (e.g., Berg 2001; Paden 2006; Ury 2004) attempted to compare student learning outcomes between online and face-to-face formats, and the findings are mixed. 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 through 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 either 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 (2009). Based on only randomized experiment or quasi-experiments, the meta-analysis suggests that on average, students in online learning conditions performed better than those receiving face-to-face instruction.[14] However, a thorough review by Jaggars and Bailey (2010) 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.

First, the majority of the studies included in this meta-analysis focused on only one specific topic, where 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 (Caldwell 2006; Cavus et al. 2007; Davis et al. 1999; LaRose et al. 1998; Mentzer et al. 2007; Peterson and Bond 2004; Schoenfeld-Tacher et al. 2001). 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.[15] However, all seven studies were conducted at mid-sized or large universities, with five rated as "selective" or "highly selective" by *U.S. News and World Report*, and all seemed to involve

[14]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.

[15]The meta-analysis (U.S. Department of Education 2009, Exhibit 4a) reports the effect sizes for six of these studies as positive for online learning, while one was reported as negative. However, the reexamination of the studies (Jaggars and Bailey 2010) suggests that three should be classified as negative (Davis et al. 1999; Peterson and Bond 2004; Mentzer et al. 2007), one as mixed (Caldwell 2006), two as positive (Cavus et al. 2007; Schoenfeld-Tacher et al. 2001), and one as unclassifiable based on information provided in the published article (LaRose et al. 1998).

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 critical to success in online education (e.g., Bambara et al. 2009; Ehrman 1990; Eisenberg and Dowsett 1990), or due to technical difficulty, such as slowness of typing, problems navigating the course management system, and difficulty following material on the screen (Aman and Shirvani 2006; Bambara et al. 2009), all problems that may be more common among students with weak educational backgrounds. Only one of the studies examined the impacts of the course delivery format on lower-performing students: Peterson and Bond (2004) 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.

In addition, the studies included in the meta-analysis almost exclusively focus on course grade and did not study attrition as an outcome. While course attrition rates might be low and ignorable in a selective institution with academically well-prepared student population, a large proportion of students enrolled in open-access public institutions, especially at 2-year community colleges, are academically underprepared. These underprepared students withdraw from courses and drop out of college at a higher rate (Bailey et al. 2010). Indeed, studies consistently identify higher course attrition rates in online courses compared to similar face-to-face courses at 2-year colleges (e.g., Bendickson 2004; Carr 2000; Rovai and Wighting 2005; Xu and Jaggars 2011a). 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,[16] timely instructor feedback, effective technical support, clear grading rubric, and well-organized course structure with intuitive navigation. Yet, the quality of the courses designed and offered by these online advocates may not be representative of 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 minimal level of synchronous interpersonal interaction opportunities (Cox 2006; Jaggars and Xu 2016).

[16]In synchronous sessions, students would interact with instructors or peers in real time, but not in person, such as through video conferences or chat-based online discussions.

Online Delivery Format Hinders Learning Outcomes

Aside from the meta-analysis, most of the other experimental and quasi-experimental studies on semester-length college courses that we are aware of 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 (e.g., Hart et al. 2018) or, at best, null results (e.g., Bowen et al. (2014).[17] The outcome measures include course grades (e.g., Figlio et al. 2013), course completion with a passing grade (e.g., Johnson and Mejia 2014), and standardized post-test scores (e.g., Bowen et al. 2014).

Four experimental studies (Alpert et al. 2016; Bowen et al. 2014; Figlio et al. 2013; Joyce et al. 2015) are conducted in relatively selective 4-year institutions and randomly assign students into different delivery formats within a single course in economics or statistics with a total enrollment ranging between 312 and 725 students. Figlio et al. (2013) compare between a purely online or face-to-face classroom setting in teaching microeconomics principles, where students assigned to the online format watch videos of the lectures online. Joyce et al. (2015) also conducted the study in the course of 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. Similar to Joyce et al. (2015), Bowen et al. (2014) compares 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. 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, as well as 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. Alpert et al. (2016) compared student learning outcomes in a microeconomic principle course delivered through three formats – face-to-face, blended, and fully online – at a public university. Both the blended and the online formats provide

[17]It should be noted that a much broader literature used randomized assignments to compare between online and face-to-face training sessions across a variety of settings (e.g., Bello et al. 2005; LaRose et al. 1998; Meyer 2003; Yaverbaum and Ocker 1998; Padalino and Peres 2007; Peterson and Bond 2004). 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.

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 et al. (2014) that identifies 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. Bowen et al. (2014) 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.

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 both online and face-to-face courses at one college (e.g., Bettinger et al. 2017b) or multiple colleges in an entire state (e.g., Hart et al. 2018). The majority of these quasi-experimental studies examine online learning at 2-year community colleges (Hart et al. 2018; Johnson and Mejia 2014; Streich 2014; Xu and Jaggars 2011b, 2013, 2014), which is a population of particular interest for policy on online learning. Four state community college systems have been examined thus far, including California (Hart et al. 2018; Johnson and Mejia 2014), North Carolina (Streich 2014), Virginia (Xu and Jaggars 2011a), and Washington (Xu and Jaggars 2013, 2014), and all states demonstrate rapid growth of enrollment in fully online course during the past decade.

Without randomly assigning students into online and face-to-face delivery formats, the key challenge to identifying the causal impacts of online delivery format 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: (i) an instrumental variable approach and (ii) a multiple fixed effects model. For the first identification strategy, Xu and Jaggars (2013) 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 (2014) 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. (2017b) combined the two instruments together, where 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 much 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 (e.g., Hart et al. 2018; Xu and Jaggars 2014) that control for any observed or unobserved selection at both the student- and course-level simultaneously.

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. It is worth noting that 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 4-year college (Bettinger et al. 2017b) or 2-year community colleges (e.g., Hart et al. 2018). In contrast, all the studies conducted at selective 4-year institutions only involve 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 4-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 4-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 2-year or for-profit colleges.

One concern that is often raised about comparisons between the online and face-to-face sections of a course in the absence of randomized controlled trials is that there might be systematic differences between instructors teaching the online versus 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. Hart et al. (2018) directly assessed the extent of this problem by including a rich set of instructor characteristics into the fixed effects model. Their analyses indicate that the inclusion of observable instructor characteristics does little to alter the negative relationship between online course-taking and student performance.[18]

Course Persistence

While course persistence – measured as making it through the entire semester of a class – is generally high at 4-year colleges, course attrition is a serious issue at open-access institutions, particularly at 2-year community colleges, where a large proportion of students withdraw before the end of a course at a high rate

[18]Specifically, four types of instructor characteristics are included into the model: (i) the contract status of the instructor (temporary adjuncts, tenure-track non-tenured, or tenured); (ii) years of experience; (iii) whether the instructor is teaching any courses as an overload; and (iv) whether the course is team-taught.

(Bailey et al. 2010).[19] 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 to 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 (Xu and Jaggars 2014) and 15 percentage points (Xu and Jaggars 2011b) 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. It is worth noting that students who withdraw during the add/drop period were not included in the analysis. As a result, mid-semester course withdrawal not only penalizes students 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 student that withdraw after the add/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 (e.g., Hart et al. 2018) defined as whether a student retakes the same course; subject persistence (e.g., Hart et al. 2018) defined as future enrollment in other classes within the same subject area; follow-up course grades (e.g., Krieg and Henson 2016); and college persistence – as opposed to dropping out of college after that term (Huntington-Klein et al. 2017; Jaggars and Xu 2010; Shea and Bidjerano 2018).

Using a multi-way fixed effects model, Hart et al. (2018) find that online course-taking is positively associated with course repetition and negatively associated with subject persistence at the California community colleges. Based on transcript records from nearly 40,000 students at a large comprehensive university over a 10-year period, Krieg and Henson (2016) 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. They find that students taking online prerequisites courses earn lower grades compared with 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

[19]Course persistence is defined as persisting to the end of the course, or completing a course no matter if they 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 4-year institutions did not study course persistence as an outcome, probably because course persistence at 4-year institutions, particularly relatively selective ones, is fairly high regardless which delivery format is used.

course may either reduce the student's probability of taking another course in a particular field or drop out from college completely. While both are undesirable, the latter is particularly worrisome, since completing college – not just enrolling in it – is imperative when it comes to 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 (Huntington-Klein et al. 2017; Jaggars and Xu 2010; Shea and Bidjerano 2018). For example, based on data from Washington community colleges, Huntington-Klein et al. (2017) find a negative effect of two percentage points of taking an online course on the probability of earning a degree. Based on data from Virginia community colleges, Jaggars and Xu (2010) 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 4-year college.

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 are able to estimate the causal impact of exposure to online learning and labor market outcomes are still missing from the literature.

Heterogeneous Impacts by Student and Course Characteristics

A handful of experimental (e.g., Figlio et al. 2013) and quasi-experimental studies (e.g., Hart et al. 2018; Johnson and Mejia 2014; Krieg and Henson 2016; Xu and Jaggars 2014) compared the size of the online performance decrement by a number of student characteristics and found strikingly consistent patterns. 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 4-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% increase (Johnson and Mejia 2014).

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 (e.g., Hart et al. 2018; Johnson and Mejia 2014; Xu and Jaggars 2014). For

example, based on data from the Washington community college system, Xu and Jaggars (2014) 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 where a larger proportion of peers are at risk for performing poorly online.[20] 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, Xu and Jaggars 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 (e.g., Bambara et al. 2009).

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 et al. (2018) 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. Also using data from California community colleges, Johnson and Mejia (2014) provides a much more detailed subject categorization that includes 17 subject areas in total. 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 as well as by different subject areas.

What Explains Online Performance Decrement?

Why do students struggle more in fully online courses? Practitioners and scholars increasingly acknowledge two critical challenges to successful learning in online environments: requirement of higher-level self-directed learning skills and greater difficulties in enabling effective human interactions. On top of these challenges,

[20]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).

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% of African Americans and 57% of Hispanics had high-speed Internet access at home, compared to 72% of Caucasian and 81% of Asians (Rainie 2010).

Requirement of Self-Directed Learning Skills

The literature in education psychology (e.g., Azevedo et al. 2004; Hannafin and Land 1997) converges to suggest that technology-enhanced student-centered online learning requires individuals to assume greater level of responsibility for this self-paced learning compared with traditional learning context. Unlike face-to-face courses where 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 (e.g., Bambara et al. 2009; Ehrman 1990; Eisenberg and Dowsett 1990; Roll and Winne 2015). 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 (Corbeil 2003; Guglielmino and Guglielmino 2003).

Granted, these skills – generally falling under the broad rubric of "meta-academic" or "self-directed" learning skills – are important to success in any learning environment, but they are more critical 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" (Allen and Seaman 2014, p.23). 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. Yet, upon college entry, most students are unaware of or tend to underestimate the challenges associated with learning in a fully online environment (Bork and Rucks-Ahidiana 2013), nor have they been equipped with the learning skills that allows for control of the self-directed learning in online courses. Consequently, many students need additional support, investment, and scaffolding to move toward successful online learning that reflects self-directed and self-regulated philosophies.

Lack of Interpersonal Connections

The primary interactions in many of the online classes happen between an individual learner and the course management system with limited and sparse social

interactions. As a result, online courses not only create a physical separation between students and instructors; rather the physical separation is likely to lead to a psychological and communication gap, what Moore (1989) defines as "transactional distance." The lack of interpersonal connections imposes at least two challenges to individual learners. 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 (e.g., Blanton et al. 1999; Huguet et al. 2001). In traditional classrooms, peer comparisons happen naturally with the physical presence and visibility of classmates, where students can easily identify "desired" role models and learn from them. 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 based on the social presence theory. Initially posed by Short et al. (1976) and further developed by Gunawardena (1995), the theory of social presence posited that user satisfaction within a communication is fundamentally dependent on the degree to which a person is perceived as a real person, or the degree of "social presence." An individual's social presence also serves as a critical component of her social integration and sense of belonging (Tinto 1998). An extensive literature in psychology consistently indicate that an individual's sense of belonging, defined as feeling acceptance, respect, and inclusion as well as feeling valued within a group, is particularly relevant to student learning outcomes, as common challenges become much more severe when students feel they are the only ones dealing with them (Fulford and Zhang 1993; Kearsley 1995; Moore and Kearsley 1996; Friesen and Kuskis 2013; Picciano 2001; Salmon 2002, 2004; Scardamalia and Bereiter 2006; Sherry 1995). 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 (Cox 2006; Jaggars and Xu 2016). Low levels of social presence may lead to increased feelings of loneliness and isolation (e.g., Grubb and Hines 2000; Robinson 2000), which has negative effects on course persistence and learning performance (Wei et al. 2012).

Why Is the Online Performance Decrement Particularly Wide Among Some Students?

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. Why is online learning more challenging for some students than others? Successful online learning requires a high level of self-directed learning skills; yet, existing literature on learning autonomy suggests that

females, White students, and individuals with high prior educational attainment on average have higher level of self-directed readiness than males, Black students, and individuals with lower educational attainment (e.g., Hoskins and Van Hooff 2005; Jun 2005; Muse 2003; Stewart et al. 2010; Wiggam 2004). Studies also consistently support the notion that self-directness may have a positive developmental trajectory over the lifespan until the 50s (Reio and Davis 2005). As a result, older students may have higher levels of self-regulation and self-directed skills that would contribute to success in online course. These substantial variations in self-directed learning readiness and regulation skills across student subgroups imply that learners may not be equally predisposed to engage in online learning. As directly pointed out by Michael Zastrocky, research director for academic strategies for the Gartner Group, "there are some students who really do not do well outside a traditional classroom. There are some who do very well" (cited in Kokmen 1998, p. 1).

The notion that certain subgroups of students, such as racial minority students and academically underprepared students, may perform more poorly than other students in online courses would be unsurprising, given that these students tend to perform more poorly in college overall, due to systematic disadvantages in the quality of their primary and secondary schooling (Allen 1997; DuBrock 2000; Feldman 1993; Wiggam 2004). However, the possibility that students may vary in their ability to learn as effectively in online environment as they can in face-to-face delivery format warrants further policy attention, as it suggests that online learning may widen the equity dimensions of student performance gap by aggravating the academic challenges. For example, while one would expect students with lower levels of academic preparation to fare more poorly in any course compared to their better prepared peers, one might expect that performance gap to be even wider in the online context. In this regard, the continuing online expansion in college, especially in high-stake lower-division courses, may in effect exacerbate rather than improving performance gaps that are already observed in traditional face-to-face courses.

Strategies to Improve Online Education

What Online Design Features Predict Better Learning?

The effectiveness of online learning depends on how specifically an online course is designed and delivered. Therefore, the first step toward benchmarking online course quality is to identify specific course design features and instructional practices that have substantial impacts on successful online learning. Numerous studies have been conducted in the arena of teaching effectiveness, examining the online delivery format through theoretical approaches, student ratings, and faculty opinions (e.g., Grandzol 2006; Keeton 2004; MacDonald et al. 2001; Ralston-Berg 2010, 2011; Smissen and Sims 2002). To ensure the quality of online education, several educational associations have synthesized research findings from existing studies into rubrics to certify the quality of online courses, some of which have been widely adopted by higher education institutions, such as the "24 Benchmarks for Success in

Internet-Based Higher Education" created by the Institute for Higher Education Quality (Merisotis and Phipps 2000), Sloan Consortium (Sloan-C)'s "Five Pillars of Quality Online Education" (Moore 2005), and the widely adopted rubric "Quality Matters" developed by MarylandOnline.

While these online rubrics have provided a comprehensive set of recommended online instructional practices, research has not yet established a clear empirical link between these specific indicators and student learning outcomes. As a result, it is both difficult for instructors to choose among the wide variety of recommended practices to design their own online class, and for institutions to decide which items to use for measuring online course quality. In order to link various aspects of online course design features and student course performance, Jaggars and Xu (2016) grouped the specific instructional practices mentioned in the current rubrics into four general areas and explored the impact of each area on student end-of-semester performance in 35 online classes at two community colleges. The four areas are: (1) organization and presentation – course has an easy to navigate interface and helps students to identify and manage course requirements; (2) learning objectives and alignment – learning objectives and performance standards are clearly outlined so that students have information about what they need to know and will be asked to do; (3) interpersonal interaction – course includes plentiful opportunities for students to interact with the instructor, and other students; (4) technology – instructor integrates current technologies into courses in an easily accessible way. Their findings indicate that while well-organized courses with well-specified learning objectives are certainly desirable, these design features do not significantly predict student learning outcomes. Among the four areas of design features examined, only the quality of interpersonal interaction relates positively and significantly to student grades.

The links between effective interactions in online courses and student learning outcomes are also bolstered in several empirical studies that focus on student-faculty interactions and peer interactions in online classes (e.g., Bernard et al. 2009; Gunawardena and Zittle 1997). Bernard et al. (2009) conducted a meta-analysis of the experimental literature of online education that compares interaction treatments with other instructional treatments. The results from the meta-analyses suggest that designing effective interactions into online education courses, either through increasing interaction with the course instructor or with peers positively affects student learning. The adjusted average effect of 0.38 represents a moderate and significant advantage for interactions over alternative instructional treatments, including less prominent ones. In addition to evidence from experimental designs, studies that explore student and faculty perceptions of online learning also lend support to the importance of effective communication and interactions (e.g., Ralston-Berg 2010, 2011; Smissen and Sims 2002). Student and faculty seem to agree that effective faculty-student and student-student interactions are critical to effective online learning.

The importance of effective interpersonal interactions in online learning is closely in line with learning theories that nominate active interactions with faculty and peers as a critical predictor of general sense of belonging and college persistence (e.g., Tinto 1998), and in the online learning environment specifically (e.g., Anderson

2004). The "Theory of Online Learning" proposed by Anderson (2004), for example, argues that effective learning environment should afford many modalities of interactions between the three macro components namely students, instructors, and content. These interactions are described as critical to effective learning and take place when the learning environment is learner-centered, knowledge-centered, assessment-centered, and community-centered. Balaji and Chakrabarti (2010) in their theoretical review of online education also indicate that "interactivity has been considered as central tenet to the concept of 'online learning theory.'"

The major advantages of effective interactions, according to these online theorists, are twofold: First, collaborative work and effective interactions can help build a learning community that encourages critical thinking, problem solving, analysis, integration, and synthesis, thus promoting deep understanding on a topic (Fulford and Zhang 1993; Kearsley 1995; Moore and Kearsley 1996; Picciano 2001; Scardamalia and Bereiter 2006; Sherry 1995). In addition, many researchers (e.g., Gunawardena and Zittle 1997; Shearer 2013; Young 2006) indicate that effective interactions can also reduce the sense of isolation and increase student satisfaction with online learning by enhancing the extent of social presence. Young (2006), for example, directly pointed out: "When interactive activities are carefully planned, they lead not only to greater learning, but they also enhance motivation" (p. 67).

Promises and Caveats of Specific Strategies to Facilitate Online Learning

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. It should be noted that 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 (Jaggars 2014) and that older students typically have higher level of self-directed learning skills, college may be able to expand online learning more drastically in courses or programs enrolling a large proportion of adult learners. In contrast, in lower-division course where 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 that has been adopted by many colleges 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. However, since online students often choose the format in order to accommodate work and family responsibilities (Jaggars 2014), they may face challenges accessing these supports if they are delivered exclusively on campus. 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.

The California community college system, for example, 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 (Online Education Initiative 2018). 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 that help students evaluate their readiness for online learning, as well as to 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 (Nguyen 2017). 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 utilize 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 (e.g., Walker and Leary 2009), and providing synchronous online discussion sessions to improve instructor-student interaction by mimicking traditional classroom interactions (e.g., Means et al. 2009). 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 (e.g., Acitelli et al. 2003), 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.

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 (Cho and Kim 2013; Hrastinski 2006) and office hour visits are often brief and underutilized (Jaasma and Koper 1999; Nadler and Nadler 2000). Based on these observations, some researchers suggest providing structured group face-to-face meeting session as a substitute for office hours for answering student questions (Nadler and Nadler 2000).

While students may benefit substantially from a well-organized online course with high-level of peer interactions and student-faculty interactions, maintaining these high-level interaction requires instructors to devote a substantial amount of time throughout the course. For example, in a recent study based on a total of 35 online course sections selected from the most popular introductory academic subjects at two community colleges (Jaggars and Xu 2016), students in high-interaction courses reported that their 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 responsive to that input. All these activities require strong time commitment 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, as well as the cost of supporting instructors in using sophisticated technology infrastructure and instructional platforms.

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 (Romero and Ventura 2010). 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 in order to identify and intervene to help struggling students before they withdraw from the course. For example, Arnold and Pistilli (2012) 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. 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 advisors provide.

Scaffolds for Online Learning Skills and 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 (Azevedo et al. 2004; Corbeil 2003). Given the critical 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 in order to build those skills (Azevedo 2005; Quintana et al. 2005; Shapiro 2000). For example, some researchers (e.g., Ashraf et al. 2006; Giné et al. 2010; Kaur et al. 2015) 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.

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 (Bork and Rucks-Ahidiana 2013) 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. 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 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 indeed has the potential to 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 to 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 given by students 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 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 online courses are substantially more prevalent at nonselective institutions that disproportionately enroll students from underrepresented groups and from lower socioeconomic background.

In the particular setting of nonselective institutions, students on average learn less well in online courses compared to similar students in face-to-face classes. Research finds that online learning can even exacerbate education inequality among different demographic groups that already exist in traditional face-to-face classrooms, since

successful online learning requires high level of self-directed learning skills that often impose additional challenges to students who are academically less prepared.

While future research is still needed to examine the overall net gain of the current online expansion in human capital accumulation at the postsecondary education sector, what we do know from the current literature is that the net benefits of online learning vary significantly across subgroups of students. While older students performed more poorly in online courses than in face-to-face courses, many of these students have family and childcare obligations and may need to take fewer courses or not be able to receive postsecondary education without the flexibility of online learning. For this population, a slight decrement in performance may represent a rational trade-off. In contrast, many students opt into online sections either because of limited availability of face-to-face sections or due to misconceptions regarding the challenges of distance learning. These students would be subject to performance decrement while not benefit from the flexibility of online learning at the same time.

Based on the growing knowledge regarding the specific challenges of online learning, institutions seem to be increasingly invested in benchmarking the quality of online courses and providing necessary supports to online students. Central to these efforts is the advocate for effective interpersonal interaction opportunities in a virtual learning environment. Yet, while some students may benefit substantially from a well-organized online course with high-level of peer interactions and student-faculty interactions, maintaining these high-level interaction 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 responsive to that input. All these activities require strong time commitment 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, as well as the cost of supporting instructors in using sophisticated technology infrastructure and instructional platforms.

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Appendix A: Experimental and Quasi-experimental Evidence on the Impact of Online Learning on Student Outcomes

See Table 1.

Table 1 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 et al. (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 post-test 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)

Table 1 (continued)

Study	Setting	Sample	Experiment conditions	Description of online format	Methodology	Outcome measures	Key findings
Alpert et al. (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-experiment studies						
Coates et al. (2004)	Public universities	N = 126	Face-to-face with online assignments; fully online	Online lecture with online synchronous or asynchronous discussion	2SLS correction	1. Course grade	1. Negative effects of fully online format on course grade.
Xu and Jaggars (2011b)	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% online); Online (over 51% 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% 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
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)	Reginal comprehensive universities	N = 38,652	Face-to-face; online (over 75% online)	Unspecified	Fixed-effects with instrumental variable	1. Subsequent course grade	1. Negative effects of online format on subsequent course grade
Bettinger et al. (2017b)	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

(continued)

Table 1 (continued)

Study	Setting	Sample	Experiment conditions	Description of online format	Methodology	Outcome measures	Key findings
Hart et al. (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 2. Negative effects of fully online format on course completion 3. Fully online format increases likelihood of same-course repetition 4. Fully online format decreases likelihood of subsequent course enrollment in the same subject

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