COVID-19 in California Community Colleges: College Responses, College Resources, and Student Outcomes

Cassandra M.D. Hart[a], Di Xu[b], Emily Alonso[a], & Michael Hill[b]

(a) University of California, Davis. Address: School of Education, University of California, Davis, One Shields Avenue, Davis, CA 95616
(b) University of California, Irvine. Address: School of Education, University of California, Irvine, 3200 Education Bldg, Irvine, CA 92697

Correspondence: Please direct correspondence to Cassandra Hart. Email: cmdhart@ucdavis.edu. Address: School of Education, University of California, Davis, One Shields Avenue, Davis, CA 95616. ORCID: 0000-0003-3737-789.

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Abstract

In Spring 2020, colleges across the nation swiftly transitioned their operations—including both classes and student support services—to remote delivery on an emergency basis in response to the crisis posed by the COVID-19 pandemic. While prior research has documented that the transition was associated with decrements in student outcomes, there remains limited understanding of the organizational factors that might have mitigated these negative associations during the pandemic. Drawing on administrative data from the California Community College system, along with a novel survey conducted among distance education leaders, our study reveals that the degree of declines in course completion and course passing rates varied based on pre-COVID online education resources (such as the ratio of distance education personnel to students and the availability of pre-COVID professional development programs in online learning): Colleges with greater pre-COVID online resources experienced more modest declines in student performance. To a lesser extent, we also found that declines in student performance during the onset of the pandemic varied depending on the responses implemented in reaction to the pandemic, such as the extent of technology delivery to students. The implications of our findings extend to the realm of planning for the continuity of operations in potential future crises.

Keywords: COVID-19, community colleges, distance education, online education

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Introduction

In spring 2020, colleges across the nation struggled to respond to campus closures necessitated by the COVID-19 pandemic. In the wake of the crisis situation (Bundy et al., 2017) posed by COVID-19, colleges moved quickly to expand remote instruction and transfer previously-face-to-face classes online on an emergency basis. While a number of studies have documented the effects of this rapid online transition on student academic outcomes (e.g., Bird et al., 2022; Bulman & Fairlie, 2022; Linden et al., 2022; Rodríguez-Planas, 2022), few studies have looked at the types of organizational factors that may have moderated how successfully colleges were able to transition their face-to-face (FtF) students to remote instruction in the wake of the crisis posed by COVID-19. For instance, colleges equipped with well-established resources for online instruction, such as pre-existing online student support services and distance education departments prepared to offer training for online instruction, may plausibly have encountered smoother transitions for both faculty and students during the shift to remote learning. Similarly, specific responses implemented by colleges, such as providing training to assist students in adapting to online course formats, may have helped facilitate a more seamless transition. Understanding these factors is vital for developing strategies to improve future crisis responses and ensure the continuity of education in similar emergency situations.

This paper aims to bridge this gap in the literature by specifically examining whether the degree of changes in student outcomes associated with the pandemic and the resulting move to online instruction in Spring 2020 varied based on colleges' pre-pandemic online teaching and learning resources, as well as college responses during the pandemic. We examine this question in the context of the California Community College (CCC) system—the largest system of higher education in the nation (California Community Colleges Chancellor's Office, 2020).

Community colleges serve as a vital segment of the higher education system, offering access to education for a diverse and often underserved student population, including those from low-income backgrounds, first-generation college students, and working adults (Bailey, Jaggars, & Jenkins, 2015). Often operating with fewer resources and less robust online infrastructure compared with four-year institutions, community colleges faced unique challenges during the COVID-19 pandemic when institutions needed to quickly adapt their teaching methods and support systems during the rapid shift to remote instruction. Therefore, understanding the factors associated with the successful implementation of remote learning strategies in the particular context of community colleges may provide valuable insights into their reliance and adaptability in the face of resource constraints.

To address this question, we draw on novel surveys of community college distance education (DE) coordinators (college personnel responsible for coordinating resources for the provision of high-quality online courses) and administrative data to answer three main questions:

1) How did student outcomes such as completion and course-passing rates change during the Spring 2020 term compared to prior terms? Were there differential changes in outcomes for students whose courses were originally intended to be face-to-face and those who were originally enrolled in online courses?

2) Did the degree of changes in student outcomes during Spring 2020 vary based on colleges' pre-existing *campus resources* (e.g., online counseling services, training for online faculty, distance education-oriented human resources), for students transitioning from face-to-face to emergency remote instruction?

3) Did the degree of changes in student outcomes during Spring 2020 vary based on *campus responses* (e.g., distance education training for faculty new to remote instruction,

technology provision to students), for students transitioning from face-to-face to emergency remote instruction?

We find that there was a significant and substantial decline in student outcomes during the onset of the pandemic. Specifically, students enrolled in classes intended to be delivered FtF in Spring 2020 saw significant declines in course completions and course passing rates compared to students in earlier years. However, certain colleges demonstrated a greater capacity to mitigate the negative academic consequences of the pandemic during this challenging period. Colleges with stronger pre-pandemic online learning resources—such as a higher share of courses offered online, a higher pre-pandemic ratio of dedicated distance education personnel relative to the student population, and pre-existing professional development for online teaching—had less severe disruptions to student learning outcomes in Spring 2020. To a lesser extent, campuses with stronger responses— such as the provision of various technology resources to students —also experienced more modest declines in online learning outcomes. While we caution that our data do not allow us to make strong causal claims about the resources and responses that we study, the pattern of results uncovered by our analysis raise some important considerations for colleges going forward around how to promote continuity of operations in the event of future disruptions to on-campus educational delivery.

Literature Review

Our study is motivated by the notion that in the wake of the crisis posed by COVID-19, some colleges may have been better situated to mitigate declines in student outcomes related to the pandemic. We draw on theories around factors that influence organizations' outcomes in crises to situate our predictions. We then turn to describing the acute phase of the COVID-19 pandemic as the backdrop for our study, and outline the conceptual grounding for why we

anticipate that student outcomes may have differed based on colleges' pre-crisis online learning resources, as well as their responses to the crisis posed by the pandemic.

Crises and Organizational Resiliency

A lengthy literature has emerged looking at how crises affect different organizations and the factors that promote organizational resilience, continuity of operations, and recovery. Bundy et al. (2017) synthesize this literature to provide several key definitions around crises and the facets that describe how organizations manage them. They define organizational crises as salient, unexpected, and potentially disruptive events besetting organizations that threaten those organizations' ability to achieve their goals and maintain strong relationships with external stakeholders (Bundy et al., 2017). One important aspect of crises captures external perspectives, in which organizations manage their relations with external stakeholders (like consumers or community members) during crises (Bundy, 2017). However, a second aspect—arguably more within the organizations' control—relates to their own internal procedures.

In particular, the internal perspective highlights three stages of crisis management: the *precrisis prevention* stage, the *crisis management stage,* and the *postcrisis outcomes* stage. In the *precrisis prevention* stage, organizations undertake activities that may minimize the likelihood that crises will occur in the first place, or that may minimize the seriousness of crises that do occur (Bundy et al., 2017). For instance, Bundy et al. note that organizations that create structures to improve their reliability in operations are less likely to suffer severe outcomes from crises that arise, even for organizations that operate in relatively volatile conditions (e.g., NASA or SWAT teams). In the *crisis management* stage, organizations marshal resources to provide acute responses to crisis situations. Bundy et al (2017) describe scholarship in this area as largely addressing approaches to "fixing the problem", including leadership factors that may

promote more adaptive responses. In the *postcrisis outcomes* stage, organizations learn from the crisis and, ideally, implement lessons to help the organization better weather future crises. For instance, organizations may draw lessons around how to prevent future crises of a similar type, or around how to promote continuity of operations in the face of similar crises in the future (e.g., Bennett, 2021). A spate of recent studies have drawn on crisis management literature to explore organizational outcomes for educational institutions during the pandemic (e.g., Spais & Paul, 2021; Steinsund & Eid, 2023; Yuan et al., 2023).

In this study, we look at different features of colleges that may have made them better able to weather the crisis posed by the shift to emergency remote learning during COVID-19. In particular, we posit that colleges that had greater pre-pandemic online learning resources—i.e., that were better resourced to support online learning during the *precrisis* stage—may have been better poised to transition face-to-face courses online during the acute stage of the COVID-19 crisis, as reflected in student course success. Similarly, we posit that colleges' responses in the immediate face of the pandemic—during the *crisis management* stage—may have been associated with changes in student course success. We argue that our findings have implications for colleges as they consider lessons from the pandemic during the *postcrisis outcomes* stage.

While we draw on the crisis management framework articulated by Bundy et al. (2017), we acknowledge some important deviations between the way we theorize about colleges' management of COVID and a canonical application of their framework. In particular, while pre-pandemic online learning resources may reflect efforts made during the *precrisis* stage, in general, we do not believe that these investments were made *with the intent* of crisis prevention or crisis management per se. Rather, pre-pandemic online learning investments most likely reflected other factors like colleges responding to demand for online courses or to pressures to

improve online course quality. Despite this, we believe that the framework can yield valuable insights about how institutions may have been differently poised to respond to COVID, with implications for their students' success.

COVID-19 as an Educational Crisis

In recent years, a number of studies have examined the impacts of the COVID-19 pandemic on college student outcomes and resources allocated to meet student need. With regard to student outcomes during the pandemic, particularly in the acute phase of the crisis in 2020, several studies show negative impacts on outcomes such as course completion rates and student retention (Bird et al., 2022; Bulman & Fairlie, 2022; Linden et al., 2022; Rodríguez-Planas, 2022).[1] At the same time, the severity of the pandemic's effects on educational outcomes may have depended on colleges' pre-crisis resources, as well as on their responses during the crisis management phase, as we detail below.

Pre-Crisis Online Learning Resources as a Potential Buffering Factor

We posit that the challenge of switching to widespread remote instruction may have differed based on the pre-crisis levels of experience with online instruction on each campus, or the prior adoption of tools like virtual counseling platforms that allow online students to more easily access student supports. Colleges with more robust distance education offerings (i.e., a greater share of courses offered online) may have been better suited to weather the crisis for several reasons. For example, instructors in colleges with more online offerings may have had greater prior opportunities to teach online; instructors with prior experience in turn may have been better situated to move their previously-in-person courses online. Moreover, some

[1] Distinct but related sets of studies have examined questions such as online vs. face-to-face student outcomes during later stages of COVID (Kofoed et al., 2021) and documented college student experiences during the pandemic (e.g., Aucejo et al., 2020; Schudde et al., 2022; Tate et al., 2022).

interview-based studies suggest that instructors who previously taught online were able to share online teaching materials with other colleagues teaching the same course who were moving their courses online for the first time (Hart et al., 2021b). Colleges with more robust pre-pandemic online offerings may logically have been better situated to benefit from this type of sharing.

Similarly, colleges with more pre-pandemic infrastructure in place related to online instruction may have fared better. For instance, colleges who had faculty leaders and administrators staffed in specific roles dedicated to online instruction pre-pandemic may have had a deep well of expertise to draw on to support the transition. Such personnel may have been well-situated to advise college leaders on the most crucial elements needed to support new teachers and learners in online settings, and to provide crucial support to colleagues moving classes online (Moreno et al., 2022).

Likewise, the prior availability of in-house professional development programs may also have affected how easily colleges were able to provide training for instructors newly moving online. College presidents across the system reported widespread efforts to train faculty moving online, with efforts often led by distance education professionals within the colleges (Cooper et al., 2020). However, some colleges had robust training programs already in place, while others had either minimal training programs or sent faculty to training providers outside of the college (e.g., to the @ONE professional development classes provided by the California Virtual Campus-Online Education Initiative; Hart et al., 2021a). Colleges with in-house experience may have been better situated to support the move to emergency remote instruction.

Similarly, colleges that already had online student supports in place may have been better poised to scale up virtual provision of counseling, tutoring, and other student supports college-wide. Prior studies (often correlational) suggest that access to tutoring and counseling services

are associated with student success (Boylan, Bliss & Bonham, 1997; Rutschow & Schneider, 2011; Schneider & Clark, 2018; see also Hardt et al., 2023 for evidence on online tutoring during COVID specifically), so ensuring virtual access to these services may have improved student success in emergency remote instruction. While CCC leadership moved quickly to expand access to many student support resources during the pandemic, offering services such as online tutoring (NetTutor) and an online platform to run counseling appointments (Cranium Cafe) to all campuses systemwide (California Virtual Campus-Online Education Initiative, 2020), some colleges already used those systems pre-pandemic, and they may have faced fewer barriers towards scaling them up for use during the pandemic. For instance, interviews with community college leaders in the CCC system (Cooper et al., 2020; Hart et al., 2021b) suggest that some campuses with prior experience offering academic counseling were able to draw on that experience to easily guide students through using those tools, while other campuses just adopting online counseling platforms faced a learning curve in how to use those tools to serve students virtually.

In short, while we do not argue that variability across colleges in pre-COVID investment in online learning resources represented any attempt to anticipate future crises that would force learning online, it is certainly plausible that some colleges were better positioned than others to weather the transition, as an incidental result of pre-pandemic investments in online learning. Our ability to explore this question is one of the major contributions of our study.

College Responses during the Crisis Management Phase as a Potential Buffering Factor

While differences in pre-pandemic resources may have positioned some colleges better than others to confront the transition to all-remote learning, college responses likely played a role as well. Interview-based (Cooper et al., 2020; Hart et al., 2021b) and survey-based studies (Hart

et al., 2021a) looking at the California Community Colleges suggest variability in campus responses to the pandemic along several dimensions. For example, while almost all campuses seem to have provided laptop or similar devices to students who need them to some extent, colleges were more varied on whether they provided technology such as webcams (Hart et al., 2021a) which may have been important to allowing students to participate in courses delivered through synchronous instruction.

Similarly, while most colleges seem to have offered some training to instructors moving courses online, colleges varied in their approaches to training. While most colleges offered online synchronous training options, some went beyond this to offer other options like consulting with peer mentors or with dedicated instructional designers employed at the college (Hart et al., 2021a, Cooper et al., 2020). Faculty able to access a more robust set of training options may have been better poised to move classes online.

Finally, while most colleges offered some support to training students, there was also variation in how widely available such options were. For instance, while most colleges offered training in how to use Canvas and Zoom, fewer offered more general training such as how to use specific devices (Hart et al., 2021a). Students with access to a broader set of training options may have faced fewer barriers in accessing and completing online classes.

Our study explores whether colleges with more robust responses along such dimensions predicted better student success during the crisis period of Spring 2020.

Methods

This project weaves together primary data from surveys of distance education coordinators with secondary data from systemwide administrative records and institutional information from the National Center for Education Statistics Integrated Postsecondary

Education Data System (IPEDS). To characterize changes in student outcomes during the COVID-19 crisis, we draw on administrative data from the California Community College (CCC) system. The data includes course enrollments, course outcomes, and student and course characteristics for all enrollments across all CCC campuses. In addition to examining Spring 2020 data, we use data from Fall 2015-Fall 2019 to establish a comparative baseline of pre-COVID-19 outcomes. While the primary focus of our analyses centers on outcomes for students with intended face-to-face enrollments (e.g., where the student enrolled in a section that was planned to be delivered face-to-face), we also explore intended-online enrollments to provide context for changes during the COVID quarter. Our analyses comprise nearly 38,000,000 student-by-course level observations.

Survey data are drawn from the COVID Distance Education Leaders Survey (CDELS). To collect this data, the research team emailed survey invitations in Fall 2020 to DE leaders on all CCC campuses. Because the structure of DE departments varies across colleges—ranging from departments led by dedicated deans to colleges lacking a dedicated point person—we targeted a role that existed at most colleges: DE coordinators, who help promote online course quality within colleges. While the specific duties can differ from one college to another, the role typically entails responsibilities such as staying informed of state guidelines around online course quality, providing training for online pedagogy, and similar functions. In instances where colleges did not have a designated DE coordinator, we directed the survey to individuals with related roles (DE deans, online faculty coordinators, leaders on faculty committees related to online course quality, instructional designers, etc.). To enhance the study's visibility and participation, we disseminated an announcement during a meeting of the California Community College (CCC) system's statewide Distance Education Coordinators Organization.

Surveys were delivered through personalized Qualtrics links, with two reminder emails sent to DE leaders who had not yet completed the survey. We received responses from leaders at 44 colleges.[2] Survey questions asked about college responses to the pandemic (such as offering devices or training in online success skills for students and providing training to faculty to promote higher quality of remote classes) and resources for online learning on campus prior to and after the COVID-19 crisis (such as online tutoring or counseling). We use these surveys, supplemented with some additional data as described below, to generate the measures denoted as "Resource" variables, which capture pre-COVID resources for online learning, and "Response" variables, which encompass the campuses' response to the pandemic. Further details regarding the survey and associated measures can be found in Hart et al. (2021a).

Finally, we incorporate a select set of variables from the IPEDS, including information on the full-time equivalent enrollment and instructional expenditures.

Models

Our primary analyses start by estimating a model that captures the overall change in student outcomes during the shift to online instruction for students in intended-FtF courses during the terms most acutely affected by the COVID-19 pandemic. These terms include Spring 2020 and, in some model specifications, Winter 2020. The model is designed to assess how this transition was associated with changes in outcome *Y* for student *i* enrolled in section *j* of course *c* in college *s* in term *t*:

$$(1)\ Y_{ijcst} = \partial COVID_t + \gamma StudChar_{it} + \pi CrsSecChar_{jcst} + \omega TermChar_t + \theta_{cs} + \varepsilon_{ijcst}$$

We control for a host of student characteristics *($StudChar_{it}$);* course and section-level characteristics that vary over time ($CrsSecChar_{jcst}$), and term characteristics *($TermChar_t$).* We

[2] We show in Appendix Table A1 that responding campuses look similar to the system overall. We drop one college that returned a survey but did not have responses.

also include college-by-course fixed effects, θ_{cs} to capture heterogeneity in student outcomes that is associated with specific courses at specific colleges. The term of interest in these models is δ, which is interpreted as the average difference in the outcome during the COVID-affected Spring 2020 term relative to other terms in the analysis. In some analyses, we extend this model adding interaction terms to, e.g., capture the differential changes associated with COVID for intended-online students compared to face-to-face students, or for students with prior online experience.

However, our primary research interest centers on understanding how changes in student outcomes related to the onset of COVID differed based on key contextual variables, including college pre-COVID online educational resources and college COVID responses. We therefore fit models that add interaction terms between the COVID indicator and variables capturing resources and responses. To explore this with respect to resources, we include in the model a variable capturing a particular college pre-COVID online learning resource of interest *(*$Resource_s$*)* and its interaction with the COVID indicator to capture the differential changes in student outcomes related to COVID under conditions of different resources.[3]

(2) $$Y_{ijcst} = \partial COVID_t + \beta COVID * Resource_s + \sigma Resource_s + \gamma StudChar_{it} + \pi CrsSecChar_{jcst} + \omega TermChar_t + \theta_{cs} + \varepsilon_{ijcst}$$

The key term in these models is β, which captures whether the change in each student outcome during COVID was differentially stronger (or weaker) given pre-COVID levels of a given resource. Each set of interaction terms is tested in separate models in our initial specifications. For instance, while we posit that the prior availability of online counseling and prior faculty online professional development options may both be associated with more modest declines in

[3] While the main effect for $Resource_s$ is included in the equation for clarity, in practice it is absorbed by the college-course fixed effect term.

student performance during the COVID term, the moderating role of these resources are initially examined in distinct models. We also include models that test composite "Resources" and "Responses" index variables as interaction terms; these index measures are described below. Finally, in some models, we include interaction terms with both the Resource index and Response index variables simultaneously to see which was more strongly related to changes in student outcomes during COVID.

Measures

Outcome measures

We focus on two main measures of courses success. The first outcome (*Complete*) captures course completion; it is set to 1 if students have final grades or pass/no-pass designations on their transcripts, and 0 if they withdraw from the course or do not complete the course (i.e., have grades of Incomplete). Enrollments that were dropped during the add/drop period are not included. The second outcome (*PassABC)* is an indicator for whether a student passes a course, defined as earning a grade of C or better, or a pass designation.

We also estimate models using several alternative outcomes. In one model, we estimate whether COVID was associated with a change in the likelihood of course failure, as measured by an indicator for whether students earn "F" or "NP" grades (vs. any other outcome, including both passing and withdrawals). In another, we capture withdrawals (1 if students withdraw from a course and 0 otherwise); this is nearly a converse measure to completion. The only difference is that in the "Complete" measure, both withdrawal and receiving an "Incomplete" grade are treated as a "failure to complete" the course, whereas the "Withdraw" variable specifically focuses on the act of withdrawal, attempting to distinguish this particular behavior from receiving an "incomplete" grade or successful completing a course. Finally, we distinguish "excused

withdrawals" (referred to as "EW" in the tables) specifically. These designations allow students to withdraw from courses due to approved excuses without negative effects on their GPAs or threatening their full-time status for financial aid purposes, and interview data suggests a dramatic expansion of this designation during COVID (Cooper et al., 2020).

COVID

We designate the spring 2020 terms as COVID-affected (*COVIDt*=1). For schools on the quarter system, for our main models, this includes the spring quarter but not the winter quarter. In robustness tests, we show that the results are not sensitive to this decision.

Course Mode

As others have posited (e.g., Bird et al., 2022), it is reasonable to think that while online students were affected by the onset of COVID, they may have been less affected than students in courses intended face-to-face. Most of our models focus on changes in success during the COVID-affected terms in courses intended to be face-to-face—those that had to transition online mid-term. However, we also include some models that compare changes in outcomes during COVID for intended-online vs. intended-face-to-face enrollments. In these models, we include an indicator for whether the course sections taken by students were intended online using records from the CCCCO to capture the mode of each course section. Classes offered synchronously or asynchronously are considered online ($Online_{jcst}=1$). Courses intended face-to-face in Spring 2020 had indicators capturing their intended designations, as the first weeks of the term were conducted face-to-face.

Student Controls

Models also include controls for student characteristics (captured in the vector $StudChar_{it}$ in Equations 1 and 2), drawn from CCCCO data. These controls include a vector of race

indicators (White, Asian, Black, or other race, with Hispanic omitted); an indicator for sex (female; male omitted); a variable capturing age at term; an indicator for whether the student ever uses financial aid in the years observed in the data; an indicator for whether a student is a first-generation student based on reports of parent education at admission (neither parent earning a BA); an indicator for whether a student has dependents, based on FAFSA reporting; an indicator for whether a student is ever recorded with a primary exceptionality; an indicator for whether a student ever took any basic-skills classes; a vector of indicators for load in the given term (more-than-full-time, less-than-full-time; full load omitted[4]); a vector of indicators for prior educational credentials (no high school degree, high school credential earned through General Education Development or California High School Proficiency Examination, Prior AA/Prior BA; high school graduate omitted); and a vector of indicators for academic goals reported at admission (associates degree with no intent to transfer, vocational goal, fulfilling interests, gaining basic skills, obtaining credit for degrees at other institutions, or goal unknown; transfer goal omitted). Missing variable dummies are included for all control variables to avoid dropping observations with incomplete data.

Table 1 provides summary statistics of the outcome and student characteristics for students attending in Spring 2019 and Spring 2020. Note that while the outcomes differ sharply in the two periods, the student control variables look quite similar; this is unsurprising given that COVID was an unexpected shock and we would not expect anticipatory changes in enrollment patterns.

Course, Section, and Term Controlsf

[4] 12 units is full-time for a semester; 18 units is full-time for a quarter

Models also include a series of section and course controls captured in the CCCCO data (represented in the vector $CrsSecChar_{jcst}$ in Equations 1 and 2), as well as term controls (captured in $TermChar_t$ in the equations). At the section level, we include averages of student characteristics in each section, leaving out the focal student to capture peer characteristics. These leave-one-out measures include the share of students using financial aid, the share with exceptionalities, and the share aiming for associates degree or transfer as educational goals. A variable capturing the number of students in each section is also included.

At the course level, controls include a vector of indicators for course subject, an indicator for whether a given course is considered a career-technical education (CTE) course; an indicator for basic-skills status of a course; and a vector of indicators for course level (transferrable to the California State University (CSU) system only, transferrable to both the University of California and CSU systems, non-transferable courses omitted). A variable capturing the pass rate of the course in the year prior in face-to-face sections is also included to capture course difficulty. Note that course-by-college fixed effects are also included in our models, which capture the persistent, time-invariant factors associated with particular courses at particular colleges over time.

Finally, at the term level, we include an indicator for whether a given term is an academic quarter (semester omitted), as well as indicators for spring and fall terms (fall omitted; summer and intersession terms are excluded from analysis).

Pre-COVID Resource Measures

We examine five distinct measures of pre-COVID online resources to determine whether any observed changes in Spring 2020 student performance varied depending on the extent of online education resources. We also combine all of these underlying measures into a single

index, which we describe at the end of this section. The resource variables are represented by $Resource_s$ in Equation 2.

Our first measure of resources captures pre-COVID online penetration at a school. This is measured at the college level using CCCCO data and captures the share of courses offered online within college *s* measured in 2018-19 school year. A course is considered to have been "offered online" if at least one section of the course was taught online in 2018-19. As alluded to in the literature review, the theory here is that if courses were offered online for at least one section, resources for those classes (e.g., online course shells and materials) could be shared with colleagues who had only taught face-to-face to ease their transition.

Our second measure of resources captures instructional expenses (in $1000s) per full-time equivalent student. The numerator and denominator measures are both drawn from the IPEDS. The theory behind this measure is that colleges spending more on instruction may have more instructional resources that could be devoted towards the transition online, and they may have therefore transitioned more easily.

Our remaining measures draw from responses of DE leaders to the CDELS survey. The third measure of resources captures the number of reported DE personnel/1000 students. The number of pre-COVID FTE DE personnel was estimated by survey respondents, and is standardized by FTE student number from IPEDS. Our theory here is that more personnel with expertise in DE relative to college size may make it easier to support transition online, e.g., by providing more personal help to instructors shifting their courses online.

Our fourth measure captures DE leaders' reports on whether their college provided an in-house professional development program for online instruction. Many colleges require or offer training to online instructors to help them learn techniques for online pedagogy. Because the

pandemic put new demands on instructors transitioning online, as noted in the literature review section, we theorize that colleges with curricular materials already created for induction of new online instructors, and with expertise in providing training in online pedagogy, may have been better positioned during the transition.

Our final measure of pre-COVID resources is an indicator capturing whether online counseling was available online pre-COVID, based on DE leader reports from the CDELS. Initially, we intended for this measure to capture whether both online counseling and online tutoring were available at a given college. However, all responding colleges had some online tutoring options, so we could only capture variation in availability of online counseling. We theorize that colleges with online support services in place may have been better able to support students transitioning online. The top part of Table 2 provides means, standard deviations, and counts of non-missing observations for the pre-COVID resource variables

Finally, we combine all of these measures into a single Resources Index variable. For each of the underlying measures, we standardize them within the sample for which the variable is available. If a college did not contribute to a particular variable (e.g., due to item non-response on the CDELS), they were given the mean value of that variable for the sample. The columns on the right show that after standardization, all variables have mean 0 and standard deviation of 1 as expected. The standardized values of these variables were averaged across colleges to generate the resources index measure; after the variables were combined, the resulting index scale was itself standardized. As the final row of the top panel of Table 2 shows, the resulting standardized Pre-COVID Resources Scale is also distributed with a mean of 0 and a standard deviation of 1.

COVID Response Measures

We examine three distinct measures of responses in Spring 2020 to determine whether they moderate Spring 2020 outcomes. All measures of responses are drawn from responses to the CDELS survey. As with the resource variables, we combine these three measures into a "Responses" index as well.

Our first measure captures the number of types of technology distributed to students. CDELS respondents indicated which whether the following types of technology were distributed by the college in Spring 2020: laptops/Chromebooks, cameras, headsets, and hotspots. We summed these to generate an index measure, theorizing that students in colleges with more extensive tech provision may have been better situated to continue with online courses.

A second measure captures the number of approaches to instructor training during COVID. Survey respondents reported on which of the following methods they used to offer training to instructors shifting online: synchronous trainings through college, asynchronous tutorial sessions through college, asynchronous tutorials through the California Virtual Campus-Online Education Initiative (a statewide organization supporting online teaching and learning in community colleges), asynchronous tutorials through other providers, individual consultations with DE personnel, individual consultations with faculty mentors, and individual consultations with instructional designers. We theorized that colleges offering more distinct avenues for instructors to receive training may have made it easier for faculty to transition their courses online.

The third measure captured the number of skill domains in which colleges provided training to students transitioning online. Respondents reported whether colleges had provided training to students in each of the following eight domains: using Canvas, accessing online student services, communication skills in online classes, using Zoom, online study skills,

technical requirements to connect to online courses, using software products in online courses, using devices to access online courses. For this measure, we theorized that colleges that provided a broader range of supports to students may have helped students successfully transition online. The bottom panel of Table 2 shows the distribution of these Spring 2020 Response component variables, in raw form (on the left-hand side of the table) and when standardized (right-hand side).

Finally, we combine the three measures into a single Responses Index variable. The procedures mirrored those used to construct the Resource Index variable: the underlying variables were standardized and averaged, and the resulting index variable was then re-standardized. As the final row of the bottom panel of Table 2 shows, the resulting standardized scale capturing intensity of responses is also distributed with a mean of 0 and a standard deviation of 1.

Results

Table 3 presents the estimated average difference in student course performance outcomes during Spring 2020 compared with terms in the pre-COVID era. Columns 1-2 present results for the two primary outcomes: whether the student completed the course (versus withdrawing [W] or receiving an incomplete [I] grade), and whether the student successfully passed the course with a grade equal to or higher than C (versus receiving a D, F, NP, I or W). In addition, Columns 3-5 further present results for whether the student failed the course (that is, receiving an F or NP versus receiving D and above, I, or W, Column 3); withdrew from the course (that is, receiving W versus other grades, Column 4); or had an excused withdrawal from the course (Column 5).

The top panel (Panel A) shows the results that focus only on students with intended face-to-face enrollments. The results indicate that the average course outcomes changed substantially during COVID. Specifically, students were less likely to complete a course by 8.5 percentage points during Spring 2020 compared with pre-COVID, and were less likely to successfully pass a course with C or above by 3.4 percentage points. The fact that the size of the coefficient on course completion is substantially larger than successful completion suggests that the declines in student performance during Spring 2020 were largely driven by an increased probability of course withdrawal. Indeed, excused withdrawals saw a particularly sharp increase during COVID, with a 16-percentage point difference between Spring 2020 and the previous terms. Note that the high level of withdrawals also results in a lower amount of course failure (Column 3) compared to in prior terms; the 3.1 percentage point decline in course failure rates suggests that students at risk of poor performance took the opportunity to withdraw from courses rather than receive poor grades.[5]

Panel B shows the change in performance during COVID for students enrolled in sections designated pre-pandemic as online (intended-online enrollments), as well as the difference between estimated changes in outcomes during the COVID term for students in intended-online vs. intended-FtF courses.[6] Declines in performance during the COVID term are much less pronounced for intended-online students than for students enrolled in intended-FtF courses. For instance, while intended-online students were also less likely to complete a course during Spring 2020 compared to in prior terms (Column 1), the size of the coefficient is only

[5] See Appendix Figure A1 for a presentation of raw changes in outcomes in graphical form. See Appendix Table B1 for evidence that these main results are robust to various adjustments to our specifications estimated in Table 3, Panel A.

[6] These estimates come from models estimating the effects of COVID on online vs. face-to-face enrollments separately using interaction terms applied to the full sample of students.

around one third of that for intended-FtF students (-0.027 compared to -0.085). Interestingly, intended-online students actually tend to have a higher chance of passing a course with C or better during the COVID term than previous terms (b=0.035), which is aligned with observations in other studies that many instructors and institutions may have chosen to adopt more lenient instructional policies as a response to the challenges induced by COVID (Johnson et al., 2020; Bulman & Fairlie, 2022).

Finally, Panel C focuses on students with intended-FtF enrollments again (as in Panel A) and further examines whether the declines in student performance during COVID differ for intended-FtF students with vs. without prior online learning experiences. We characterize students as having prior online learning experience if they are observed in any intended-online course taken from 2015 to spring 2020. We interact the COVID term with this indicator for prior online course-taking, and present the estimated coefficient on the COVID term for each group (those with prior online experience and those without) separately. The results indicate that intended-FtF students without prior online learning experiences particularly suffered during COVID: The course completion rate was more than 10 percentage points lower for students without online experiences in Spring 2020 relative to prior terms, compared with a 7 percentage point decline in course completion for intended-FtF students with prior online experience.

Moderating Variables: Pre-Crisis Online Learning Resources and College Responses

We next examine potential variations in the changes in student course performance outcomes associated with COVID across different colleges. Figure 1 shows the variation in the changes observed during COVID in average course completion rates among students with intended face-to-face enrollments across colleges. The figure suggests substantial heterogeneity

in the changes in student outcomes associated with COVID, with estimated coefficients on the COVID term ranging from negative –0.22 to positive 0.07.

In view of this between-institution variability in COVID declines, Panels A-E in Table 4 explore specifically how the changes during COVID in course completion and course passing for students with intended face-to-face enrollments differ based on pre-COVID college resources. The generally-positive interaction terms indicate that higher levels of each type of institutional resource are associated with smaller declines in performance during COVID, although the magnitude of the coefficients on the moderating variables varies across types of resources and are not always significant on both outcome measures. In particular, the number of DE personnel seems to have an especially strong relationship with the size of the COVID penalties across outcome measures, where each one additional DE personnel per 1000 student was associated with a reduction of about half the magnitude of the main effects observed on the COVID variable. Note that a one-unit change in this measure, however, would be relatively large, as the average number of DE personnel/1000 students was 0.44 and the standard deviation was 0.58. Instructional expenses/student and the availability of prior in-house training programs around online pedagogy were also associated with significantly smaller declines in outcomes during COVID for both student outcome measures.

In contrast, the relationship between COVID and student outcomes seems to vary little based on pre-COVID availability of online academic counseling. This variable only attenuated the negative associations between COVID and successful course passing rate by less than 1 percentage point and had a null relationship with course completion rates (with the direction of the coefficient representing the sole negative interaction, albeit at non-significant levels).

Finally, the bottom panel (Panel F) of Table 4 summarizes the overall moderating role of the resource scale at an institution, and the estimates are aligned with the patterns shown above: The declines associated with COVID are attenuated at institutions with higher levels of resources.

In addition to institutional resources prior to COVID, the changes in student performance outcomes associated with COVID may also be moderated by an institution's level of response to COVID. Table 5 examines this possibility by estimating the moderating role of three specific dimensions of responses: (i) the number of types of technology distributed to students (Panel A); (ii) the number of approaches to instructor training (Panel B); (iii) the number of student skill domains to which colleges provided training (Panel C), along with the overall response scale (Panel D). The results suggest that schools with stronger responses saw smaller performance declines during the COVID term, although the coefficients for each individual response tend to be fairly small.

Finally, we take into account both responses and resources, and include them both in the same model. Results presented in Columns 1 and 2 in Panel A of Table 6 suggest that resources are more predictive of the extent to which outcomes changed during COVID than responses when both are considered simultaneously. Once prior institutional resources are included in the model, the moderating effects of response level become small and non-significant.

To examine whether the stronger effects of institutional resources during Spring 2020 on student outcomes was unique to the COVID period (when we would expect them to matter most), we further conduct a series of placebo tests, where we drop Spring 2020 (the COVID term) and name other spring terms as "pseudo-COVID" terms (Table 6, Panels B-E). If the observed moderating effects of pre-COVID resources are unique to the special setting of

COVID, when we anticipate that they should matter, we should not observe interaction effects between institutional resources and the pseudo-COVID terms that are of the same magnitude as in 2020. Indeed, the results shown in Panels B to E indicate that the coefficient on the Resource scale interaction are all small in magnitude (particularly with respect to course completion) and sometimes negative for all other pseudo-COVID terms. This bolsters our confidence that these variables mattered for intended-face-to-face students' outcomes uniquely during the term affected by COVID.

Discussion

The transition to remote learning at California community colleges was complex and varied as institutions were forced to respond to the needs of their student populations quickly and with limited guidance (Cooper et al., 2020; Hart et al., 2021b). Given the somewhat turbulent and unexpected nature of the transition to remote learning, it may be unsurprising that we find decreases in student performance such as higher rates of withdraw and lower rates of passing, as was true in other prior studies of student outcomes in Spring 2020 (e.g., Bird et al., 2022; Bulman & Fairlie, 2022). These decrements in performance associated with COVID were particularly pronounced for students who were in face-to-face classes at the time of the transition compared to students who enrolled in intended-online classes. These face-to-face students were challenged to adapt in their learning environment while they also adapted to social distancing and quarantine. It can be difficult to learn in the face of such uncertainty.

However, we also find college efforts to support students were associated with smaller declines in student performance observed during the abrupt shift to remote learning. While our design does not support strong causal claims, we observe that declines in performance were smaller at campuses with higher pre-COVID resources. This suggests that it is possible that *pre-*

crisis organizational decisions may have played into colleges' ability to maintain continuity of operations (Bundy et al., 2017). For instance, decreases in course completion rates during COVID were smaller among colleges where higher proportions of online classes were offered at a given campus before the pandemic (though we saw no differences in course passing rates based on pre-COVID online course offerings). Moreover, investments in personnel, professional development, and student support were associated with better student outcomes (both course completion and course passing) during the transition to remote instruction. The importance of these resources was particularly evident during the transition period; these resources were not consistently associated with stronger performance for face-to-face students in non-COVID terms in our placebo tests. This suggests that the existence of greater pre-COVID DE resources may have contributed to a lesser degree of overall disruption and turbulence during the transition: Greater pre-COVID investments in faculty training in online course design and delivery, for instance, may have better positioned faculty to make the jump to online when required. As a result, faculty and students may have felt less uncertainty during the transition, knowing they had access to support resources if needed.

Similarly, decisions at the *crisis management* stage were also associated with student outcomes; students at colleges with more pronounced responses during the crisis along the dimensions measured saw smaller declines in performance associated with the pandemic, although these did not remain significant when pre-crisis resources were also controlled for. This finding may have reflected the fact that better-resourced campuses were also poised to provide stronger responses during the acute crisis phase. For instance, the better-resourced campuses may have been able to put supports more quickly and efficiently in place for student technology needs, faculty training, and student learning support.

Our study has several limitations. First, given the complex nature of the transition to remote learning, it is impossible to accurately capture every resource available and every response made at each college. We were limited in the number and complexity of questions we could ask in surveys to avoid over-burdening respondents, but this results in coarser measures in some cases than would be ideal. For instance, our measures of prior online academic counseling reflect only whether online options were available, but not other relevant dimensions such as how thoroughly counselors had been trained to use such online options. In other cases, we drew measures from secondary sources that were themselves limited. For instance, we obtain data from the IPEDS about the total amount spent on instruction, but we cannot observe the specific amount allocated to distance education at each college.

Second, our survey captures responses only at a particular point in time, around Spring 2020. While an interesting extension to this paper could be to explore whether resources and responses were associated with the degree to which enrollment rates changed in Fall 2020 compared to prior years, our surveys would necessarily mis-measure the strength of responses in place by that point since we did not ask about activities over the summer. Prior interview-based research (Hart et al., 2021b) suggests that summer 2020 saw heavy investments in training for CCCs as they prepared for online fall terms.

Third, we are unable to account for variation in school- and course-specific policies that may have systematically affected student outcomes. For instance, some colleges or individual professors may have provided students with greater flexibility in terms of course deadlines, more forgiving grading practices, and more flexibility in terms of drop and withdrawal deadlines during the early days of the pandemic. Depending on how widespread and generously policy flexibility was applied across campuses, our results may be under-estimating the declines in

performance associated with the transition to remote learning. Similarly, there may be important elements of variation in implementation of the types of pre-COVID resources and responses that we study that may have been associated with student outcomes during COVID. For instance, while we identify pre-COVID training programs for online faculty as one factor associated with better outcomes during the transition, training programs likely vary widely across colleges. In data collected for an interview-based study (Hart et al., 2021b), we heard about online pedagogy training programs that varied widely in duration (e.g., some colleges had programs that lasted less than ten hours while others required over 100 hours of training). Future work should attend to questions of how variation in implementation of various resources and supports relates to student outcomes.

Despite these limitations, our findings suggesting that colleges' pre-pandemic investments in DE programs and services were associated with significantly smaller declines in performance during the COVID-19 shift to online learning in California Community Colleges are an important contribution to the literature. Distance education met the need created by the stay-at-home orders and subsequent social distancing requirements that were necessitated by the pandemic, but it may be difficult to anticipate the needs generated by a future crisis.

Our study also dovetails with other work suggesting the importance of investments in training and support for faculty and students in maintaining online instructional effectiveness, even outside of emergency remote teaching. Prior work suggests that improvements in support, training, and stronger campus commitments to online teaching and learning are likely to improve online student outcomes in non-pandemic conditions (Lee, 2008). While the nature of specific investments may vary from campus-to-campus as each considers specific organizational and operational needs, structured training and support for faculty and students are promising

practices for improving online teaching and learning (Karp, 2011; Pedro & Kumar, 2020; Scherer et al., 2021). Our work showing the value of these investments in a crisis environment suggests the importance of future work along these lines to further evaluate their value in normal times.

Finally, our findings are important as colleges think through how to prepare for the possibility of future crises and disasters. The ability to learn from the COVID crisis is an important part of ensuring successful *postcrisis outcomes* from the pandemic, in which organizations take lessons from crises to make themselves more resilient in dealing with future crises going forward (Bundy et al., 2017). Such crises may include pandemics but could also include scenarios such as natural disasters that necessitate lengthy closures of campus. Some campuses have been forced to contemplate resumption of online classes for non-disaster-related reasons as well; for instance, in 2023, the University of California Davis moved evening classes online in the wake of a string of stabbings near the campus (Burke, 2023). Colleges may also face higher expectations around the ability to swiftly switch to remote learning as needed in future disaster situations. Having once switched operations fully online, stakeholders may expect colleges to plan for the ability to do so again if needed. Future work should continue to investigate specific responses to the COVID-19 pandemic in the hope that we can better prepare for the next crisis.

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Table 1. Student-Level Descriptive Statistic (Intended FtF Enrollments)

	Spring 2019		Spring 2020	
	Mean	St. Dev	Mean	St. Dev
Outcomes				
Completion	0.87	(0.34)	0.78	(0.41)
Pass/A/B/C	0.74	(0.44)	0.70	(0.46)
Fail	0.09	(0.29)	0.06	(0.24)
Excused Withdrawal	0.00	(0.02)	0.16	(0.37)
Student Characteristics				
Hispanic	0.48	(0.50)	0.50	(0.50)
White	0.24	(0.43)	0.23	(0.42)
Asian	0.11	(0.31)	0.10	(0.30)
Black	0.06	(0.23)	0.05	(0.23)
Other Race	0.11	(0.32)	0.12	(0.33)
Female	0.51	(0.50)	0.52	(0.50)
Age at Term	24.49	(9.26)	24.15	(9.09)
SES and Family Char.				
Ever Financial Aid (BOG/Pell)	0.67	(0.47)	0.67	(0.47)
First Gen (No Parent with BA+)	0.70	(0.46)	0.69	(0.46)
Parent (Has Dependent)	0.12	(0.33)	0.12	(0.32)
Educational Enrollments				
Ever Includes Exceptionality	0.08	(0.28)	0.08	(0.27)
Any Basic-Skills Enrollments	0.54	(0.50)	0.48	(0.50)
Full Time+ (12 Units/Sem; 18/Qu)	0.51	(0.50)	0.53	(0.50)
More than Full-Time	0.38	(0.49)	0.39	(0.49)
Less than Full-Time	0.49	(0.50)	0.47	(0.50)
Prior Ed. Credentials				
No Prior High School Degree	0.06	(0.24)	0.07	(0.26)
Prior GED/CHSPE	0.05	(0.22)	0.05	(0.21)
Prior High School Diploma	0.80	(0.40)	0.80	(0.40)
Prior AA	0.03	(0.18)	0.04	(0.18)
Prior BA+	0.05	(0.22)	0.04	(0.21)
Educational Goals				
Transfer (with or without AA)	0.55	(0.50)	0.55	(0.50)
AA (No Transfer)	0.06	(0.23)	0.06	(0.23)
Vocational Credential	0.08	(0.27)	0.07	(0.26)
Goal Unknown	0.20	(0.40)	0.20	(0.40)
Interest	0.04	(0.20)	0.04	(0.21)
Basic Skills	0.02	(0.12)	0.02	(0.12)
Pursue HS/4-Year Credit	0.06	(0.24)	0.06	(0.24)
N (Student Enrollments)	2,800,785		2,592,087	

Authors' calculations from CCCCO Data.

Table 2. Descriptive Statistics for Resource and Response Scale Elements

	Raw Variables, Full Sample			Standardized (Mean Replaced), Survey Sample		
	mean	Sd	N	mean	sd	N
Pre-COVID Resources						
Frac. Courses Offered Online Pre-COVID	21.70	(10.24)	114	0.00	(1.00)	44
Instructional Expenses/FTE Student	5827.68	(1926.81)	44	0.00	(1.00)	44
FTE DE Personnel/1000 FTE Students	0.44	(0.58)	38	-0.00	(1.00)	44
Pre-COVID Prior Online PD Program	0.81	(0.40)	42	-0.00	(1.00)	44
Virtual Counseling Pre-COVID	0.62	(0.49)	37	0.00	(1.00)	44
Pre-COVID Resources: Scale				0.00	(1.00)	44
Spring 2020 Responses						
Types Devices Distributed	2.11	(0.95)	44	-0.00	(1.00)	44
Fac. Training Approaches: Count	4.78	(1.62)	41	-0.00	(1.00)	44
Student Skill Training Types: Count	4.16	(2.57)	44	0.00	(1.00)	44
Intensity of Response: Scale				0.00	(1.00)	44

Means (SD) and number of non-missing observations for each variable are given. Standardized versions are standardized within the sample of colleges that returned surveys. Missing responses are imputed at mean for variable for purposes of combining in scale.

Table 3. Student Outcome Changes During Spring 2020: Main Results

	(1) Complete	(2) Pass/ A/B/C	(3) Fail	(4) Withdraw	(5) EW
Panel A. Main Specification, Students in Intended-Face-to-Face Courses Only					
COVID: FtF Courses	-0.085***	-0.034***	-0.031***	0.081***	0.162***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
(N)			30,697,367		
Panel B. Students in Intended-Online Courses vs. Intended-Face-to-Face					
COVID: Online Courses	-0.027***	0.035***	-0.050***	0.026***	0.126***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Diff. Impact for FtF	-0.058***	-0.070***	0.019***	0.056***	0.036***
Courses	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
(N)			37,980,964		
Panel C. Students in Intended-FtF Classes, by Prior Online Experience					
COVID: Prior Online	-0.068***	-0.011***	-0.036***	0.065***	0.148***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
COVID: No Prior Online	-0.104***	-0.061***	-0.026***	0.100***	0.179***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
P-val (Diff)	0.00	0.00	0.00	0.00	0.00
Total (N)			30,697,367		

Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. Coefficient (cluster robust standard error) Standard errors clustered at college-course level. All analyses include student controls (for student race/ethnicity, sex, aid use, age, matriculation goal, course load, parenting indicators, first gen status, exceptionality status, basic skills enrollment, and prior degree); section controls(share of students using financial aid, share of students with exceptionalities, share of students aiming for AA or transfer, size); course controls (year-prior face-to-face pass rate, basic skills vs. transfer level, CTE status, course subject indicators); and time(indicators for term (spring/winter vs. fall) and course length (quarter vs. semester). All models include college-course fixed effects. Results in Panel B are based on models including main effects and interaction terms for COVID and course modality (using a sample of both FtF and online enrollments). The results in Panel C are based on models that include main effects and interaction terms for prior online course-taking (i.e., an indicator for taking at least one (intended) online course between fall 2015-spring 2020.) Coefficients represent total effects for groups with prior and no prior online experience. The number of enrollments for students in intended-FtF classes with prior online experience was 18,220,502; the number of enrollments for students in intended-FtF classes with no prior online experience was 12,476,865).

Table 4. Changes in Outcomes During Spring 2020: By College Pre-COVID Resources

	(1) Complete	(2) Pass/A/B/C
Panel A. By Share Courses with 1+ Online Section, 2018-19		
COVID	-0.084***	-0.034***
	(0.001)	(0.001)
COVID*Frac. Crs. Virt	0.087***	0.020
	(0.013)	(0.012)
(N)	30,697,367	30,697,367
Panel B. By DE Personnel/1000 Stud.		
COVID	-0.076***	-0.030***
	(0.002)	(0.002)
COVID*DE Personnel/Students (K)	0.038***	0.014***
	(0.003)	(0.004)
(N)	10,294,931	10,294,931
Panel C. Instructional Expenses (K)/Student		
COVID	-0.077***	-0.029***
	(0.002)	(0.002)
COVID*Instruct. Exp (K)/FTE Stud	0.002***	0.003***
	(0.001)	(0.001)
(N)	11,041,059	11,041,059
Panel D. By Pre-COVID Faculty Training Program Availability		
COVID	-0.107***	-0.048***
	(0.005)	(0.005)
COVID*Prior Training Prog.	0.036***	0.022***
	(0.006)	(0.006)
(N)	10,758,258	10,758,258
Panel E. By Prior Availability of Virtual Counseling		
COVID	-0.073***	-0.033***
	(0.003)	(0.003)
COVID*Prior Counseling	-0.003	0.007*
	(0.004)	(0.004)
(N)	9,821,579	9,821,579
Panel F. By Resource Scale		
COVID	-0.076***	-0.029***
	(0.002)	(0.002)
COVID*Resource Scale	0.014***	0.011***
	(0.002)	(0.002)
(N)	11,041,059	11,041,059

Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. Each panel represents a separate regression. Cells include b (cluster robust standard error). Standard errors clustered at college-course level. All models include full set of student, college, course, and time characteristics. Each unit represents a student-enrollment in a class intended face-to-face.

Table 5. Changes in Outcomes During Spring 2020: By College Response Intensity

	(1) Complete	(2) Pass/A/B/C
Panel A. By Num. Tech Types Distributed		
COVID	-0.077***	-0.030***
	(0.002)	(0.002)
COVID*Tech Types	0.005***	0.005***
	(0.002)	(0.002)
(N)	11,041,059	11,041,059
Panel B. By Num. Faculty Training Approaches		
COVID	-0.075***	-0.029***
	(0.002)	(0.002)
COVID*Num. Training Approaches	-0.001	0.004***
	(0.001)	(0.001)
(N)	10,475,231	10,475,231
Panel C. By Student Skill Domains		
COVID	-0.077***	-0.030***
	(0.002)	(0.002)
COVID*Num. Study Skills	0.003***	0.001
	(0.001)	(0.001)
(N)	11,041,059	11,041,059
Panel D. Response Scale		
COVID	-0.077***	-0.030***
	(0.002)	(0.002)
COVID*Response Scale	0.006***	0.006***
	(0.002)	(0.002)
(N)	11,041,059	11,041,059

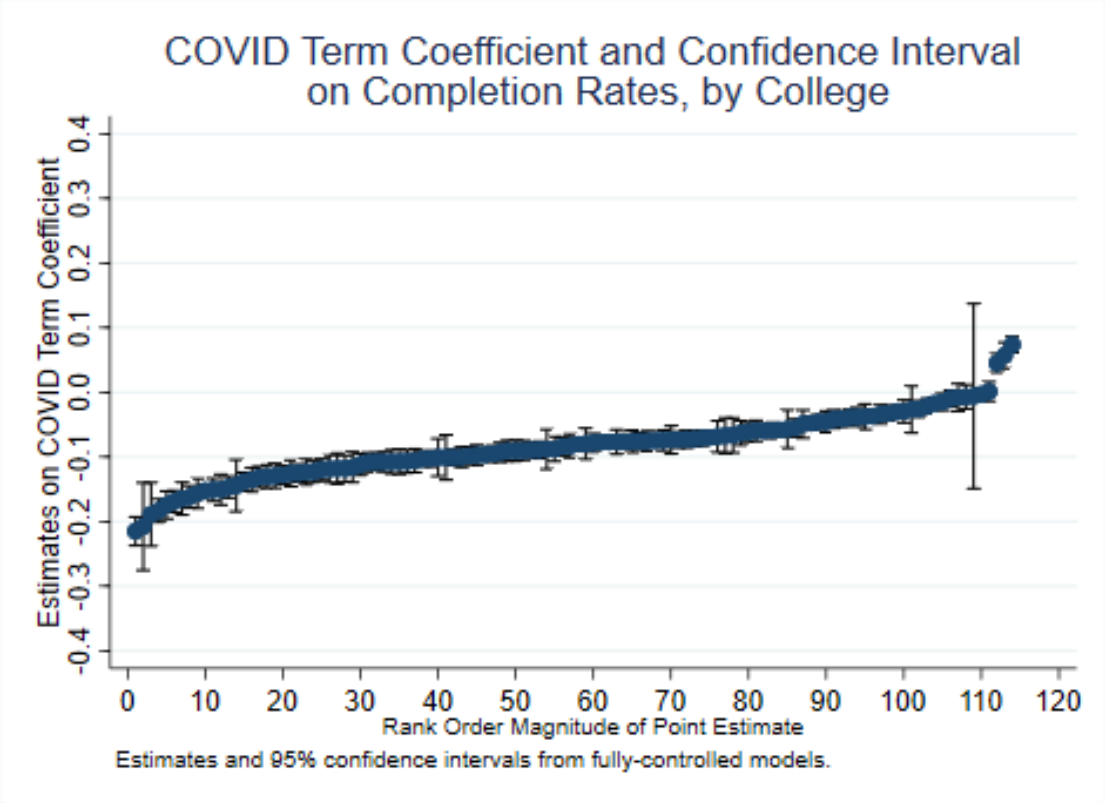
Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. Panels all from separate regressions: b (cluster robust standard error) Standard errors clustered at college-course level. Each unit represents a student-enrollment in a class intended face-to-face.

Table 6. Moderating Variables: Pre-COVID Resources and Spring 2020 Responses

	(1) Complete	(2) Pass/A/B/C
Panel A. Combined Regression Main Results		
COVID*Resource Scale	0.013***	0.010***
	(0.002)	(0.002)
COVID*Response Scale	0.001	0.002
	(0.002)	(0.002)
COVID	-0.076***	-0.029***
	(0.002)	(0.002)
(N)	11,041,059	
Panel B. Placebo Term: Spring 2016		
Placebo 2016*Resources	-0.001	-0.005***
	(0.001)	(0.001)
Placebo 2016*Response	0.001*	-0.000
	(0.001)	(0.001)
(N)	9,020,352	
Panel C. Placebo Term: Spring 2017		
Placebo 2017*Resources	-0.003**	-0.002*
	(0.001)	(0.001)
Placebo 2017*Response	-0.000	0.001
	(0.001)	(0.001)
(N)	9,020,352	
Panel D. Placebo Term: Spring 2018		
Placebo 2018*Resources	0.002**	0.005***
	(0.001)	(0.001)
Placebo 2018*Response	-0.002**	-0.001
	(0.001)	(0.001)
(N)	9,020,352	
Panel E. Placebo Term: Spring 2019		
Placebo 2019*Resources	0.003***	0.005***
	(0.001)	(0.001)
Placebo 2019*Response	-0.001	-0.003**
	(0.001)	(0.001)
(N)	9,020,352	

Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. b (cluster robust standard error). Standard errors clustered at college-course level. All models include Placebo-COVID main effect and full set of student, college, course, and time characteristics. Each unit represents a student-enrollment in a class intended face-to-face. Fall 2019 on dropped from placebo analyses. Placebo involves labelling spring terms in other years as COVID-affected.

Figure 1. Estimates on Completion Changes by College (114 Physical Campuses)

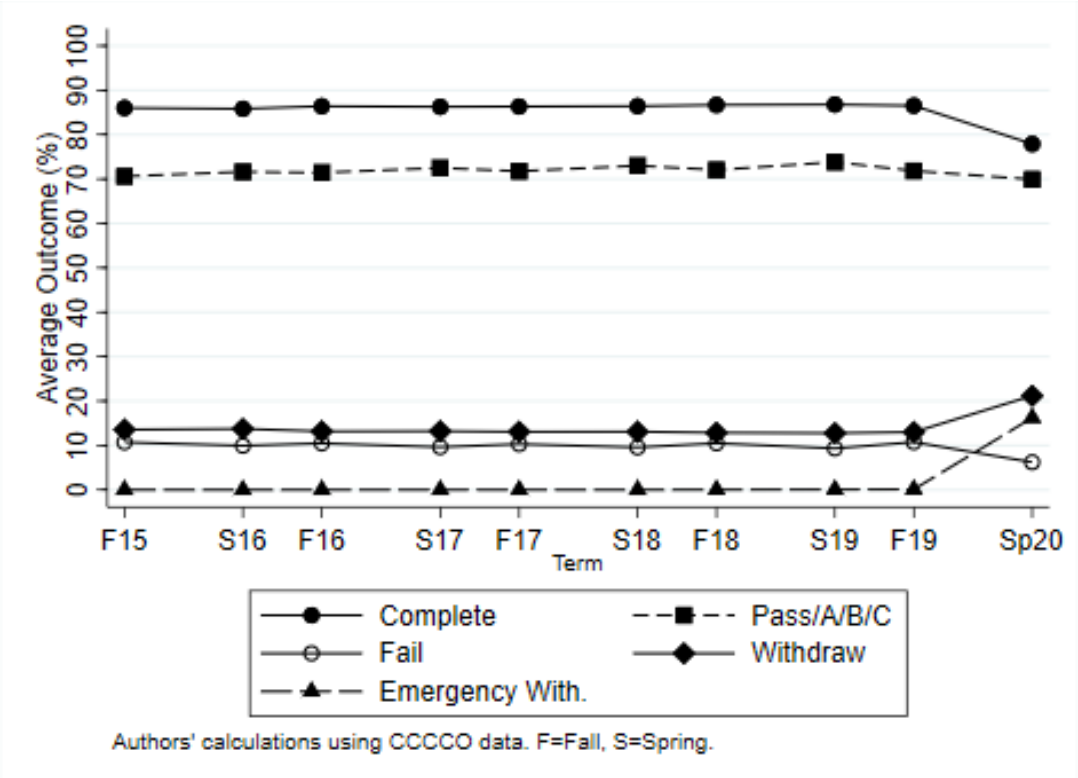


Appendix Table A1. Survey Sample vs. Full Sample, College Characteristics

	Non-Survey Sample	Survey Sample	P-value, Diff
Urbanicity			
Rural	0.114	0.114	0.992
Urban	0.457	0.386	0.462
Suburban/Town	0.429	0.500	0.460
Pre-COVID Online Course Penetration			
Frac. Courses in College Offered Online (1+Sec) 2018-19	0.220	0.212	0.697
Frac. Sections in College Offered Online 2018-19	0.199	0.185	0.451
Frac. Enrollments in College Taken Online 2018-19	0.252	0.229	0.280
Colleges	70	44	
Total Colleges	114		

Authors' calculations from CCCCO Data. Each unit represents a unique college. One college that returned a survey that was non-responsive to all questions used here is excluded from the survey sample.

Appendix Figure A1. Average Outcome Rates by Term: Fall 2015-Spring 2020



Note: All models include controls and fixed effects as in main models, with exception of COVID indicators.

Appendix B. Robustness Checks

We apply several robustness checks to ensure our results finding poorer student outcomes during the COVID-affected term are not sensitive to different modeling decisions. Panel A of Appendix Table B1 replicates our main results in Table 3, Panel A for clarity. This panel also includes standard errors when we employ different levels of clustering (e.g., by term, or by college-term); our results would retain significance regardless of the level of clustering used.

Panel B addresses the concern that quarter schools experienced the forced shut-down of campuses at the very end of Winter Quarter; while classes would have been delivered as normal for the vast majority of the term, the shut-down may have affected the final 1-2 weeks of instruction as well as finals. We show that classifying Winter 2020 as COVID-affected for quarter schools makes little difference to our overall results.

In Panel C, we show results if we employ student fixed effects (using a sample of students who were enrolled in both Spring 2019 and Spring 2020 to ensure variability within students over time). The use of such student fixed effects makes little difference to the pattern of results.

Panel D provides estimates using a slight expansion of the sample of students included. Our main estimates drop students enrolled in a small number of courses where **all** students received excused withdrawals, suggesting that the college might have effectively decided that the course could not be adequately offered online and proactively disenrolled all students from the course.

In Tables B2 and B3, we re-run our specifications looking at the extent to which resources (B2) and responses (B3) moderate the estimated main effects of the COVID-term disruptions, adding term-by-year fixed effects to more closely narrow in on comparisons within the specific COVID terms. In these specifications, the *COVID* indicator is multicollinear with the new fixed effects and so is dropped from the model. Our focus is on the interactions between the *COVID* indicator and each resource or response variable. Our estimates are highly consistent with results using our main models, improving our confidence in those results.

Appendix Table B1. Robustness of Main Results (Table 3, Panel A) to Different Modelling Choices

	(1) Complete	(2) Pass/A/B/C	(3) Fail	(4) Withdraw	(5) EW
Panel A. Main Specification, Errors Clustered at Different Levels					
Main	-0.085***	-0.034***	-0.031***	0.081***	0.162***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cluster by Term	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cluster by College-Term	(0.004)	(0.002)	(0.003)	(0.004)	(0.007)
(N)	30,697,367	30,697,367	30,697,367	30,697,367	30,697,367
Panel B. Alt. Specification of COVID-Affected Terms					
Incl. Winter 2020	-0.083***	-0.033***	-0.031***	0.080***	0.160***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
(N)	30,697,367	30,697,367	30,697,367	30,697,367	30,697,367
Panel C. Alt. Specifications: Stud. FE for Stud. Enrolled Spring 2019, 2020					
Stud. FE, Spr. 2019/2020	-0.094***	-0.056***	-0.018***	0.090***	0.148***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
(N)	8,290,083	8,290,083	8,290,083	8,290,083	8,290,083
Panel D. Alt. Samples					
Incl. All-EW Courses	-0.088***	-0.037***	-0.031***	0.085***	0.166***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
(N)	30,710,367	30,710,367	30,710,367	30,710,367	30,710,367

Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. All models include full set of student, college, course, and time characteristics. Each unit represents a student-enrollment in a class intended face-to-face.

Appendix Table B2. Changes in Outcomes During Spring 2020: By College Pre-COVID Resources. Model Includes Semester-Year FE.

	(1) Complete	(2) Pass/A/B/C
Panel A. By Share Courses with 1+ Online Section, 2018-19		
COVID*Frac. Crs. Virt	0.083***	0.016
	(0.013)	(0.012)
(N)	30,697,367	30,697,367
Panel B. By DE Personnel/1000 Stud.		
COVID*DE Personnel/Students (K)	0.038***	0.013***
	(0.003)	(0.004)
(N)	10,294,931	10,294,931
Panel C. Instructional Expenses/Student		
COVID*Instruct. Exp (K)/FTE Stud	0.002***	0.003***
	(0.001)	(0.001)
(N)	11,041,059	11,041,059
Panel D. By Pre-COVID Faculty Training Program Availability		
COVID*Prior Training Prog.	0.036***	0.021***
	(0.006)	(0.006)
(N)	10,758,258	10,758,258
Panel F. Prior Availability of Virtual Counseling		
COVID*Prior Counseling	-0.003	0.006*
	(0.004)	(0.004)
(N)	9,821,579	9,821,579
Panel F. By Resource Scale		
COVID*Resource Scale	0.013***	0.011***
	(0.002)	(0.002)
(N)	11,041,059	11,041,059

Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. Each panel represents a separate regression. Cells include b (cluster robust standard error). Standard errors clustered at college-course level. All models include full set of student, college, course, and time characteristics. Each unit represents a student-enrollment in a class intended face-to-face.

Appendix Table B3. Changes in Outcomes During Spring 2020: By College Response Intensity. Model Includes Semester-Year FE.

	(1) Complete b/se	(2) Pass/A/B/C b/se
Panel A. By Num. Tech Types Distributed		
COVID*Tech Types	0.005***	0.005***
	(0.002)	(0.002)
(N)	11,041,059	11,041,059
Panel B. By Num. Faculty Training Approaches		
COVID*Num. Training Approaches	-0.001	0.004***
	(0.001)	(0.001)
(N)	10,475,231	10,475,231
Panel C. By Student Skill Domains		
COVID*Num. Study Skills	0.003***	0.001
	(0.001)	(0.001)
(N)	11,041,059	11,041,059
Panel D. Response Scale		
COVID*Response Scale	0.006***	0.006***
	(0.002)	(0.002)
(N)	11,041,059	11,041,059

Authors' calculations from CCCCO Data. ***p<.01, **, p<.05, *p<.10. Panels all from separate regressions: b (cluster robust standard error) Standard errors clustered at college-course level. Each unit represents a student-enrollment in a class intended face-to-face. All models include semester-year fixed effects. COVID indicator is multi-collinear with the new fixed effects and so is automatically dropped in these models.