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"I Wish There Was a Way to Share": The Changing Campus Ecologies Around Community College Life Science Courses

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ABSTRACT

We present a case study of changing campus ecologies for students in life science courses at an urban community college. Through analysis of six surveys ($n = 583$) over a three-year period, we note how changes in students' coursework affect their virtual and physical developmental ecologies. Students' abilities to access peers for academic and social support declined and rose relative to social distancing activities, but upon return even when students could identify accessible peers, they expressed a lack of knowledge for how to form social and academic relationships on campus. Changes in social-distancing policy shaped students' access to socio-academic integrative moments. Students expressed appreciation for their instructors during the transition to online learning, but encountered a number of social and technical roadblocks to participating effectively. Competing demands on their time, lack of access to the internet and digital tools, constraints produced by digital tools like proctoring software, and a general frustration with the amount of "screen time" that the transition required all undermined students' formation of learning communities. The lack of third spaces – publicly accessible space that is neither home nor work – created a challenge for students who could not demarcate academic space in their homes. Among life science students were a considerable number who worked in health sciences, a field where pandemic-related burnout was considerably higher. Many of these students expressed plans to slow down their education or leave community college entirely. We identify implications for practice including strategies for instructors to foster community in their classroom.

The onset of social distancing policies rapidly changed the character and nature of place-based education in community colleges across the U.S. (and beyond). As students and instructors left campus for an indefinite period, their interactions were increasingly mediated by digital technologies and web-based interfaces. The ecology of community college campus life, as a consequence, was potentially reconfigured where important relationships with peers, institutional agents, and other key sources of support were placed at a physical and psychological distance (e.g., Smith et al., 2022). This may be particularly true for students intending to transfer into science fields where the development of a "logic of collaboration" in early coursework is linked with later success (Nespor, 2014). In this study, we present research that explores the impact of the disruption of in-person learning on how students develop and maintain community on community college campuses. We ask, specifically, how did students' perceptions of their ecological systems on campus change as a result of the shift of online learning, and what short and long-term consequences can we observe from students' shifting

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perceptions for the organization of urban CC environments? The shift to online learning (and the persistence of that modality of delivery post-social distancing policy) requires practice guidance that explicitly takes up students' experience of transitioning back and forth between physical and virtual learning communities.

Background

Academic success efforts in the community college benefit from an ecological approach to student learning and development, as ecological theory directs our attention to the diverse and complex systems of interactions that span physical environments and institutional contexts (e.g., Ozaki et al., 2020; Renn & Arnold, 2003). While a diverse host of factors across campus impact community college student academic success, including peer groups, academic momentum, and family ties (Wang, 2021), understanding the intersection and interaction of these factors can potentially help us understand what fosters or deters students' transfer decisions. Students might need to draw upon knowledgeable institutional agents who can help them navigate the arcane process of college access (Stanton-Salazar & Dornbusch, 1995), while simultaneously looking to their peer networks for social and academic support (e.g., Canche et al., 2014; Deil-Amen, 2011).

Community college campus ecology

The college campus is composed of a variety of physical and digital spaces that were built by humans to support student learning and development. These physical and digital spaces, in turn, influence learners by structuring and facilitating how, when, and where the interactions that foster learning and development occur. Campus ecology models emphasize the dynamic relationship between students and their campus environment, with the goal of understanding how to structure optimal learning conditions (Renn & Patton, 2011). Originating from discussions of campus design and architecture (Astin & Holland, 1961), campus ecology has been used to examine the organizational structures and configuration of everything from physical building layouts to students' peer interactions and campus climate (Hall & Sandler, 1984; Renn & Patton, 2011). Although there is a breadth of research dedicated to campus ecology, one critique is the lack of comparison or distinction between institutional types, particularly the community college sector (Deil-Amen, 2011).

The distinctive community college context requires a consideration of ecology that allows for porous movement between on and off campus social worlds, as the curriculum, campus culture, and physical environment of CCs differ significantly from their 4-year counterparts (Kisker et al., 2023). While higher education institutions broadly were transformed by the COVID-19 pandemic, community colleges, in particular, reorganized their offerings in ways that appear durable. In the context of this study, more classes were offered online, but social support resources, student organizations, and hands-on learning experiences like labs still required students to come to campus in person. This bifurcated experience has a particular manifestation in urban community colleges that deserves more scholarly and practical attention.

Community colleges were created with the mission to provide localized open-access education. In doing so, community colleges educate and enroll more adult learners, first-generation students, women, racially minoritized students, and students with disabilities (Aquino & Scott, 2023; Kisker et al., 2023; Renn & Patton, 2011). On average, community college students are also more likely to be commuters, work full or part-time while attending school, and have parent or family obligations at home (Kisker et al., 2023). When welcoming a diverse student body to campus, community colleges need to consider how to best serve the various needs of students who enroll in their programs. For example, in the case of technical education programs (welding, automotive mechanics, nursing, etc.) hands-on training and time spent on-site is important for understanding the tools and skills of their trade. However, for other adult learners, parents, and working students, night classes and online education are a key feature of what makes a CC education desirable. To create ideal learning

environments for students that have many outside obligations, community colleges have prioritized flexible program offerings, leading the field in online and hybrid education (Cejda, 2010; Hart et al., 2022). However, despite meeting student needs related to flexibility, widespread implementation of online and distance programs have not improved student retention (Xu & Xu, 2019).

Finding ways to make students feel involved and connected to campus, while learning remotely has been a consistent challenge for CCs (Cox, 2005; Li et al., 2021), a reality exacerbated by the COVID-19 pandemic. While community colleges have often had more experience providing support to students who are not on campus (Xu & Xu, 2019), the rapid transition to fully online instruction almost certainly unsettled all campus environments. Interruptions to campus ecology have taken place over the years in the form of updated technology (online courses) and changing populations (increased gender, racial, and ethnic diversity) (Brown & Smith, 2024). However, the COVID-19 pandemic is an example of a comprehensive global phenomenon that markedly changed the ways students learn and interact with their teachers, peers, and mentors (Smith et al., 2022). Understanding how organizational and curricular arrangements that emerged during the period of social distancing impacted learners can provide insight into current campus ecologies (Penrod et al., 2022; Smith et al., 2023).

Socio-academic integration

An ideal campus environment is one that encourages student learning and progress to degree, while also giving students a sense of safety, belonging, and assurance (Astin, 1984, 2014; Tinto, 1975, 1987). Campus ecology focused research attempts to find a balance between academically supportive and socially engaging environments. Building on Tinto's Theory of Student Departure (Tinto, 1975, 1987, 1993), retention scholars argue that a student's subjective sense of belonging and membership is a fundamental component of student decisions and academic outcomes (Fong et al., 2021; García & Garza, 2016; Newman et al., 2015). Students are more likely to persist in college when they perceive intellectual and social congruence, or a fit between the student and the values, social rules, and academic quality of the college community (Brown, 2019; Deil-Amen, 2011). Although there is still debate over which mode of integration is more important (social or academic), there is decisive agreement that both forms of integration are connected, and when they occur, student likelihood of persistence increases (Deil-Amen, 2011; Tinto, 1987).

By the time students arrive on campus, they have a variety of existing support systems, connections, and skills they employ as they navigate higher education (Canche et al., 2014). An important aspect of integrating students on a college campus is to encourage them to form, maintain, and prioritize connections that support their academic performance (Brown, 2019). Not all social or academic connections can be used to support a student's academic experience and support progress through coursework. Research on student's peer networks has demonstrated that networks provide the most benefit when social and academic connections cross over or are shared, otherwise known as socio-academic integrative movements (Deil-Amen, 2011).

Deil-Amen (2011) illustrated how concepts of socio-academic integration should be modified to pertain more appropriately to two-year students, and the relevance of class, race, and ethnicity, for a more indicative measure of community college student experience. Community college students are less likely to have preexisting ties with academic mentors or institutional agents at the college, including faculty, administration, and advisors (Canche et al., 2014). The absence of existing ties to these important academic supporters can make socio-academic integration more difficult for community college students. Traditional views of social integration depict student socialization as comprehensive, where students spend time with their peers both inside and outside of classes. However, Deil-Amen (2011) found that authentic interactions and conversations during class can be enough to give community college students a sense of belonging and support, even if they do not extend beyond the classroom. Building opportunities for students to develop socio-academic connections with institutional agents like faculty and other students during class have been found to ease student

concerns and contribute to feelings of comfort or assuredness in their role as a college student (Brown, 2019; Deil-Amen, 2011).

Socio-academic integration varies based on students' on and off campus social roles, competing demands on their time, and their approach to navigating the campus environment. For example, Pichon (2021) observed that traditional age college students tended to use campus resources as a site of integration (i.e., student organization office, student centers, lounges), while non-traditional students were more likely to be observed using student business service offices on a needs-basis while on campus (i.e., Financial Aid, Bursar, Advising). As CC students have significant competing demands on their time, many of their interactions on campus are those of necessity, or opportunities that students view as directly impacting their educational progress (Canche et al., 2014; Deil-Amen, 2011). Prior research suggests that academic integration is more critical to the persistence of nontraditional students due to their reliance on campus ties for learner and student identity development (Ozaki et al., 2020). Community college students' have many preexisting social connections; however, the development of key academic role identities, such as a "student" or "learner" identity, and the self-characterization of that role as positive or negative evolves over time and is informed by their interactions on campus (Ozaki et al., 2020). Students who have few campus interactions will have fewer experiences that support and inform their developmental and learning experiences than students who spend more time on campus. For example, opportunities to engage directly with faculty were cited across the literature as extremely influential in community college student retention as these interactions influenced student role identities (I am a good student, I am a learner, etc.; Canche et al., 2014; Ozaki et al., 2020). When students have limited opportunities to engage instructors and peers during their classes, a student's social and academic networks are often constrained as a result (Brown, 2019).

Levels of socio-academic integration and student dropout can also vary by academic field. For example, STEM fields experience high student attrition rates compared to other areas (Belser et al., 2018), and because of this, researchers have found that interventions that allow for increased socio-academic integrative moments during class can help retain students (Brown, 2019; Turetsky et al., 2020). STEM coursework requires a logic of cooperation that is embedded in course structures (e.g., Peer Instruction, lab work), with majors that have heavy-course loads that limit students' time spend on things outside of coursework (Brown, 2019; Estrada et al., 2016). All of this contributes to students centering their peer networks around their academics and generating relationships that serve multiple purposes (social and academic) (Brown, 2019; Brown et al., 2023; Smith et al., 2022).

Effects of COVID-19 on campus ecologies

The rapid shift to remote education during the pandemic resulted in a variety of institutional changes to accommodate and prepare for online learning environments. Institutional changes included the immediate move to fully remote classes, distribution of personal computing devices and internet-hotspots for students, faculty support and new course software to support remote learning, and virtual student support services (Hart et al., 2021; Penrod et al., 2022; Pichon, 2021). In many instances, community colleges were more prepared to transition online due to their infrastructure and the presence of fully online programs and remote education that was already being offered (Hart et al., 2021). In a study of the California Community College system, Hart et al. (2021) found that institutions with fewer pre-COVID online learning resources focused on building foundational efforts, such as online student services, access to technology and broadband internet, etc. Institutions with greater pre-COVID infrastructure offered a somewhat broader response to training students and faculty in the skills needed to successfully navigate learning systems and course software (Hart et al., 2021). The flexible culture of community colleges had resulted in online delivery and familiarity with fully remote coursework. However, the pandemic still changed many aspects of how education was structured and delivered, especially for career and technical education programs.

In a study examining community college student perceptions of remote learning shifts, Prokes and Housel (2021) found that students ($n = 356$) felt less confident in their ability to complete important learning tasks. Significant changes to work-life balance and mental health impacted students' performance and many students felt unprepared for the level of organization and planning required to complete online coursework (Prokes & Housel, 2021). During the social distancing period, the elimination of other engagement and social opportunities due to isolation increased stressors that affected students' motivation and mental health, increasing instances where students felt a lack of motivation, boredom, loneliness, and anxiety (Leal Filho et al., 2021). Other impacts of the COVID-19 pandemic on academic progress included issues working or studying due to interruptions in communication, access to online materials, and difficulty managing work/studies with the increased confinement with family or children (Leal Filho et al., 2021). As many community college students have children of their own, accomplishing their learning tasks on top of supervising their children's remote learning was extremely difficult to manage (Lin et al., 2022).

When considering the impact of the pandemic on socio-academic integration, students who enrolled at community colleges during the pandemic had mixed feelings about online learning. The importance of faculty interactions and guidance, combined with the difficulty in fostering these connections during the pandemic, was a concern for students in nursing programs, for example (Penrod et al., 2022). Termed "network shock," Smith et al. (2023) examined the disruptions to students' academic and social connections on campus at four-year institutions as a result of social distancing. On average, students lost or decreased the number of academic ties they had pre-pandemic, which in this study included connections to study groups or classmates. Whether and how students recovered from disruptive network shock, especially in the community college context, remains unknown.

Life science courses and the impact of COVID-19

For students in STEM and health professions in particular, isolation during the pandemic was universally seen as detrimental to their academic progress, adding time to degree and limiting field experience (Crismon et al., 2021; Thanawala et al., 2022). STEM coursework typically requires hands-on instruction and lab work, and research has found that students perform better when given opportunities to engage with each other and faculty in the classroom setting (Brown, 2019; Michaelsen et al., 2014). The pandemic posed issues both for students who were and were not able to conduct fieldwork. Some students were unable to attend necessary labs due to social distancing, while the health professions and nursing students were over or underworked depending on their work status, as many students were already employed or trying to accrue clinical hours in healthcare positions when the pandemic started (Bdair, 2021).

Penrod et al. (2022) explored the experiences of nursing students and other allied health majors at a community college during the pandemic to research trends related to student success. They found that instructors provided pathways of communication and support during online courses was essential. Additional course management choices such as deadline flexibility and student choice opportunities in the work of the class aided student effort and learning success. Differences in age and level of experience learning online did provide a need for more or less support, with older students and students without previous online experience needing additional assistance (Penrod et al., 2022). In a similar study, Bdair (2021), found that nursing students were moderately satisfied with online learning and benefitted from the flexibility it provided but were concerned at their ability to build nursing competencies with the shift of in-person skills session to online material and videos (Bdair, 2021).

While studies are beginning to generate a picture of what happened during the pandemic, what is less clear are the long-term effects. Prior research suggests that college students' social networks shrunk in breadth and diversity during and after the implementation of social distancing policies (Smith et al., 2022, 2023) leaving students with fewer connections to peers and institutional agents to draw on. Yet, very little is known about recent potential changes in the campus ecology of community

college students and the consequences of those changes as a result of social distancing. The traditional inter-personal resources that students relied upon to interpret the campus environment may have been lost during the period when students' interactions were focused on digital and virtual learning contexts (Brown et al., 2023).

As such, our guiding research question is, *"how did the implementation of social distancing policies influence how community college students in life science courses 1) navigated campus ecologies and 2) developed, maintained, or abandoned their campus connections"*? To that end, we have constructed a single institutional case study identifying how changes in policy, practice, and social norms throughout the period impacts the success of students in introductory life science courses who had expressed an intention to transfer to four-year institutions.

Research design

This study employs a case study design with complementary methods of data collection (Moss & Haertel, 2016). The case focuses on a single urban community college in the western United States. The institution offers a variety of programs including associate's degree programs, career and technical education, and community enrichment courses.

Study context

This study was conducted at an urban community college in the Western United States. The CC is part of an urban system with multiple campuses. Students can attend any campus in the system, but often select a "home" campus. At the time of this research, over 9,000 students were included in the institutional headcount, although slightly more than 20% of students were considered full-time. We should also note that the overall enrollment number decreased by over 20% over the subsequent academic years. The CC is a majority minority institution, with Latinx and Asian American and Pacific Islander students making up more than half of enrolled students. The institution enrolls slightly more women than men, although this varies substantially by disciplinary focal area, and more than 60% of students are 18–24. This research was conducted as part of an evaluation of a federal retention program for CC students in STEM career pathway programs, although this research was conducted prior to the implementation of the program to provide baseline data.

Data collection

Surveys were administered in three courses each semester: two introductory biology courses and an introductory anatomy course. These courses served as prerequisites for biology and health sciences students. The survey instrument was administered in the first 2 weeks of the semester and contained items regarding expectancy value motivation (Perez et al., 2019), an instrument designed to measure science identity among community college life science focused students (Perkins et al., 2023), and items related to housing and food insecurity developed by the Hope Center (Koppish et al., 2021). The survey included 24 questions, including the instruments mentioned above which were composed of multiple items. Qualtrics survey software estimates that the average respondent would take between 20 and 25 min to complete the instrument. The survey included the three instruments, demographic questions, and the three open-ended questions we describe below. The response rate averaged from 55% to 47% across administrations, with an average response rate of 49%.

For the purpose of this manuscript, we report results from the social connection instrument developed by Brown (2017, 2019) and open-ended responses to questions about students' experience during the pandemic. The Brown instrument had a Cronbach's alpha above 0.80. Brown's instrument helps us capture the number of individuals students' can identify within their personal ecological micro-systems that provide specific forms of academic and social support that other researchers have identified as essential for persistence. We asked respondents:

- How has your strategy for studying for your science course changed, if at all, now that the course is online?
- What else would you like instructors to know to help support your learning?
- What has changed in your day-to-day life as a result of the COVID-19 pandemic?

Overwhelmingly, responses to the open-ended questions focused on how students' engagement with virtual and physical micro-systems impacted their learning in online courses during the period of social distancing, and how changes in their interpersonal relationships impacted their ability to engage in help-seeking related to their courses.

Data analysis

We draw on data from six surveys with students (see Table 1). Data was collected between Fall 2020 and Spring 2022 from the onset of social distancing policy through the return to campus. The first author deductively coded open-ended survey response themes related to changing campus ecologies. The first author drew specifically from the conceptual frameworks we describe in the next section for sensitizing concepts (see Appendix for our code list). The first two authors engaged in member checking about initial inferences. We also analyzed descriptive data from the survey instruments to identify the number of connections students reported in three categories:

(1) How many people they believed they could go to if they missed a class
(2) How many people, if any, they study with to prepare for class
(3) Who they would consider a friend among individuals affiliated with the community college

(for a max of 10 connections in each category).

Conceptual framework

We draw on Brown and Smith's Campus Ecological Networks framework (2024) to guide our research on students' experience of their virtual and physical learning environments. Brown and Smith pull together related frameworks to offer guidance for research on how students' interactions with different actors (on and off campus) inform campus ecologies. They encourage researchers to identify important individual interactions (referred to as microsystems) that come together to form students' mesosystems which structure their access to social support, information, and other material resources. This structure of opportunity can determine how effectively students persist in a campus environment. They argue that learning experiences, structural inequality, and the formation of communities on campus are fundamentally relational processes. These interactions (and the relationships that do or do not result) should be investigated for their relational features (whether a relationship is mutual, the content of that relationship, frequency of interaction); how those relationships generate a network of opportunity (how many ties an individual has in their network, whether they are central or bridge

Table 1. Social and academic connections in introductory biology and anatomy courses.

		Social Distancing/Fully Online			Return to Labs	Return to Campus
		Spring 2020 (n = 148)	Fall 2020 (n = 84)	Spring 2021 (n = 136)	Spring 2022 (n = 134)	Fall 2022 (n = 81)
How many other students in your biology course could you	Reach out to if you missed a class (informational resource)	3.48 (2.22)	4.25 (2.72)	2.16 (2.76)	3.48 (3.22)	4.36 (2.72)
	Study with to prepare for class (academic resource)	3.52 (2.21)	3.72 (2.86)	2.09 (2.16)	3.5 (3.22)	3.94 (2.86)
	Consider a friend (social resource)	2.62 (1.97)	2.26 (2.65)	1.88 (3.40)	2.62 (2.97)	3.33 (2.65)

a number of other relationships), and the modality of the relationship (virtual, physical, or blended interactions).

Brown and Smith draw on recent research into virtual and physical developmental ecologies to expand Renn and Arnold's (2003) campus ecologies model. Specifically, they identify three principles developed by Navarro and Tudge (2022) that help scholars trace the convergence of virtual and physical interactions in campus-based ecologies. Specifically,

(1) There exist two types of microsystems: virtual and physical. Physical microsystems are defined by face-to-face interactions and virtual microsystems are defined by interactions through digital technologies.
(2) The developing individual can exist in more than one microsystem at once
(3) The opening and closing of virtual microsystems are defined by the interactions and activities in which the developing individual engages

Brown and Smith also draw attention to the relational features that students describe as part of their interactions, including the content of a tie, whether relationships are perceived to be reciprocal, and the modality of students' interactions (online, face-to-face, synchronous).

In this study, we focus on how changes in students' social and academic networks inform their approach to their coursework. For students in life science pathways at our focal community college, the move to online learning results in shifts from synchronous impermanent interactions in physical micro-systems to asynchronous semi-permanent interactions across multiple digital platforms in virtual micro-systems. We were interested in how these experiences played out and how students' perception of the campus is shaped by their virtual micro-system(s) experiences during social distancing. We trace students' consensus about how the move to online learning, the period of full online learning, and then the transition back to campus informed their help-seeking and academic resource seeking behavior, and how, if at all, their networks were (re)configured as a result.

In our analysis, drawing from Brown and Smith's framework, we identify the average number of contacts a student would identify for three important relationships: classroom-based informational resources (operationalized as "how many other students in your biology course could you reach out to if you missed a class?"); study partners ("how many individuals in your biology course do you study with to prepare for class?"); and friendships ("how many individuals in your biology course do you consider a friend?"). The two open-ended survey questions we focus on in this discussion relate to how students perceived changes in their campus affiliated relationships as a result of the shift to online learning, and what factors related to an online-only modality were impacting their ability to persist.

Findings

Across the semesters, students, on average, reported fewer academic and friendship contacts within their courses. Their connections generally followed a pattern – decreasing as social distancing went on and increasing as students returned to campus. It is worth noting that students were able to identify more "academic" focused contacts than friends, which accords with prior research on 4-year students (Brown, 2019; Brown et al, 2022; Smith et al., 2023). Students also demonstrated significant variability in their reporting for each type of connection. Some report no contacts whatsoever (regardless of the category) and others report upwards of 10 peer connections in each category. A student who reported three connections they could reach out to if they missed a class had, in their mind, three other students in their current course. We use the term connection throughout our discussion to refer to the networked nature of these contacts. A connection might, for example, also be a study partner and a friend.

We observed three key periods that resulted in changes to students' participation in virtual and physical micro-systems of social and academic relationships. These changes illustrate how new

arrangements of ecological networks impacted students' academic success. We detail those periods below, students' changing ecological networks as a result of social distancing policies, and the potential impact of changing ecologies on how students experience socio-academic integration on and off campus.

Moving online

Initially, during the rapid implementation of online exclusive learning, students in life science courses expressed gratitude for instructors' flexibility as well as apprehension about the future. They did not observe much about their interactions with digital platforms in this initial phase. They did express anxiety related to the potential impact of long-term online learning use on their ability to persist in the life science pathway.

Still, students struggled with the abrupt shift to online delivery for classes they had intended to take in person. This was, in part, because students had not opted into an online course. In many cases, students had no experience with taking science and math courses online. Even among students who had prior online course-taking experience – which was more common among students who had been at the community college for more than one semester – almost none of our respondents had chosen to take math or science courses online. In fact, among many students, there was a widespread belief that one cannot or should not teach STEM courses online.

> There are some courses that I believe you cannot teach online. There may be a semester or two that I will have to wait for this pandemic to go down so that students are able to go back to the classroom to learn.

The lack of peer interaction, synchronous interaction with instructors, and guidance about help-seeking resources left students feeling isolated during the online transition. Some students, like the respondent above, took a strategy of waiting out the return to campus before they continued their studies. While students expressed gratitude to their instructors for the quick transition, which did not mean that students' transition to online learning was frictionless.

The wide range of technologies instructors ended up using complicated their coursework strategies, as tools meant to bridge the gap between in-person hands on learning and online participation, often were not interoperable with the Learning Management System. Courses were fundamentally different beyond their new online modalities. The intimacy of a classroom was replaced with the distance of an online learning module.

> Distant learning (sic), not being able to interact with other students, and not being able to ask questions about homework was frustrating. Also, learning from videos wasn't as helpful as classroom learning. Doing labs at home by yourself was not helpful nor did I feel like I learned anything that way . . . . having to access assignments from multiple websites instead of only using Canvas was absolutely absurd. One instructor had assignments on her own *personal website, syllabus, through email and Canvas*! [Emphasis original]

Across the surveys, students expressed how important relational factors like a sense of connection to the classroom, a desire to work with other students, and the need for contexts in which they could receive synchronous mastery-oriented feedback, generally led to feelings of demotivation. One student put this succinctly, "the transition to Canvas made me unmotivated."

Instructors simply had not had the time to think about how to construct a community in their new classroom contexts, because they were scaling up the classroom on demand. Especially because course schedules did not change in light of the move to online learning leaving many students on digital platforms all day for work and then well into the evening for classes.

Simply being online was a challenge for students because they often shared the wi-fi in their residence or a hotspot with family members or roommates. Students did not know how to communicate this, but expressed regret that "some teachers weren't aware that we couldn't be online for a long time." Throughout all phases of the ecological re-alignment, students referenced unreliable or limited

access to both the internet. The devices that they used to connect to the internet were also in short supply and unreliable.

> Not having a strong internet connection is preventing me from achieving my academic and career goals. It's tricky when it comes to not having a stable connection when taking exams and losing connection during my lectures.

Although the institution and local agencies like libraries attempted to provide hot spots that expanded household access to broadband, the need to connect to the internet for all aspects of an individual's life increased exponentially- for work, school, and socialization. Often CC students were competing with younger siblings for internet access. Compulsory K-12 education took priority as attendance was potentially linked to other crucial benefits that the household relied on like food and housing vouchers. In this way, students experienced tension within their household social circles that impacted their ecological networks.

Students often expressed that their instructors did not provide them the same latitude or care that they felt they provided instructors throughout the social distancing period. Expectations about assignments or the use of technologies like proctoring tools often placed the onus of problem-solving on the student. For example, students described major challenges in setting up exam proctoring given the software requirements – including expectations and lighting and the insistence that no one else could be in the room with the student. Additionally, the timing of due dates and the administration of assessments online was a major stressor for students.

> [The instructor] doesn't realize some of us don't have high speed internet because of cost. Especially when little ones are using the service too. When tests were due, [my instructor] was very reluctant to accept late work that may have been turn[ed] in a minute late because of connectivity issues.

While nearly all students in the survey reported having a web enabled phone, nearly all students acknowledged that using phones for coursework was an alternative of last resort.

Being online

In the second phase, during fully online semesters, students expressed frustration about the quality, visibility, and lack of synchronicity of their virtual micro-system interactions with their instructors and their in-course peers. Additionally, students had a challenging time connecting with their peers because the campus environment was closed. The digital platforms used as part of course activities limited synchronous interaction. Few avenues were available to connect with peers in courses.

The shift of lab courses online, the temporary closure of a number of local businesses, and the hold placed on undergraduate research opportunities and internships, prevented some Associate-degree pursuing students from getting practical learning experiences they needed for the workforce. Online labs were an incomplete replacement for the kinds of hands-on training that comes from being in person. Students lamented about the lack of bench work, when they knew that many of the careers they were aiming for made hours spent at the bench a requirement for consideration. Students were caught in a transitional Catch-22, underprepared for the jobs they wanted, and unable to gain professional experience because lab sites were closed except for essential workers.

> The pandemic has put a hold on my ability to find a job in a lab, so I have slowed down. I'll probably need more lab and job experience in order to bolster my resume.

Challenges related to work and employment were a persistent theme in students' decision-making and course planning in the online period. At the start of the pandemic, many students transitioned to part-time course-taking or chose to drop courses in progress. "I was recently furloughed from work which caused me to drop [the] Microbiology class I registered for." Students also reported taking fewer courses overall, and slowing down their degree progress as they did not want to transfer before they could return to campus in person at their future four-year institution.

Slowed academic momentum was also, potentially a byproduct of other pressing influences in students' ecological networks. Existing inequalities were exacerbated by the pandemic, leaving students who were financially precarious increasingly concerned about their ability to make progress.

> I work a lot of hours. I have two jobs and I'm the head of household caring for my daughter and disabled father. I pay all the bills at home, and I'm physically tired as I get little sleep. I can only attend classes part time.

Unlike in prior ecological research with students in four-year institutions (e.g., Brown, 2019; Brown & Smith, 2024), CC students were not primarily oriented to their academic connections and the campus aspects of their ecological networks. Instead, they had significant demands competing for their limited time, attention, and financial resources. This was particularly true for students who were providing daily care within their homes or as part of their jobs outside of the campus environment.

Being online: Health science careers, life science courses

As the focus of our research was on the campus ecological networks of students in life science courses at an urban community college, many of the students in our study were working full- or part-time in health services roles. They were frequently taking Biology and Anatomy related coursework as part of their plan to pursue a nursing credential or to advance in their current career.

The stress of the pandemic had distinctive impacts for these students. One student who worked as a home health aide, acknowledged that she had withdrawn from campus connections because of the ballooning demands of her job. As one student noted, "[The pandemic] has been more difficult for people who are already working in the medical field because this time around is when they are needed the most." She had less flexibility in her day to study or prepare for class and had little energy for those activities when she did have time.

This is a potential area of consideration for CCs who serve health science professionals as part of their educational offerings and workforce development. The burnout that many of the students who worked in Health Services careers experienced was a field level phenomenon. Students reported having a hard time finding their way back to coursework and in many cases, coursework became such a low priority that students had plans to simply withdraw at the end of a term. It is impossible to calculate how many students departed from life sciences or health sciences pathways as a result of the pandemic, but it is worth considering given the current nursing shortage in the United States if these students can be induced to re-enroll with the right set of incentives and supports.

Being online: Third spaces

As social distancing stretched into additional semesters, students who persisted lamented the lack of third spaces – the kind of communal, accessible, and free space that is not home or work (Soja, 2008). On college campuses, third spaces often include lounges, libraries, coffee shops, or outdoor public spaces. Community colleges often do an excellent job of providing these sorts of spaces, but as a general rule third spaces were uniformly closed as part of social distancing policies to maintain public health and safety.

One student's experience echoed many respondents who lived with multiple individuals, in a densely populated urban environment that was effectively closed for over a year.

> I also don't have a quiet environment at home where I can study. I spent a lot of time at the [CC] library or other public libraries but they were closed down due to the pandemic.

The lack of third spaces was also highlighted in how students described the limitations of taking classes "at home." Noise, requests for time and attention from other folks in the household, and the limited physical dimensions of many homes, meant students were unable to carve out academic space within their residential environments. Physical third spaces also allow for the kinds of interactions that support social and academic integration.

In the final phase, as students continued to take online lectures but switched to in-person labs, students expressed a preference for synchronous small in-person learning experiences, an

aversion to digital tools, and surprise at the "quiet" nature of the campus environment. Students expressed concerns about how changes in the economy (what ecologically minded researchers would call the exo-system) would impact their future academic plans. As one student noted, "I think it depends on how our society will be in the next few years. But if nothing major happens, then I think I can finish my academic goals and achieve my career goals."

Throughout the transition: Cultivating the logic of collaboration

In each phase, students encountered barriers to develop socio-academic relationships and had trouble cultivating their own logic of collaboration as their courses were primarily focused on individual work. Labs during the final phase of social distancing required students to work at a distance and deterred interaction to support public health. As they slowly began to return to campus, students expressed a lack of knowledge or ability to form socio-academic relationships in their lab courses, where science identity and the scientific logic of collaboration is often cultivated.

In the social distancing period, technology deterred students from collaborating to engage in scientific problem solving and discussion. When they returned to campus, the extended period of virtual interaction, which relied on different forms of social cues and a lack of synchronicity, meant that students had to relearn how to connect in person, which is a prerequisite for socio-academic relationships to emerge. This resulted in multiple students expressing concern about their preparedness to engage in scientific inquiry after they transferred.

Limitations

Our study is limited by the survey methods we selected. Although we have used our connections instrument and the open-ended questions in other contexts to observe campus ecologies (e.g., Masked for Review), there is the potential that students may have interpreted the questions in ways that deviate from our design. A more significant limitation is that students answered these questions in different phases of the pandemic and so their meaning making in each moment might reflect the contemporary challenges they faced as students. To that end, we have attempted to clearly demarcate when in our administration a theme emerged. Finally, our average response rate for each semester, while including more than half of students, may have systematically underrepresented the students who struggled the most during the pandemic, as they may be the least likely to fill out the survey. Our results are, therefore, susceptible to survivorship bias.

Discussion and implications for practice

Our work shows changes in ecological arrangements through shifts in modality, peer interaction, and frequency of peer to peer communication resulting in changes to students' approaches to their coursework. The three-year period that this study covers illustrates a fundamental problem of CC campus ecologies. Virtual micro-system interactions, absent a culture of social interaction and technologies that support peer engagement, will leave students unable to engage in the kind of fruitful socio-academic integration that other researchers have identified as key to CC student success (e.g., Deil-Amen, 2011). As CCs increasingly move toward online coursework delivery, institutional actors who want to cultivate community and connection among students will need to re-envision how peer interactions happen in a campus ecology that is divorced from a physical campus environment.

Being online

The institution that is the focus of this study was unable to identify ways to bridge students' social and academic worlds, and it is perhaps unreasonable to expect that they would. Research is needed that

explores the time and burden on faculty that these transitions produce, the availability of resources that students and faculty draw on, and the institutional and individual costs associated with software that could facilitate social and academic bridging.

The transition to virtual modalities also meant that significant hands-on learning opportunities were often missed. Students in this period did not simply miss out on augmenting their social connections with academic interactions – they lost the opportunity to interact with peers in academic contexts generally. That future incoming generations of students might not have this skill set, because of their own experiences in primary and secondary education during the social distancing period, should be part of academic planning processes.

Being Online: Disciplinary specific burnout

While many students reported high levels of stress and anxiety throughout the pandemic, students in health science fields were embedded in a larger disciplinary field (and in many cases involved in the health services workforce) in ways that potentially shaped their campus ecologies. Instructors connected to fields like nursing and students preparing to enter those fields may find that their pathways to socialization are different from prior cohorts because of post-social distancing reorganization.

Students who planned to enter health science fields during the pandemic through community college pathways potentially had their academic trajectories impacted if not significantly deterred. Institutions might consider how they support these students, and in particular, investigate if these students exited health sciences pathways. Many students in our study reported slowing their course taking or pausing until a "new normal" emerged. However, throughout our survey data, students were skeptical of future opportunities and generally could not envision what a new equilibrium might look like. As a consequence, the campus ecologies of health sciences students taking life science courses may merit more focused attention and investment.

Being online: Hybrid micro-systems and technological failure

Students' micro-system interactions with their peers and instructors were unfortunately constrained by digital technologies throughout the period of our study. Unreliable or inaccessible internet reduces the opportunity for socio-academic integration as students have fewer opportunities to interact. Similarly, the technologies that students used to connect for class were not designed to afford social interaction. Reliance on asynchronous video in lieu of laboratory experiments meant students had reduced (or in some cases zero) hands-on time learning how to work in a lab.

No particular technology is to blame for students' frustration with online learning. Rather, the cultural norms related to online participation deterred peer connection. Students simply did not know how to connect with their classmates online because all of the strategies they had learned through schooling relied on in-person cues. Additionally, the increased use of digital technologies for work and other responsibilities left students uninterested in spending more time outside of class to connect with their peers.

When students were online, their "presence" was fundamentally different from synchronous classes. Posting to a forum often involved making semi-permanent posts that required students to "be visible" to their peers and instructors in ways that they could not control. As M. G. Brown and Smith (2024) note, the lack of synchronous interaction can deter the formation of ecological networks.

Instructors and campus leaders might consider what technologies they adopt and how those technologies are designed, if at all, to support socio-academic integration. Asking important questions about how students are able and expected to participate, how they become visible in web-enabled learning technologies, and how these technologies might connect with or direct students to other resources on campus are now, perhaps, central to pedagogical and curricular decision-making.

Often, third party technologies are interoperable with other campus resources, producing disconnected media ecologies that, in turn, fracture campus ecological networks. Systems that had a surveillance or disciplinary function, like proctoring tools or plagiarism detection platforms, drew the most student ire. These tools made students feel like suspects in their learning activities and

furthered the sense of isolation and social disconnection, in part, because they explicitly discourage students from talking to each other.

Additionally, instructors should consider the activity system of their classroom (e.g., Brown, 2017, 2020). What constellation of artifacts and technologies is a student reasonably expected to interact with to complete their work. Throughout the transition to online learning, instructors distributed classwork and assessments across digital and static artifacts that aligned with the logic of their pedagogy, in ways that often complicated students' coursework planning. Centralizing resources and making plain to students the purpose behind why help-seeking and academic resources are stored where they can help students navigate complex online and hybrid classroom environments.

Being online: Virtual third spaces

One of the major challenges of the social distancing period, and one that will persist for online and hybrid students, was the lack of third spaces for students to connect with peers and to make space for academic work. For many students in the study, the lack of spaces like libraries, coffee shops, and campus commons, was a particular challenge given their living environment. Institutions might consider how they (re)-introduce third spaces to students as they return to campus and how they might highlight these spaces for online and hybrid students. Prior work suggests that individuals encounter (or even stumble upon) third spaces through a process of discovery (Moles, 2008). Students may need to be explicitly directed to these spaces, regardless of their course modality, given the less immersive experience they have in campus environments.

This is especially true if institutions attempt to create online or virtual third spaces. Students appear to have no existing strategies for making connections through classroom-based online forums. Institutions might consider developing or acquiring online quasi-public virtual spaces that use spatial chat technologies. These tools would need intentional programming and cultivation of a user culture, though, in the same way that students need orientation to physical campus environments. Educators might look to existing tools that students already used effectively like Discord servers or Slack channels, while paying careful attention to digital divides that will naturally emerge between students who are existing users and those for whom the platforms are brand new. As a corollary, institutions should consider whether achieving third spaces through corporate owned platforms meets the needs of students and instructors.

Conclusion

Meso-systems, which are effectively networks of actors defined by shared contexts or shared roles, can facilitate or deter student success. Students identified that overlapping or intersecting meso-systems – what Deil-Amen (2011) calls socio-academic integrative moments – were essential to navigating the campus environment, but occurred infrequently during the periods where academic interactions were mostly or exclusively virtual. Students with lower levels of socio-academic integrative capacity tend to struggle in introductory science courses (Brown, 2019). The new normal of campus ecology may rely increasingly on virtual interactions that prevent socio-academic integration without a reconsideration of how digital tools are designed and how students are able to connect through virtual space and time.

An ecological perspective on community college student life draws our attention to how specific peer and faculty interactions that foster learning and development occur in bounded space and time. Our research suggests that those boundaries – the socio-cultural borders that define academic and social communities – are fundamentally different from prior generations of students. Virtual meso-systems require a rethinking of how both social and academic worlds are bridged, and how virtual and physical interactions constitute student's community college campus ecologies.

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Appendix. Codebook

Parent Code	Code
Physical Vs Hybrid	
	Physical Interaction
	F2F Environment
	In-Person Instruction
	Virtual Environment
	Online Course
	Online Interaction
Disciplinary Influences	
	Health Sciences
	Burnout
	Lab Work
	Biology Learning
	Anatomy Learning
	Pedagogy
	Curriculum
	Curricular Policy
	Curricular Sequence
	Academic Momentum
Technology	
	Internet access
	Internet enabled devices
	Mobile Phone
	Alternative tech
	Problems w/tech
	Surveillance tech
Ecological Networks	
	Peer Connection
	Academic Interaction
	Social Interaction
	Faculty Connection
	Family
	Home/Living Environment
	Relationship Modality
	Thirdspace
	Campus Space
	Campus Connection (staff)
	Modality