

Navigating transfer ‘pivotal points’ in challenging contexts: A longitudinal investigation of STEM transfer students’ pathways during COVID-19

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Abstract

Community colleges have long been touted as a pathway to increase social mobility through their transfer function, yet this promise has not always been realized. This study uses the lens of community cultural wealth (Yosso, 2005), particularly the concepts of aspirational, social, and navigational capitals, to understand vertical transfer students’ experiences and outcomes during the pandemic. Longitudinal interviews were conducted with 27 students over a four-year period as they moved through the transfer pathway in STEM majors. Students who transferred to a university immediately prior to or during the pandemic experienced greater academic and navigational challenges and reported diminished access to social capital. Students employed multiple, informal navigational strategies and drew on social networks, when possible, to maintain their academic progress. Findings also reveal the importance of the transfer-receiving department, especially access to supportive institutional agents, in sustaining STEM transfer students’ progress during COVID-19.

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Introduction

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Community colleges have been touted as a mechanism for social mobility because of the access they provide for historically underserved students (Malcolm & Feder, 2016; Bahr et al., 2017), yet few students complete the vertical transfer pathway from community college through to bachelor’s degree completion (Jenkins & Fink, 2016). This already difficult pathway to a bachelor’s degree has been made more challenging due to conditions created by the COVID-19 pandemic. Overall, the pandemic has disproportionately impacted communities of color and has laid bare deep structural inequities in U.S. society (Khazanchi, et al., 2020; Laster Pirtle, 2020). Indeed, vertical transfer rates have declined by 16% since the start of the pandemic in spring 2020 (National Student Clearinghouse Research Center [NSCRC], 2022), still we know little about the actual experiences or tipping points that may have thrown some students off course and if and how those problems may have been overcome. This qualitative, longitudinal study investigates STEM students’ experiences as they navigated STEM vertical transfer pathways during the pandemic, with a focus on what supported students’ success during this time, and, for a few of them, what derailed them from their goals. Therefore, the lessons learned from the real-time experiences of STEM transfer students during the pandemic shed light on the ‘pivotal points’ of the transfer pathway in which students need more institutional support to maintain their academic momentum.

Vertical Transfer and Access to STEM Fields

Because of their high STEM enrollment rates and diverse student populations, community colleges hold the promise of broadening participation in STEM fields through their vertical transfer function (Malcom & Feder, 2016; Wang, 2013). The vast majority (80%) of community college students intend to transfer and earn a baccalaureate degree (Horn & Skomsvold, 2011). Yet only 21% of community college students vertically transfer to a 4-year

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institution and only one in six go on to earn a bachelor’s degree (Jenkins & Fink, 2016). There are also substantial disparities in transfer rates between White students and their Black, Latinx and Indigenous counterparts (Crisp & Nunez, 2014; Wang, 2016).

The rigid, sequential nature of STEM major pathways contributes to the complexity and challenge of transfer in STEM fields. These challenges can result in lost time, money, and credits for students (Packard et al., 2013). Racial/ethnic disparities in STEM transfer are also greater than in transfer into non-STEM majors (Wang, 2013; National Center for Science and Engineering Statistics [NCSES], 2021). Yet students’ everyday interactions at their colleges can influence whether or not they successfully transfer. Institutional agents, typically defined as college administrators, faculty and staff, play a vital role in increasing students’ transfer aspirations and easing their post-transfer transitions (author, 2021; author, 2022a,b; Dowd, et al., 2013; Kruse et al., 2015). Advisors provide STEM transfer students with essential support, encouragement, and information (author, 2022a; Myers et al., 2015; Packard et al., 2011; Packard & Jeffers, 2013; Packard et al., 2013). Supportive institutional agents can also help students overcome personal challenges to their ability to successfully transfer (Wickersham & Wang, 2016). However, due to the novelty of COVID-19, we know little about how students interacted with institutional agents in remote learning environments and how this affected their transfer outcomes.

Post-Transfer Adjustment and Degree Attainment in STEM Fields

Once students have successfully transferred, they may still face challenges at the transfer-receiving university. Transfer students encompass a range of backgrounds, and their adjustment process is complex and multi-faceted (Ogilvie & Knight, 2021). Transfer shock, including the decline in grades for recently transferred students, has been documented in STEM majors (Elliott

& Lakin, 2020). Post-transfer challenges have often been attributed to differences in expectations and institutional cultures between the community college and university (Corwin et al., 2020; Elliott & Lakin, 2020; Ogilvie & Knight, 2021; Reyes, 2011). On the other hand, participation in high-impact practices, such as research experiences, internships, or mentorship, can bolster STEM degree attainment for transfer students (Dinh & Zhang, 2021; Smith & Van Aken, 2020; Wang, 2009; Zilvinskis & Dumford, 2018).

Access to social capital—namely supportive faculty and peers—and professional development opportunities are critical to transfer students’ adjustment, ongoing success, and sense of belonging at the university (author, 2022; Bacon & Packard, 2018; Jackson & Laanan, 2015; Lopez, 2017; Packard et al., 2011; Scott et al., 2017). Involvement in campus activities and professional development opportunities promotes the successful university adjustment of transfer students (Smith & Van Aken, 2020; Townley et al., 2013). Participation in STEM transfer cohorts cultivates community and a sense of belonging (Bacon & Packard, 2018). The development of community is vital because STEM students place a greater emphasis on sense of community at the transfer-receiving institution than at the community college, although women and racially/ethnically minoritized students struggle more to develop a sense of community (Townley et al., 2013).

Background demographic and personal factors also influence the probability that STEM transfer students will complete a bachelor’s degree. The gender and racial/ethnic disparities in STEM degree attainment among First Time in College (FTIC) students also exist among transfer students (Dinh & Zhang, 2019; Wang, 2009; Zhang et al., 2019). Yet we still know little about STEM students’ experiences and adjustment processes after transfer (Wang, 2013). Students’

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post-transfer success is tenuous and predicated on a range of academic, personal, social, and cultural factors, all of which may be further complicated by the COVID-19 pandemic.

COVID-19 and Higher Education

While it is clear that students face significant challenges in STEM transfer and bachelor’s degree attainment, the COVID-19 pandemic is another contextual factor that is likely to affect the pathways of STEM transfer students. The full impact on students’ lives may not be clear for years, but research to date indicates that undergraduate students experienced many struggles. Due to the pandemic, nearly 90% of higher education students shifted to remote learning and a small number of students experienced more substantial disruptions: 4% withdrew from their institutions and another 4% took a leave of absence (NCSES, 2021). Students from racially/ethnically minoritized communities were more likely to withdraw from courses and question their academic futures (Aucejo, et al., 2020; Garcia & Cifuentes, 2020; National Academies of Science, Engineering and Medicine [NASEM], 2021). In particular, Latinx, Black, and multi-racial students were more likely to cancel or delay plans to enroll in higher education in fall 2021 (Ahn & Dominguez-Villegas, 2022). Vertical transfer rates from community colleges to universities have also declined during the pandemic, and Black and Latinx students have been disproportionately impacted (NSCRC, 2022). Besides academic concerns, students faced personal and financial issues, such as lost work opportunities and basic needs insecurity (Garcia & Cifuentes, 2020; Goldrick-Rab, 2020; NASEM, 2021).

Though instructors had to rapidly shift to remote instruction in spring 2020, little is known about how individual faculty members adapted STEM courses. The American Association for the Advancement of Science profiled effective adaptations in STEM courses, highlighting faculty who used alternative assessment methods, created inclusive virtual learning

environments, and developed interactive labs (Manier et al., 2022), yet the report leaves unanswered the question of how faculty teaching practices during the pandemic impacted students’ learning, motivation, or persistence. On the National Survey of Student Engagement COVID-19 module, seniors were much more likely than first-year students to report that their instructors had showed care and concern, suggesting the precarity of transitioning into college during the pandemic (National Survey of Student Engagement [NSSE], 2021). Faculty made a difference in students’ interest and commitment to their STEM degrees, but faculty support in and out of the classroom was variable (author, 2021). However, we do not know how the pandemic has affected transfer students’ academic trajectories, especially in technical, applied fields, such as STEM majors. Yet the pandemic’s impacts may linger for years in higher education institutions writ large and in the lives of individual transfer students whose pathways and learning were disrupted. Therefore, we address the research question:

- *How has the COVID-19 pandemic affected the academic experiences, access to social capital, and educational outcomes of vertical transfer students on the STEM pathway?*

Community Cultural Wealth and Academic Pathways

We use the lens of community cultural wealth (Yosso, 2005) to longitudinally examine the resources and assets that students employed to navigate transfer and post-transfer adjustment during the pandemic. Community cultural wealth critiques and extends Bourdieu’s (1986) conception of cultural capital. By drawing on a critical race theory framework, community cultural wealth rejects the predominant deficit-oriented approach and instead focuses on the knowledge, skills, values, and networks possessed by students from historically marginalized groups. Community cultural wealth offers a framework for understanding the experiences and pathways of students from historically marginalized groups as they draw on assets and resources

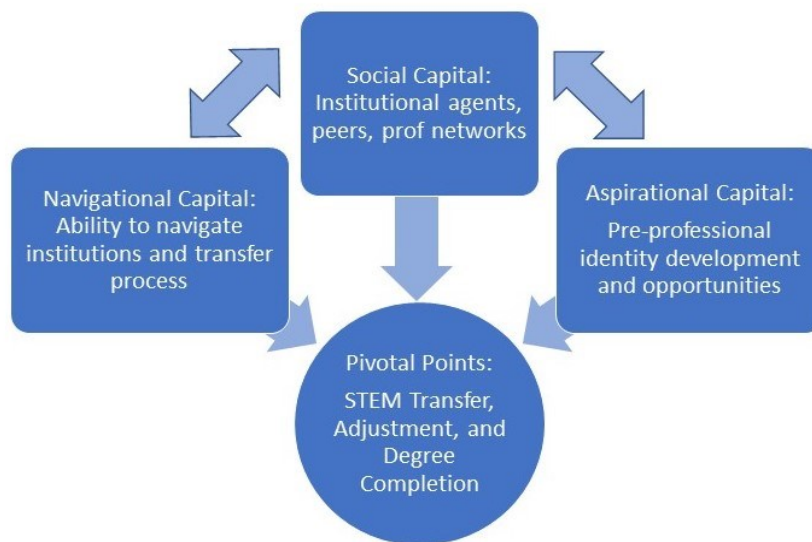
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to persist in their local educational contexts, such as students from underrepresented populations navigating the challenging STEM transfer pathway.

Community cultural wealth encompasses six interrelated forms of capital: aspirational, familial, linguistic, social, navigational, and resistant. In this study, we focus on the three forms of capital—aspirational, navigational, and social—that students encountered in their learning experiences and were most salient to their experiences on STEM transfer pathways during the pandemic. These three themes continually resurfaced in interviews throughout the pandemic and, therefore, are the main focus of this analysis. While familial capital was important to students’ persistence in this study, we focus on the other three forms of capital in this paper because we are interested in students’ experiences in institutional environments during the pandemic. The figure illustrates the interaction of these capitals in institutional contexts. In students’ accounts, social capital often mediated navigational and aspirational capital and was the cornerstone for the accrual of the other capitals.

Figure 1.

Social, Navigational and Aspirational Capitals and STEM Transfer



According to Yosso (2005), aspirational capital is students’ ability to maintain their goals in the face of challenges and structural barriers. Social capital is the peer and other networks that provide support to students in navigating educational systems. In particular, institutional agents, such as faculty and advisors, are vital in integrating students from historically marginalized communities into the culture of STEM and expanding access to professional development opportunities for them (Bensimon et al., 2019). Navigational capital refers to students’ ability to navigate higher educational systems and maintain academic progress and success in inequitable educational environments. Navigational capital allows for individual agency yet acknowledges the constraints that students experience within inequitable structures. We explore how the social capital provided by institutional agents assisted students in navigating inequitable and complex transfer processes and maintaining their educational goals in challenging contexts, such as the

pandemic. We also look at student outcomes when they had difficulty in remotely accessing the capitals that they had been able to access in-person.

Research Design and Methodology

We present results from the qualitative, longitudinal component of a larger, national descriptive case study of STEM transfer in five institutions in three state contexts (three universities and two community colleges). Case studies are ideal for understanding complex systems in a rigorous, holistic and in-depth manner, such as investigating students’ transfer pathways within the social and cultural context of a pandemic (Yin, 2003). Case studies also allow for examining individuals’ pathways (the unit of analysis in this study) within institutional environments (remote learning) and sociocultural contexts (the pandemic).

Institutional Context and Selection

Participating institutions were selected after an exhaustive process of examining enrollment, degree completion, and transfer rates of all public colleges and universities in the United States using the Integrated Postsecondary Education Data System (IPEDS). Institutions were selected based on high enrollment of students of color, Pell recipients, and high transfer rates. We also sought campuses that had no equity gaps in degree completion rates for Black, Latinx, and/or Pell recipients. Using this process, we identified institutions that had surpassed their peers in equitable degree completion outcomes. We then examined institutional websites for programs and messaging around transfer, STEM, equity, and diversity. We selected three matched pairs of community colleges and universities in three state contexts. At the beginning of data collection, one of the community colleges withdrew from the study, leaving two community colleges and three universities. To compensate for the loss of the paired community college, we

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interviewed recently transferred students at the college’s partner university and followed their pathways throughout their degree program.

Data Sources

This paper draws from longitudinal interviews with STEM students who began their studies at community college. We conducted in-depth, semi-structured interviews for baseline and follow-up interviews (Fontana & Frey, 2005). Semi-structured interviews allow for systematic data collection with some customization for individual’s experiences and backgrounds. Baseline and follow-up interview protocols addressed students’ current academic and social supports, STEM classroom experiences, and external factors that impacted transfer trajectories, including questions such as: “What is your greatest current challenge to your educational progress? What or who has helped you to stay on track in college? What university or departmental services or resources have been helpful to you? What university or departmental services or resources have been not helpful to you?” During the pandemic, the interview protocol was amended to specifically inquire about the impact of COVID-19 on students’ learning experiences and outcomes, life experiences, and access to faculty, peers, and institutional resources during remote learning.

Data Collection

To recruit students, we used institutional records to identify a stratified interview sample of transfer-ready, community college students who were representative of the general STEM student population at the college. At the two community colleges, we selected from a pool of students who had completed at least 30 credits of STEM pre-requisite courses and had indicated interest in transfer. From these students, we stratified a sample based on disciplinary diversity, and demographic categories, including Pell eligibility (as a proxy for socioeconomic status),

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women, first-generation college status, Latinx, Black and Indigenous students. We used the same process at the university to identify a pool of students who had transferred into the university from a community college during that academic year. We sent interview invitations to selected students with a sign-up questionnaire to confirm eligibility for the study.

Baseline interviews were conducted during week-long site visits to each study site by a team of four researchers in 2018 and 2019. Interviews were conducted in person on campus. Baseline interviews lasted from 60 to 90 minutes. All baseline interviews were completed prior to the pandemic. Follow-up interviews were then conducted each semester after the initial baseline interview through spring 2022 for this analysis. Follow-up interviews were conducted over the phone or Zoom web conferencing technology. Follow-up interviews have typically lasted from 30 to 60 minutes. Participants have received a small stipend for each completed interview. All study procedures were approved by the university institutional review board. To preserve confidentiality, all participants are referred to by pseudonyms.

Study Participants

We conducted baseline interviews with 41 students who began their STEM studies at community college. Twelve of these students were recent transfers to the university study site and the remaining 29 students were enrolled at the two community college study sites. We lost 14 of the original sample of students to attrition. Therefore, the sample for this paper comprised the 27 participants still enrolled in the study at the onset of the pandemic. The data set consisted of 27 baseline interviews and 112 follow-up interviews conducted over the next five semesters. Five students graduated during the pandemic and, therefore, did not complete interviews after their graduation dates. Eight students also missed at least one round of data collection at some point over the five semesters of follow-up data collection. However, most of the 27 participants

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did complete interviews each semester of the study. Although we purposefully selected successful institutions as study sites, some of the community college students transferred to the partner university study sites, while others did not transfer to partner study sites, and instead, transferred to other institutions in their states. Therefore, not all recently transferred students in the study attended universities that can be considered exemplars in the retention and graduation of students from historically marginalized populations.

Based on our stratified sampling procedures which over-sampled students from groups underrepresented in STEM, nearly all 27 students have at least one aspect of their social or cultural identity that is underrepresented in STEM fields. In all, half of the students are women. Many are low-income: 55% received a Pell grant and many others received need-based scholarships. Students are racially and ethnically diverse: 55% are Latinx, 25% are White, 8% are Black, 8% are Pacific Islander, and one student is Arab American. Nearly half are the first in their family to attend college. All students have complex intersecting identities, and some may have experienced privilege in some areas, while identifying with an underrepresented group in others (e.g., a white male first-generation college student from a low-income family). Given the relatively small sample size of students in this study, it is not possible to disentangle all aspects of students’ complex identities. Therefore, we report general patterns in students’ experiences, rather than unpacking the unique intersectional identities of specific groups.

Data Analysis

We used domain analysis because it allows for both inductive and deductive coding of qualitative data (Spradley, 1980). We systematically identified constructs of interest in our data based on our research question and theoretical framework (e.g., transfer planning, student-advisor interactions, student-faculty interactions, etc.), while also identifying unanticipated

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themes that emerged as important in students’ accounts (e.g., lack of use of campus resources, etc.). A team of four researchers collectively created the coding framework and coded all interviews in NVivo for Teams software. First, we hand-coded multiple interviews while collectively generating a set of codes through ongoing dialogue amongst the research team. Parent codes, called domains in domain analysis, were organized into categories of interest, such as institutional supports, faculty-student interactions, and peer interactions. Each domain was then sorted into categories of meaning using taxonomies, for instance, identifying the types of positive student-faculty interactions. Domains and sub-codes within domains were compared across categories, such as stage in the transfer process (e.g., pre-transfer or post-transfer or pre-COVID-19 and post-COVID-19). Table 1 illustrates some of the relevant interview questions that informed this analysis along with the analytic codes and theoretical constructs that aligned with questions from the protocol.

Table 1.

Interview questions, theoretical constructs, and analytic codes

Interview Protocol Question	Theoretical construct	Relevant analytic code(s)
What or who has been helpful to you in maintaining academic progress (toward transfer, toward bachelor’s degree completion)?	Navigational capital/social capital	Institutional Support/Faculty support/Peer support/Advisor support
How has COVID-19 impacted who or what has been helpful to you in maintaining academic progress?	Navigational capital/social capital	COVID institutional support/COVID faculty support/COVID peer support/COVID advisor support
How have your experiences with faculty in your major been this past semester?	Social capital	Faculty support
Has COVID-19 affected your experiences with faculty in your major?	Social capital/Aspirational capital	COVID faculty support

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How have your experiences with peers in your major been this past semester?	Social capital	Peer support
Has COVID-19 affected your experiences with peers in your major?	Social capital/Aspirational capital	COVID peer support
What or who has influenced your plans for your career or further education after college?	Social capital/Aspirational capital	Career planning
How has COVID-19 influenced your plans after college, if at all?	Aspirational capital	COVID career planning

To augment domain analysis and provide a more holistic view of students’ trajectories, we also used narrative analysis (Riessman, 1993) to examine a single participant’s narrative over time. Narrative analysis is helpful for identifying turning points in students’ trajectories, such as the antecedents behind a student’s decision to switch majors or drop a required class during the pandemic. The relevant codes that were used to develop the analysis for this paper include course experiences, faculty interactions, advisor interactions, peer interactions, career planning, out-of-class opportunities, transfer planning, and university adjustment. We coded interviews in NVivo for teams to enhance inter-rater reliability, resulting in high rates of coder agreement across all relevant codes (averaging 90% to 96% inter-rater agreement for the codes used in this analysis).

Results

To holistically understand how the pandemic influenced STEM transfer students’ progress and experiences, we present key findings related to students’ classroom learning experiences, peer and faculty networks (social capital), access to campus resources (navigational capital), and their educational pathways and outcomes (aspirational capital) during COVID-19.

Remote Classroom Experiences

Most students reported difficulties in the initial shift to online learning, especially during the abrupt pivot in Spring 2020. Although most students experienced challenges, we found that

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students who were already well established at their institution– that is, they had been enrolled for at least a year prior to the beginning of the pandemic – tended to adapt to the ‘new norm’ of fully online courses more quickly than students who had just recently transferred to four-year institutions in fall 2019 or later. Students who transferred in spring 2020 or later were especially negatively impacted.

Many students struggled with learning course material – in at least one of their STEM courses – in the remote environment. Students believed some complex scientific material is better delivered in person, found most pre-recorded lectures unengaging and boring, struggled to focus, and were unable to interact with faculty and peers during class time, as described by Tomas, a computer science student who transferred during remote instruction:

I don’t like being remote because some of the teachers just do pre-recorded lectures and it’s just boring. I’m not able to get in the zone when I’m in online class. At least when I’m in an in-person class, I know when to focus... But when I’m at home, it’s just so difficult sometimes.

Labs were particularly difficult for students, regardless of how recently they had transferred into their university and even for students who had regularly achieved high grades prior to the pandemic. Students lamented that they had lost the hands-on aspects of scientific laboratory work. They did not feel that watching the lab offered the same level of learning or comprehension as performing the lab themselves and having teaching assistants present to guide them in their work, as noted by Bianca, a recent transfer student in biology: “We were given half of the experiment already done because we couldn’t have done it in our homes. But everyone was clueless.” Students, like Bianca, seemed to be aware that they were likely not acquiring the same level of necessary skills needed to be able to perform hands-on, scientific work, and they

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worried about graduating with insufficient competency in these areas. With no assistance or support for online labs, none of the students in the study were able to adapt to the online format for laboratory coursework at any point during remote coursework.

For these reasons, the most common COVID-19 disruption students experienced by students was withdrawing from or failing required STEM courses in their major due to remote instruction challenges. Despite widespread pass/fail options, a third of students withdrew or failed a class during the pandemic. Nearly all of these students had been academically successful prior to the pandemic. Because of the highly linear and sequenced nature of STEM coursework, when students did not complete a course on the first attempt, this could delay and complicate their overall academic progress, which, in turn, provoked heightened pressure, stress, and fear. Matthew, a mechanical engineering student described: “My course progression is very linear... And if I were to get off track, that would significantly slow me down. So [re-taking a class] would push my graduation back a semester, which is not good.”

Although many students struggled academically in remote learning environments, they displayed different trajectories over the course of the pandemic: most were able to correct course before the return to in-person learning, others could not and faced interruptions to their academic trajectories, while a few were hardly affected academically. For example, Diego struggled initially and eventually got back on track. He had only slight difficulties in his engineering major before remote learning, yet in spring 2020, he failed all of his classes and again failed most of his classes in fall 2020. In spring 2021, he eventually raised his grades by accessing more TA and peer support, although his graduation had been delayed by a year. In contrast, a few students initially adjusted to remote instruction and then did worse as the pandemic wore on; for instance, Ana was a high-achieving engineering student before the pandemic and initially transitioned well

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to remote learning in spring 2020, before catching COVID-19 in fall 2020. She then struggled academically with a lack of classroom support and lingering effects from the illness. Some students, especially those who were already established in their computer science and engineering majors, experienced few to no negative impacts during remote instruction. Christian, a computer science major, reported in spring 2021: “I don’t feel like I’ve really lost that much ... I feel like I have kind of figured it out.” These students viewed the shift to online learning as largely beneficial, providing more flexibility and time to study.

Faculty Support

Despite many students’ struggles with remote learning, one of the most powerful contributors to a more positive remote learning experience for students – regardless of when they transferred or how well-established they were at their institutions – was supportive faculty. In particular, students who transferred during the pandemic lacked social capital in their transfer department and benefited from faculty who provided extra support to students during remote instruction. Several faculty practices enhanced students’ ability to learn and stay on track in their coursework throughout the COVID-19 disruptions. For all students, instructors’ flexibility, empathy, and understanding were very important to students’ success during remote instruction. Students valued instructor availability and prompt responses to their questions via email, since the opportunity to ask questions in class was limited, as noted by Carlos, a computer science student who valued his professors’ flexibility in response to his increased work burdens as an essential worker in spring 2020:

I emailed my professors and said, "Hey, I'm an essential worker. They're making me work 56 hour weeks." All of my professors were so accommodating, and told me that I didn't have to attend lecture, but I have to watch the videos when I have time.

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Faculty members' flexibility enabled Carlos to maintain his good grades and academic standing throughout the pandemic and he was able to transition into master's level classes in spring 2022. Overall, faculty practices of care, concern, flexibility, and responsiveness were important to student success throughout the pandemic and helped smooth the return to in-person instruction.

Lack of Faculty Support

On the other hand, six out of the 27 students reported feeling uniformly unsupported by the faculty in their department. Of those, four had transferred since the onset of COVID-19. They described rarely interacting with a faculty member or any other institutional agent in their new four-year universities. For example, a mechanical engineering student, Sofia, who transferred to university in fall 2020, explained that uncaring faculty affected her ability to learn: “Some professors really don’t care and you can tell they’re not even trying. They just show up, don’t care, and that makes it hard [for me] to even try.”

A few students noted that they struggled to get online help from their instructors which left them feeling frustrated and sometimes unable to effectively complete assignments. For example, Isabel, a chemistry student who transferred in spring 2020 commented she felt “like the professor didn’t even try” which left her frustrated. She continued to be isolated and struggled to adjust academically throughout remote learning in the 2020-21 academic year. The impacts of unsupportive faculty were consequential for students as it hindered their ability to learn and negatively affected their motivation.

Peer and Near-Peer Support

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Similar to faculty support, an important contributor to a more positive remote learning experience was connecting with peers both in and out of class. However, it was even more difficult for transfer students to establish connections with peers during the pandemic than it was with faculty. Students who had recently transferred or who were still in community college especially struggled to access support from peers. Seventeen students described isolation and lack of peer connection during spring and fall 2020—eleven of these students were recent university transfers, four were still in community college (representing almost all students who were still enrolled at two-year colleges at that time), while only two were established transfers. Well-established students were better positioned to form group chats and virtual study sessions with peers in their major which boosted their academic success. Virtual group work assigned by instructors also helped to facilitate peer connections for isolated students. Students who were already established in their transfer destination had more positive experiences with virtual group work than those who transferred during pandemic closures. Jorge, a well-established civil engineering major, credited group projects with helping him to maintain connections with peers in his major, which in turn helped him excel and stay on track to graduate on time in fall 2021.

Institutional agents in some departments created mechanisms to develop and sustain peer networks during COVID-19. Faculty created Discord servers within courses to promote virtual interactions among peers and faculty. Diego, a student who transferred in fall 2019, described how a Discord server created by faculty had provided access to academic peer support and advice from near-peers, such as teaching assistants (TAs), during his transition to the university. As previously noted, Diego had struggled early in the pandemic, failing most of his classes, but gradually became more engaged with peers which helped him to begin passing most of his major requirements in spring 2021, as he commented:

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Last quarter was the first time that I was actively on the Discord with my class—answering questions, asking things, talking to people. I was lucky because one my TA would tell us, ‘Oh, Take this class and do this.’ He was giving us a lot of tips.

Lack of Peer Connection

Lack of peer connection was most difficult for recently transferred students who had not yet established connections within the transfer-receiving department. Nonetheless, some recent transfer students adapted through becoming involved in co-curricular activities in their departments. For instance, Tomas, a computer science student who transferred in fall 2020 commented on his adjustment to the university, “This semester was weird because there was no face-to-face. I didn’t make [peer] connections, we’re all just a little bubble on the screen. We didn’t talk to each other.” After joining an academic club in his department, he was able to form peer connections and access to a faculty mentor. In spring 2021, he participated in a virtual hack-a-thon with his peers in the cybersecurity club. He credited the club with helping him to meet peers and facilitate his successful adjustment to the university during the pandemic.

Transfer-specific organizations were also helpful for students in fostering friendships and academic connections with peers. Ana, the student who contracted COVID-19 and struggled to interact with professors, especially early in the pandemic, described how the support within the Society for Hispanic Professional Engineers (SHPE) transfer community had mitigated her sense of isolation and helped her stay on track toward her degree. She had been involved with the group at her community college and became connected to the university chapter after she transferred. She commented that she had made many close friends through SHPE which “really helped and motivated” her when she “started feeling very lonely” during the lockdown phase of the pandemic. In fall 2021, she commented “now we’re like a big family.”

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Navigating Campus Services

Many campus offices and services became less accessible during the pandemic, complicating students' transfer journey. Some reported that the lack of access to institutional services was the most challenging aspect of the COVID-19 pandemic. Students who had recently transferred were not familiar with university services and resources and struggled to access any type of help during the early pandemic. First-generation college and low-income students, in particular, faced challenges in locating services and expressed frustration with the lack of personal communication engendered by the pandemic. At the time of her interview in fall 2020, Ruth, a recently transferred first-generation college student was supposed to register for spring courses but had not contacted anyone about her schedule. She commented: "I don't really even know where to go. Because again, it's all online. You type to a computer."

Students who were still preparing to transfer faced even steeper obstacles in accessing advising support which undermined their accrual of needed social and navigational capital. For instance, students experienced challenges accessing advisors remotely, explaining that the "wait times are way longer than it was on campus." Instead, students relied on informal advice from peers in considering options and applying to universities. Five students had not yet transferred at the time of writing. As an example, Santiago had applied unsuccessfully for transfer admission to a single university, his preferred local transfer destination, for fall 2021. Largely continuing to navigate the admission process as a first-generation college student on his own, he eventually expanded his list of universities and was accepted to a different university for fall 2022. However, his transfer was delayed a year, in part, due to inaccessible transfer advisors during the pandemic.

Students' Pathways and Academic Progress

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Our findings showed that some disruptive impacts of COVID-19 on students' STEM transfer pathways could be, and were, overcome by students over time, while others had lasting effects on students' academic progression and future career plans.

Adjusting and Advancing at Transfer-Receiving Universities

Overall, students whose STEM pathways were least impacted were those close to finishing their bachelor's degrees when COVID-19 disruptions began. In contrast, students who had just transferred in the spring of 2020 encountered significant navigational barriers that undermined their momentum. Navigating what one student called the "pivotal points" of transfer transition under conditions imposed by COVID-19 was stressful and anxiety provoking for many students.

Gaps in navigational capital were reported by a quarter of students and had demonstrable consequences for students' academic progress. To continue their academic progress, students drew on several navigational strategies. In some cases, students in the same major at a university were all avoiding taking the same courses remotely, which heightened competition for access to a smaller pool of less objectionable remote course options. Some reduced their enrollment to part-time status or enrolled in more writing-intensive rather than lab-intensive courses during remote learning. Additionally, widespread and sometimes "last minute" course cancellations compounded course access problems.

Stymied by Pathway Disruptions

While our findings show that most students maintained academic progress toward their STEM degrees despite delays and challenges from the pandemic, this was not uniformly the case and slightly more than a quarter of students in the study experienced pandemic-related impacts that threatened or undermined their aspirational capital. Five students switched out of STEM

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majors and one student stopped out of university altogether due to academic problems resulting from the pandemic. Of the five students who switched out of STEM majors, three switched out of STEM completely--from engineering to business, chemistry to psychology, and pre-medicine/biology to youth and family studies. The other two students, who were biology majors, switched to STEM-like majors that required less lab-based STEM coursework, one to exercise physiology, and the other to public health.

The case of Alex, a community college engineering student is illustrative. Already struggling with physics and Calculus Two prior to the pandemic, he switched to business after the rapid shift to online learning because, "It became way too difficult to keep up." Although he maintained the same transfer destination goal, his time-to-associate-degree increased at least one semester due to changing majors. Another case involved Alicia, a biology major who transferred in spring 2021. Despite struggling to balance academics with additional family responsibilities due to the pandemic, she was strongly resolved in fall 2020 that, "COVID-19 is not going to make me fall off the tracks" to transfer and pursue dental school. However, after transferring, she was dissatisfied with her organic chemistry grade, switched her major to youth and family studies, and was less certain about whether she would be successful in her career plans.

In general, our findings showed that students who transferred from community college to university either in the semester prior to (fall 2019) or during the height of COVID-19 disruptions (spring and fall 2020) were particularly susceptible to derailment from their STEM goals. Roughly 40% of these students switched majors, stopped out of university, or actively considered doing so. For example, Jackson, a computer science student who transferred in spring 2020 described himself as initially adjusting well. However, an increase in the rigor of his STEM coursework just as COVID-19 disruptions were mounting caused what he described as "the

worst semester of my college career." Challenges with online instruction contributed to his failing multiple required major courses. By spring 2021 he had informally stopped out of university, expecting that otherwise he would have faced yet another tough semester of advanced physics and computing courses, with constrained access to help from instructors.

Career Planning and Transition

Findings described so far reveal that COVID-19 disruptions impacted students' STEM pathway progress in both transitory and lasting ways during their undergraduate programs. In addition, another category of disruption was anticipatory and pointed to precarious aspirational capital in the form of concerns about transitions from university into careers and graduate education. Students who were close to graduating were concerned about lack of access to pre-professional opportunities and inadequate preparation to enter the workforce.

Students' concerns about pre-professional opportunities and lack of learning in major courses exacerbated their fears about entering the workforce or graduate education. Five students approaching graduation expressed concern over the pandemic's impact on their upcoming transition to employment and two students had similar concerns about their plans to pursue graduate education in STEM. An additional two students delayed their graduation so they could pursue more career preparation opportunities after the return to in-person learning. Students' anticipatory concerns about entering the workforce or further education included: fear of having knowledge gaps; fear of the consequences of low grades earned due to the pandemic; fear of having experience gaps, especially due to reduced hands-on training; fear of stigma for having been an undergraduate during the pandemic; and fear of the consequences of having limited access to mentors. For example, when reflecting on his professional preparation in the hands-on electrical engineering component of his computer engineering coursework, Kai, who was close

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to graduating conceded the likelihood of having a gap in his education: “I will admit a gap in experience... I took some electrical engineering courses over COVID, and definitely, my electrical engineering skills are not as amazing as they should be.”

The cancellation of many out-of-class opportunities, such as disciplinary-based clubs, internships, and research experiences, compounded some students’ sense of disconnection and feeling of being unprepared to enter careers or graduate school. Five students recounted that their planned participation in internship or research experiences was cancelled due to the pandemic. Recently transferred students, in particular, were at a critical time of adjustment to their new campus and major, and the loss of opportunities impacted their ability to participate in the professional life of their discipline. For instance, during his first semester in university, Tomas, a computer science student, commented about the near- and longer-term negative consequences of transferring during COVID-19: “The most challenging part of COVID. I want to say everything, right? Not having in-person classes, in-person extracurriculars. I can't even go to job fairs. I feel like that would've helped with preparing for internships... It's pretty difficult.”

On the other hand, those who did engage in pre-professional opportunities often found them wanting. Students described an inability to network or gain social capital in internships and generally felt that they had done less than if the experiences had been in-person. For example, Kai, the engineering student about to graduate, stated: “[Networking] was lacking for sure within the internship... voice calls are great and all, but there's an intentionality to it which you kind of lose. Just the casual conversations that you have, that you can get to know someone better.” Kai and students like him who were nearing graduation were disadvantaged by the lack of access to pre-professional opportunities and the social capital and navigational knowledge of STEM careers that they could provide.

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Students were also concerned about entrance to graduate school. For instance, Miranda was worried about how to gain informal knowledge about graduate school that she imagined she would have gleaned from the social capital acquired through in-person interaction with teaching assistants. In spring 2021, she was uncertain she was fully ready to transition to graduate education: “With this pandemic and not having the social interaction, I’m not learning what I was supposed to learn if I was in-person. Like, speaking to the TAs about grad school. I don’t have that part of the story.” Nevertheless, she secured admission to a highly selective graduate program and enrolled in fall 2022.

Discussion and Implications

Our findings indicate that the STEM transfer pathway is vulnerable to disruptions that can undermine students’ access to the capitals needed to complete their degree program and enter STEM careers or graduate education. Students at the ‘pivotal points’ in transfer (transfer-ready at community college and recently transferred into a university) were in a transitional and precarious position that left them more susceptible to disruptions. Students’ trajectories during the pandemic brought into sharp focus how important access to specific capitals is for students who are in transition points on their STEM transfer pathway. The pandemic highlighted weak spots where institutional structures do not adequately support students’ transfer progress and adjustment. These lessons are still relevant in a post-pandemic world.

Increasingly, research focused on vertical transfer pathways frames student experiences as involving an ongoing process of navigation, including maneuvering barriers, securing opportunities and information, and maintaining academic progress and aspirational momentum (Wang, 2017; Wang, 2021). To accomplish this, students rely on social capital gained through the support of and engagement with their peers, family, and numerous institutional agents, which

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was reconfigured for some students by COVID-19 conditions. Our results show that students' social capital, in the form of peer networks and caring institutional agents, was vital to their successful adjustment at the university and continued progress during the pandemic. Indeed, during COVID-19, social capital was crucial to the accrual of navigational and aspirational capitals. Compassionate, friendly, and helpful institutional agents were one of the most powerful contributors to students' adaptation to remote learning and ability to maintain aspirational capital during the pandemic. Social capital, in the form of supportive transfer and major advisors and knowledgeable peers, was also crucial to students' ability to maintain timely academic progress towards transfer and degree completion. On the other hand, lack of social capital constrained students' accrual of navigational and aspirational capitals, which, in turn, contributed to academic failures, delayed transfer or graduation, and concerns about career preparation.

Navigational capital is essential to students' ability to smoothly traverse transfer pathways, yet many students struggled to access transfer or major advisors and other institutional agents who could support their transfer journey. Students who transferred during or just prior to the pandemic experienced the most severe disruptions to their progress; indeed, roughly 40% of students encountered a loss of academic momentum through switching majors, stopping out, or delaying transfer or graduation. However, some of these disruptions were a deliberate, strategic choice to slow down academic momentum and “wait out” the pandemic to boost their chances of academic and career success. To persist, students employed creative navigational strategies such as delaying lab-based courses, shifting to part-time enrollment, delaying graduation to accrue more navigational and social capital for careers, and even switching majors to fields that were more conducive to remote study than lab-based STEM majors. Therefore, many disruptions to students' academic pathways were rooted in their attempts to maintain some sort of academic

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momentum in the face of the pandemic so they could continue to make progress toward their degree, even if it was in a non-STEM field. Yet these disruptions could have been mitigated if students had greater access to social and navigational capital during the pandemic.

Access to pre-professional development opportunities and career planning information that cultivated aspirational capital were another critical component of successful progress during COVID-19. Access to co-curricular opportunities is vital to the pre-professional development of STEM students (author, 2011; Jackson, 2017; Malcolm & Feder, 2016), and has been greatly compromised by the onset of the pandemic (NASEM, 2021). Nevertheless, successful institutions have been able to adapt co-curricular opportunities to virtual environments (author, 2021; NASEM, 2021; Washburn & Bragg, 2022). Similarly, in our study, some institutions were more successful than others in maintaining students’ access to disciplinary-based academic clubs, research opportunities, or internships, which, in turn, helped students to maintain their aspirational capital. Students who could not access aspirational capital were more uncertain about their ability to successfully enter STEM professions and were more likely to delay graduation. Despite their limitations, access to virtual out-of-class opportunities, especially STEM academic clubs, cultivated students’ social and aspirational capitals at a time when these capitals were constrained for many.

STEM transfer students in this study displayed resiliency and strategic adaptation to the difficulties of the pandemic. Yet, unique characteristics of STEM majors, along with the complexity of the transfer process, exacerbated some students’ struggles, especially those who were close to the point of transfer or who had recently transferred. Transfer students’ ability to sustain academic momentum during COVID-19 was largely influenced by specific departmental contexts and the actions of departmentally based institutional agents, rather than by the actions of

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universities as a whole. This finding highlights the significance of the transfer-receiving *department*, rather than institution, in supporting or hindering STEM students’ adjustment and continued progress, especially in challenging contexts such as those created by COVID-19.

Students’ differing trajectories during COVID-19 also highlight the importance of paying attention to the distinct needs of both “newcomer” and “veteran” transfer students in university environments and the need to structure support systems to be responsive to students’ evolving needs throughout the transfer and adjustment process. Students’ trajectories in this study illustrate their need for effective transfer advising in the community college, access to peer and faculty networks during university adjustment, and access to pre-professional opportunities and career planning as they near graduation at the university.

Limitations and Further Research

There are several limitations to this research study which suggest additional areas of inquiry. This study is small in scope and the advent of COVID-19 could not have been anticipated during initial data collection in 2018 and 2019. Further qualitative and quantitative research with larger samples is needed to assess whether the educational experiences and outcomes of students in this study were widespread. Longitudinal research is also needed to investigate the impact of the pandemic on STEM graduates’ entrance into the workforce or graduate education. Additionally, further research using large, national data sets is needed to determine the broad impact of the pandemic on students’ course success rates, transfer rates, time-to-degree, and degree completion. Analysis of large, national data sets could also provide disaggregated results to identify which populations of students were most vulnerable to disruption during the pandemic. Findings from this study are suggestive of the impact of the pandemic on students’ trajectories, but not conclusive. This study provided insight into

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challenges faced by students during the pandemic and some of the strategies they used to maintain continuous enrollment at their institutions, yet further research is needed to fully understand the long-term impact of the pandemic on students nationwide.

Conclusion

Our findings draw attention to the key transitions, or ‘pivotal points,’ in STEM transfer students’ trajectories in which they are most vulnerable to disruption. These pivotal points include preparation to transfer, adjustment immediately after transfer, and preparation to transition into the workforce or graduate school. At each stage of students’ pathways, access to social and navigational capital supported their continued progress during the pandemic, while lack of these capitals disrupted their academic momentum and impacted their aspirational capital. For STEM students in particular, the transfer-receiving department was the primary—indeed, often the only—source of the social and navigational capitals required to persist in the face of challenges, such as the pandemic. Even after the pandemic, STEM departments’ efforts to foster students’ social, navigational, and aspirational capitals during the ‘pivotal points’ in the transfer process could be especially impactful to their ability to successfully transfer and complete STEM degrees. In all, students’ experiences during the pandemic suggest that STEM transfer-receiving departments can do much more to systematically develop and sustain disciplinary-specific support structures, foster positive interactions with institutional agents, and cultivate peer-to-peer networks for the often-overlooked STEM transfer student population.

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