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The role of holistic mentoring ecosystems in mitigating COVID-19 pandemic impacts on the persistence of low-income STEM students

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Holistic mentoring ecosystems are a comprehensive approach to addressing the diverse needs of students through interconnected support networks. While mentoring has been well-documented in existing literature, more research is needed to determine the effectiveness of mentoring ecosystems in mitigating the impact of critical junctures for vulnerable, high-attrition student populations. Guided by Tinto's model of retention, this qualitative case study investigated the role of holistic mentoring ecosystems in mitigating the impacts of the two combined critical junctures—the COVID-19 pandemic and the first year of college—on low-income STEM undergraduates. Our findings suggest that holistic mentoring ecosystems were essential in helping students adjust to the academic environment and fostering a sense of belonging in the STEM community amid the severe limitations imposed by the pandemic. This study adds to the growing body of literature investigating the approaches and strategies effective in supporting vulnerable student populations through critical junctures in their educational journey.

KEYWORDS

low-income college students, COVID-19 pandemic, higher education, holistic mentoring ecosystem, first-year academic experience, STEM disciplines

1 Introduction

The completion rates of college education for students pursuing science, technology, engineering, and mathematics undergraduate academic programs are impacted by various factors and contexts. Finding solutions to remedy these factors has greatly interested scholars and educational leaders. Many factors can impact college completion ([Bastedo and Jaquette, 2011](#); [Berg, 2016](#); [Carnevale and Smith, 2018](#); [Taylor and Turk, 2019](#)), including socioeconomic status, which is a primary indicator of an individual's probability of completing their studies ([Reber and Smith, 2023](#)). Low-income students who pursue higher education face challenges similar to those of their counterparts. However, their socioeconomic status exacerbates these challenges, making it less likely for them to complete their studies successfully compared to their more affluent peers. Statistics reveal that graduates from high-poverty high schools only have a 21 percent chance of attaining a college degree within 6 years of high school ([Reber and Smith, 2023](#)). In contrast, those who graduated from low-poverty schools have a 53 percent chance of achieving a college degree within the same time frame ([Reber and Smith, 2023](#)).

Existing studies have documented that students from low-income backgrounds often face inequities such as financial constraints, insufficient academic preparation, a lack of access to high-quality educational resources, and limited exposure to the STEM fields (Agrawal et al., 2016; Robinson and Meadows, 2020; Hansen et al., 2023; Madsen et al., 2023). They also need help with high education costs, such as the high cost of tuition, textbooks, and other related expenses for housing, subsistence, and living expenses. These challenges can be further compounded at critical junctures on their collegiate journey and can often hinder their academic success and may discourage them from pursuing higher education altogether.

Berg (2016) argued that providing low-income students with financial support alone is not enough. Low-income students also need academic support, opportunities to establish social connections and access to resources to help them develop essential life skills to support their success, particularly at critical junctures in their academic pursuits (Bastedo and Jaquette, 2011; Carnevale and Smith, 2018; Madsen et al., 2023). For instance, critical junctures such as the first year in college, transitions to new schools, changes in educational programs can be adversely impact students from a low-income background if not connected to the necessary supports to mitigate the impact (Muraskin, 1998; Michalowski, 2010). Recognizing the critical nature of the first year, institutions have implemented various initiatives and touchpoints to monitor first-year students using proactive methods.

1.1 COVID-19 critical juncture

Freshman year is known as a critical juncture for all students. In particular, studies have well documented that the transition from high school to college exposes students to a host of challenges that can impact their persistence from first year to second year of college (Muraskin, 1998; Michalowski, 2010). Interestingly, the high school class entering college in 2020 were met with an unprecedented critical juncture—COVID-19 pandemic. The COVID-19 pandemic presented a significant challenge for college freshmen in 2020, one of the most critical junctures of the last century. The pandemic coupled with known challenges of the first year in college made the college experience for freshmen in 2020 an incredibly tough and unique situation. Students had to navigate not only the typical challenges of adjusting to college life but were also forced to adapt to new technology and online learning platforms, lack in-person social interactions, and navigate the loss of loved ones. The sudden change in routine and learning environment left many overwhelmed and struggling to keep up with their academics.

Institutions across the world scrambled to rapidly mediate the impacts of the pandemic. Namely, the institutions shifted adopt virtual formats for academic instruction and social engagement (Mondisa et al., 2021; Alqashouti et al., 2023). This move toward virtual engagement allowed institutions to provide academic instruction and social engagement while adhering to social distancing restrictions. However, it also presented widespread challenges for students, threatening their academic success and overall well-being. For instance, students who relied on in-person interactions to establish connections and build networks with their faculty and peers found it challenging to form meaningful relationships without social opportunities and experienced isolation (Madrigal and Blevins, 2022).

Particularly for STEM majors, the pandemic significantly impacted their ability to acquire fundamental technical skills and research knowledge, mainly because of the absence of in-person lab courses and undergraduate research opportunities. This disruption is of significant concern because existing literature has emphasized the significance of engaging the STEM-related activities is imperative for fostering sense of belonging and connection to the STEM community. Namely, access to mentors and role models, engaging in peer interactions, and honing one's skills are essential in cultivating one's actualization as a science person (Dortch and Patel, 2017; Tellhed et al., 2017; Chen et al., 2021; Hansen et al., 2023). These opportunities are even more critical for low-income students who face a higher risk of leaving their studies.

Moreover, research on the impact of the COVID-19 pandemic on different communities has shown that marginalized or low-income individuals have been disproportionately affected by the crisis (Lederer et al., 2021; Kiebler and Stewart, 2022; Molock and Parchem, 2022). These communities have faced numerous challenges during the pandemic, such as limited access to proper healthcare, fewer job opportunities, and inadequate social support systems. For example, some students may not have access to the technology or equipment required for online learning, which has become the norm during the pandemic. Also, they may be struggling with mental health issues caused by the stress, uncertainty and increased financial pressures due to the pandemic's impact on their families (Gopalan et al., 2022; Kim et al., 2022). Therefore, the data suggests that targeted interventions and support are necessary for these communities during this critical juncture.

1.2 Holistic mentoring ecosystems

Mentoring in the STEM context has traditionally explored the impact of formalized programs focused on topical areas such as student academic success and early career STEM faculty development (Packard, 2015; Haeger and Fresquez, 2016; Mullen and Klimaitis, 2021). More recently, research in postsecondary STEM education has shifted to explore the ways in which comprehensive and inclusive approaches can be implemented to the growing needs of diverse groups of students. One such approach is holistic mentoring ecosystems. Holistic mentoring ecosystems are a comprehensive approach to addressing the diverse needs of students through interconnected support networks (Mondisa et al., 2021). This approach is particularly beneficial for at-risk students who may require additional support to overcome challenges and achieve success in their academic and personal lives (Patton and Harper, 2003; Crisp and Cruz, 2009; Luedke et al., 2019).

Research has consistently shown that mentoring in STEM fields is essential for fostering a sense of belonging, expanding social networks, and developing a science identity, among other long-term benefits (Wilson et al., 2012; Packard, 2015; Haeger and Fresquez, 2016; Dennehy and Dasgupta, 2017; Atkins et al., 2020). This is particularly important for students from marginalized backgrounds, who tend to leave STEM disciplines at higher rates than their peers (Kricorian et al., 2023). Often, their decision to depart from their discipline is not due to a lack of ability but rather environmental factors and the need for a greater connection to the scientific community (Hill et al., 2010; Harris, 2019; Corneille et al., 2020).

Our study focuses on a holistic mentoring ecosystem structure that aligns with the definition proposed by [Mondisa et al. \(2021\)](#). The ecosystem comprises interconnected support networks, including a scholarship mentoring program, science living-learning communities, student support services, and STEM student organizations. Central to the holistic mentoring ecosystem is a multi-year scholarship mentoring program that began in 2020. The overarching goal of the mentoring program is to foster an inclusive and supportive environment that equips low-income students with the necessary resources to ensure their academic and professional success. The program is based on an appreciative advising approach and offers various forms of support, including financial assistance, personalized development planning, 1-on-1 coaching, and monthly group sessions. The one-on-one bi-semesterly coaching sessions are guided by the personal development plans tailored to each student. The monthly group meetings occur throughout the academic year and are focused on topics related to STEM success. We posit that the culmination of these activities facilitates the growth and achievement of students as they navigate their collegiate careers.

1.3 Purpose and research question

As we shift to a post-pandemic environment, we sought to explore the ways in which students from low-income backgrounds in STEM disciplines persisted through the combined critical junctures of freshman year and the COVID-19 pandemic. In particular, the study seeks to explore the specific ways in which a holistic mentoring ecosystem provided critical support to these students, such as academic and emotional support, social connections, access to resources, and financial aid.

The purpose of this present study investigates the role of holistic mentoring ecosystems in mitigating the impact of critical junctures for low-income student populations. Specifically, the study explores how such involvement supported the matriculation of low-income STEM students during the COVID-19 pandemic. The central research question guiding this study is: *In what ways did participation in a scholarship mentoring program aid in mitigating the impacts of the COVID-19 pandemic on the persistence of low-income STEM students?*

2 Theory

Undergraduate student retention has been investigated as early as the 1930s. Scholars and practitioners alike have long sought to understand the factors and contexts that impact a student's ability and likelihood to be retained through to college completion. Most of the earlier student retention models and theories mainly focused on the student's attributes, knowledge, motivation and skills as the determinant for retention ([Gekoski and Schwartz, 1961](#); [Panos and Astin, 1968](#); [Newcomb, 1994](#)). However, a reoccurring critique of these works is the lack of focus on the impact of an individual's environment on their retention.

Factoring in this critique from previous literature, Tinto developed a model of retention that accounted for the individual and their environment and the ways in which these entities interplay to impact retention. The model of retention posits that students who are

academically and socially integrated into a campus community are more likely to be retained ([Tinto, 1987, 2006](#)). His work suggests that strategic practices that help students navigate critical junctures in their acclimation to college and their majors have a higher likelihood of supporting their success. In many ways, the work of supporting students' integration into the campus community supports students' sense of belonging and identity development as a member of the community ([Tinto, 2017](#); [Strayhorn, 2020](#)).

Our study is based on Tinto's retention model, a widely used framework for identifying factors contributing to a student's success in college. However, it's important to note that this model has limitations. One significant limitation is the initial design of this model was based on the experiences of traditional students with access to resources and networks that support academic navigation ([Berger and Malaney, 2003](#); [Kuh et al., 2006](#); [Palmer et al., 2011](#); [Louten, 2022](#)). This means that the model may not fully capture the experiences of students from marginalized groups, such as low-income students. With this limitation acknowledged, we center our work on the fundamental tenets of the retention model, emphasizing the importance of a student's integration and acclimation to the college community, which can bolster their persistence and retention.

Tinto's retention model has been utilized extensively in education exploring contexts and factors of retention across a multitude of institutional contexts and demographic populations ([Tinto, 1975](#); [Terenzini et al., 1996](#); [Hurtado and Carter, 1997](#); [Robbins et al., 2004](#); [Nandy et al., 2021](#)). Particularly in STEM fields, scholars have grounded their work in the retention model to explore factors influencing retention and persistence in STEM pathways for historically underrepresented groups, women and first generation college students ([Lo et al., 2020](#); [Brewer et al., 2021](#); [Premraj et al., 2021](#); [Louten, 2022](#)). There are still opportunities to research additional populations, especially low-income students, as this population remains under-researched. Therefore, this paper focuses on the retention of low-income STEM students during their first year in college amidst the COVID-19 pandemic. By examining academic and social integration, we aim to identify effective strategies that could help overcome the unique challenges faced by low-income STEM students who are at risk of dropping out during their first year of college.

3 Methods

This study utilized a qualitative case study approach to gain insights into the experiences of low-income STEM students who participated in campus mentoring programs during the COVID-19 pandemic. The goal of case studies is to "describe a phenomenon in its real-world context" ([Yin, 2014](#)). The target population of this study was undergraduate students participating in the scholarship mentoring program for STEM majors. Also, the participants in this study were classified as low-income and academically talented diverse groups. We define diverse groups in this study as participants with differences in race, ethnicity, socioeconomic, religious beliefs, sexual orientations, academic pursuits, and life experiences, among other identifying demographics. We determined the low-income status of the students through financial need analysis for college attendance.

Of the 10 students in the sample, nine were enrolled in college between Fall 2020 and Fall 2021. The remaining one senior entered

college in the Fall of 2019. Half of the students were out-of-state students. By classification, there were four sophomores, four juniors, and two seniors. By field of study, eight students were pursuing science fields, one was pursuing engineering, and one was pursuing mathematics. The gender and race/ethnicity makeup of the group is illustrated in [Figure 1](#).

3.1 Data collection and analysis

Aligned with case study methods, we utilized multiple forms of data, including interviews, student metrics, and self-reporting surveys ([Yin, 2017](#)). The primary data source collected in this study were one-on-one, semi-structured interviews lasting approximately 45 min and conducted via the Zoom platform. The Institutional Review Board approved this study at a research university in the Deep South region of the U.S. Participants were assigned pseudonyms to ensure anonymity.

Interviews were conducted in October 2022. At the time of the interviews, four students were in the scholarship program for 2 years, and six students for 1 year. Our focus for this paper is on the experiences of students who began their college journey during the COVID-19 pandemic. The interview protocol was intended to gather participants' perspectives about various aspects of college life, such as transitioning to college, the impact of COVID-19, academic perceptions, and curricular engagement. Guided by Tinto's model, we investigate points of academic and social integration to identify effective strategies that could help overcome the unique challenges faced by low-income STEM students.

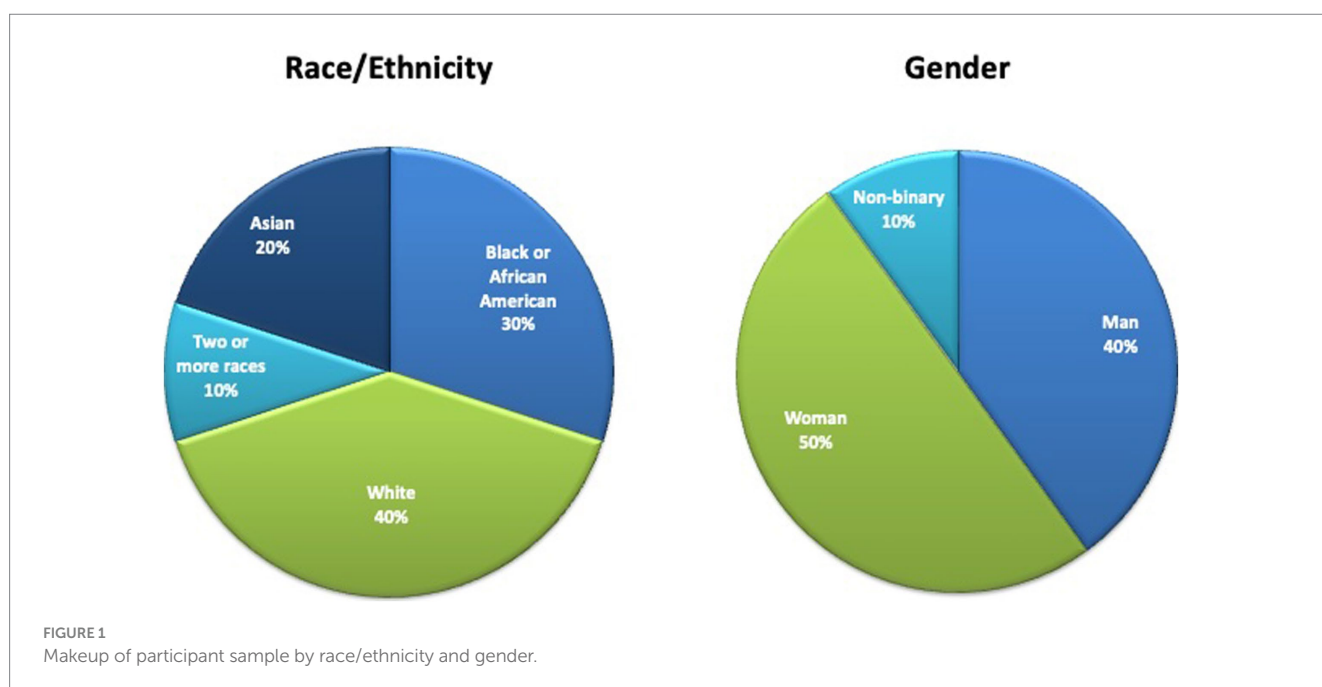
Additionally, we evaluated student metrics on each participant's academic performance, including data on their grade point average and progress reports on their individual development plans. This information was gathered to gain a better understanding of the factors that contribute to student success. In addition, we carefully reviewed the annual end-of-year evaluation of the mentoring

program to assess its effectiveness in supporting student growth and development.

Prior to engaging in the analysis process, all interviews were transcribed verbatim and read through to gain an overall understanding of each participant ([Creswell and Poth, 2016](#); [Yin, 2017](#)). Our first analysis stage was open-coding each transcript using Dedoose qualitative analysis software. Utilizing an inductive coding approach, we identified preliminary patterns and labeled codes based on concepts of interest in the interview data. Using the initial codebook, we reviewed all the transcripts through subsequent rounds of axial coding to continue refining the codebook. This codebook refining process involved consolidating, merging, and renaming codes to achieve the finalized codebook. The final codebook comprised 76 codes. Once the final codebook was completed, we then organized our codebook to determine which codes answered the research questions. Through an iterative debrief process, we utilized the codes by research questions to discover this study's emerging ideas and themes based on the identified patterns or trends between the participants' experiences. Specific to this paper, we explored the codes and emerging ideas connected to their experiences navigating the COVID-19 pandemic, college transition and supports during this transition.

4 Findings

This study centered on how holistic mentoring ecosystems mitigated the impact of the combined critical junctures of freshman year and the COVID-19 pandemic on students from low-income backgrounds in STEM. The two main themes emerging from the analysis of the students' experiences were acclimation to the academic environment and fostering connection to the STEM community. The presentation of these themes is based on the interview protocol, which concentrated on the impact of the critical junctures in the participants' academic and social contexts.



4.1 Theme 1: acclimation to the academic environment

Entering college amidst the pandemic proved to be a daunting challenge for many of our students. They encountered various anticipated and unforeseen hurdles while acquainting themselves with the college environment. As our students reflected on their first semester in college amid the pandemic, there was a shared sentiment of uncertainty navigating their environment under these circumstances. Participant 9 entered college after taking a gap year. He explained, “I was coming off of a year of no school and then to go into online school [due to the pandemic]. That was a large learning curve... I had been out of a classroom and my classes in high school were not online.” He further expressed, “You’re in a new environment. There’s a pandemic and you are on your own... These are fairly hard classes, especially for someone in college for the first time.” Similarly, Participant 6 recounted having to use “ingenuity” going into her first year because “it pretty much was like we did not really have teachers.” Much like their peers, Participant 2 discussed how entering college amid a pandemic impacted his acclimation to the campus and where to find resources. “As a freshman in the pandemic, and then going in the sophomore year of being expected to know where these offices are, where these buildings are, how to get around campus... I had never even been in the library. I did not even know we had a library.”

In addition to making sense of their non-traditional collegiate experience, students recounted academic setbacks due to an inability to engage in through traditional means. Participant 2 shared regarding establishing connections with faculty, “It was a lot harder to meet most of my freshman professors... It was also the faculty not getting to know me personally freshman year, because it’s first impressions or coming into college... where it counts the most.” Several students shared instances where their confusion could have been mitigated by in-person connection to faculty or support staff at the start of their first-year. Participant 1 recounted her experience with course selection her first semester, “It was confusing...there was some questionnaire where I picked trigonometry but somehow, I ended up taking calculus... There was a lot of confusion, and not really understanding what to do, and not really being able to talk to my professors because they were swamped with emails.” Another significant hurdle was an inability to engage in educational experiences, such as shadowing and undergraduate research, that is known to be critical experiences for their career trajectories in STEM. Participant 8 entered college in Fall 2021, she was still met with similar restrictions that were implemented during the onset of the pandemic when trying to find external educational opportunities. “A lot of opportunities, even still, were unavailable. There was one shadowing program I wanted to do with a certain doctor, but I could not do that because of Covid, and it was too restricted.”

Several of the students attributed their involvement in a small, cohort style campus mentoring program assisted in their navigation of their academic challenges amid the pandemic. Participant 8 and Participant 2 shared similar sentiments about access to essential information and resources needed to navigate college. Participant 2 explained, “The meetings we had every month are extremely helpful... the information we talk about in these meetings are things I did not know existed, and every time I think I know everything about campus I learned something new in the next meeting.” He further shared about the benefit of the one-on-one advising amid the pandemic.

“One on ones are extremely helpful because I’m able to communicate what’s going on in my life, so I know somebody is aware... I know I have somebody to ask questions to, or things come up.” Similarly Participant 4 stated, “I think it’s that stability and mentorship... If I really have a problem... I have someone from the program to reach out to... that’s been really helpful.” Even after the initial impact of the pandemic began to subside, students expressed the importance of participating in specialized programs to mitigate the lasting effects of the pandemic. Participant 9 eloquently explained, “I have a pretty good idea of what I want to do. But I am strong enough to admit that I do not have all the resources and knowledge that I need to get to places.”

4.2 Theme 2: fostering connection to the STEM community

Despite best efforts to interact socially through alternative means, the participants collectively described the feelings of isolation and difficulty in making social connections with peers. Participant 4 expressed, “...with the pandemic it was definitely hard to adjust to like not really getting that college experience like not having a welcome week, not really getting to make a lot of friends.” Participant 5 shared how severely limited his social engagement was due to fear about being exposed to COVID. When asked how the pandemic impacted his social connected, he shared, “Socially probably quite a bit because I was a bit anxious about COVID...I was a bit paranoid at first. I made sure I had my health at the forefront, so that lessened than my chances of good social interactions and hurt my chances of getting out there.”

Even for participants with more access to opportunities for social engagement, they still encountered isolation and minimal social engagement. For instance, Participant 9 discussed his experience living in the science learning community with more opportunities for social engagement. However, he recounts the feelings of isolation even though he was in in-person classes.

It would feel so weird living in the Science residential college... seeing people and not talking to them...both of my Calculus classes were in person because they were taught in the basement [of the residence hall] ... I think everyone was just afraid to be near someone else. We’d walk out of class, and then we’d walk up [to the building lobby] together in silence and then go back to our rooms.

On the other hand, Participant 2 discussed how the opportunities for social connections within the science living learning community made it possible to withstand the feelings of isolation. He shared, “... in the science learning community... they were still doing events. They took precautions to make sure everything was safe and I really appreciated the effort to get people outside because everything I went to otherwise were Zoom calls.” These accounts of the academic and social experiences from the same living-learning community highlights that even with more opportunities for engagement, it is still essential to have an organized effort from faculty and staff to foster community development.

Two of the participants, participant 3 and 6 both agreed that their education would have been severely impacted without the invaluable support they received from the mentoring program. They both

acknowledged that the program's guidance, support, and resources were crucial to their persistence. They expressed that, without this program, they would have either transferred from their institution or discontinued their education altogether. Participant 3 shared their initial concerns about making social connections and explained that their involvement in a cohort-style campus mentoring program provided them with the community they needed to stay enrolled at their current institution.

How am I going to find people? It's COVID time and they aren't doing in-person events so I don't really know how to go about meeting people... having that community built in [through the mentoring program] when I came to college... it was really helpful getting you through that first semester... Because if I didn't have anyone around me, I probably would have transferred back to Arizona.

All of our research participants agreed that being a part of a holistic mentoring ecosystem gave them opportunities to engage socially with a community of peers, which satisfied their need for social connection during a time when many students had limited opportunities for social connection. Participant 5 expressed that the program provided him with a consistent connection point with his peers despite the fear of catching COVID. "I'm happy I had the mentoring program because... you are attending meetings, and I do not have a choice. It balanced things out. I did not feel so alone." In the same way, Participant 4 highlighted the uncertainty she had as a freshman. "It was the combination of sort of not knowing where to go... not knowing what resources are available... not knowing what your community could be like... what and who you could depend on in college." She elaborated on how the mentoring program helped alleviate those concerns. "I really like the aspect of the program... to guide me through certain parts of the College of Science."

5 Discussion and conclusion

Extensive research has been conducted on mentoring practices in STEM undergraduate programs. Yet, the current global context, marked by impactful events like the COVID-19 pandemic, has paved the way for new avenues of exploration regarding the potential of mentoring to ease the burden of traumatic experiences on college students' perseverance. As such, our study seeks to investigate the role of a comprehensive mentoring ecosystem in supporting low-income and diverse students pursuing STEM fields at critical junctures. Through the accounts and reflections of our 10 participants, we explore the central research question on how the participation in a holistic mentoring ecosystem mitigated the impacts of the COVID-19 pandemic on their persistence in their first year of college.

Our research examined the academic and social engagement of undergraduate students during their freshmen year of college amid the COVID-19 pandemic. Specifically, we investigated how students dealt with limited educational opportunities and connections with faculty. Our findings show that students who participated in a structured mentoring program during the pandemic attributed it to helping them navigate the academic environment. Specifically, our students expressed how the monthly meetings and one-on-one check ins through the mentoring program provided guidance, information

about resources and motivation, which helped them feel more integrated into the educational community and enabled them to thrive despite pandemic-related obstacles. This finding builds on existing literature and deepens our understanding of the impact of mentoring at critical junctures.

In addition to supporting academic engagement, our findings show that involvement in a holistic mentoring ecosystem provided students with multiple points of social connections. In particular, engagement in a holistic mentoring ecosystem facilitated and bolstered students' social connections by creating a supportive environment that encouraged students to interact with their peers, mentors, and other individuals within the mentoring ecosystem. For instance, several of our participants lived in a science living-learning community, which gave them access to smaller, cohort-style group settings for classes and social programs. This allowed students to cultivate meaningful relationships and foster a sense of belonging, which is crucial for their overall well-being. Aligned with Tinto's retention model, we too found that acclimation and connection to the college community was vital to students persisting through their first year of college despite challenges.

Echoing Berg (2016) sentiments regarding low-income students' needs in college, we, too, assert that simply providing financial assistance is not enough. Low-income students need academic guidance, mentoring, and support that fosters community. The need is even more significant in pivotal moments, such as critical junctures during their college career. It is only through a combination of financial assistance, academic counseling, and supplementary resources that we can ensure the success of low-income students.

While this study centers around the difficulties encountered by first-year college students amidst the pandemic, this work possesses the potential for broad applicability in other scenarios. Critical junctures are not limited to the first year of college. As such, this study emphasizes the significance of holistic mentoring ecosystems in supporting students and navigating a diversity of critical junctures in the academic training of students in STEM disciplines. Moreover, the study contributes to the current body of literature on mentoring, particularly holistic mentoring ecosystems in supporting low-income student populations.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by LSU Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RD: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration,

Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. ZW-K: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing.

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