BUILDING EQUITABLE SYSTEMS IN STEM: A STATEWIDE REVIEW OF ADMINISTRATIVE PERSPECTIVES ON MENTORING FOR UNDERREPRESENTED UNDERGRADUATE STUDENT SUCCESS

Terrance McNeil
Tennessee State University
tmcneil3@tnstate.edu

Shaniqua Nixon, Ed.D.
Tennessee State University
Snixon4@tnstate.edu

Tokesha Warner, Ed.D.
Tennessee State University
twarner3@tnstate.edu

John Robinson, Ph.D.
Tennessee State University
jrobinson@tnstate.edu

Denise Green, Ed.D
Tennessee State University
dgreen10@tnstate.edu

Abstract

This qualitative study investigated mentoring practices within the Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP) program from the perspectives of university campus administrators. Semi-structured interviews were conducted with TLSAMP administrators from ten partner institutions over two years. Interview questions explored characteristics of effective mentoring relationships and programs implemented to support underrepresented students' success in Science, Technology, Engineering, and Mathematics (STEM). The findings highlighted relationship-building, communication, and representation as important mentoring characteristics. Programs provided multiple supports including mentoring, research opportunities, and academic support. Administrators desired continued assessment and

cross-institutional collaboration. This study provides insights into mentoring best practices within TLSAMP. Findings suggest mentoring relationships and institutional support promote student success and strengthen mentoring programs to expand minority participation in STEM.

Keywords: mentoring, lsamp, administrators, institutional support, stem, underrepresented

Introduction

The collective action of dedicated, committed individuals has been attributed to successful outcomes across various fields of endeavor. The mission of equitably educating students, particularly in Science, Technology, Engineering, and Mathematics (STEM) fields has been a daunting one in the United States for decades. Certain students have lagged in achievement as socioeconomic and other factors have limited them from accessing technology and being prepared to pursue STEM fields at the same rate of success as others. According to the National Center for Education Statistics (n.d.), 773,971 total STEM degrees were awarded by postsecondary institutions in the United States in the 2019-2020 year. Of the total number 385,132 (49.8%) were awarded to White students. Meanwhile, only 55,642 (7.2%) and 94,927 (12%) were awarded to Black and Hispanic students respectively. Only 6.5% of STEM baccalaureate degrees were attained by Black students (NCES, n.d.). The implementation of programs designed to boost interest and achievement in STEM was deemed a plausible solution for this disparity.

Diversity in STEM (Science, Technology, Engineering, and Mathematics) is not just a matter of equity; it is essential for innovation and progress. Historically, individuals from marginalized backgrounds have made significant contributions to STEM disciplines, driving technological advancements that have shaped our world. However, the underrepresentation of these groups in STEM today poses a threat to the United States' ability to innovate and compete globally (Jackson, et al., 2019).

Historical Contributions and Importance of STEM diversity

Historically, marginalized groups have made substantial contributions to STEM. For instance, figures like Katherine Johnson, a Black mathematician whose calculations were critical to NASA's early space missions, exemplify how diverse perspectives can lead to monumental achievements. Similarly, George Washington Carver, an African American scientist, revolutionized agriculture with his work on crop rotation and sustainable farming practices. These contributions highlight the importance of including diverse voices in STEM fields.

Despite the historical contributions of marginalized groups, significant disparities persist in STEM education and workforce participation. Data indicates that while the number of degrees awarded to Hispanic, Black, and Indigenous students has increased, these groups remain underrepresented in STEM fields relative to their population size in the United States (NCES, n.d.). Part of the issue is retention of these students, as they often change majors after entering post-secondary STEM programs (Flynn, 2016). This phenomenon occurs less frequently with White Students, indicating the likelihood of systemic barriers that hinder academic persistence disproportionately. The lack of gender parity is also evident, particularly in fields like engineering and computer science, where women, especially women of color, are significantly underrepresented (Palid, et al., 2023). This underrepresentation not only limits opportunities for these individuals but also stifles the potential for innovation that diverse teams can bring.

Implications for Innovation and Competitiveness

The implications of a lack of minority participation in STEM extend beyond individual careers; they affect the overall capacity of the United States to remain competitive in a rapidly evolving global landscape. Research indicates that diverse teams are more likely to outperform homogenous teams due to their varied perspectives and problem-solving approaches (Hofstra, et al., 2020). A meta-analysis on diversity and inclusion initiatives highlights that organizations

implementing such initiatives experience increased innovation, improved decision-making, and enhanced employee engagement and satisfaction. These benefits stem from creating a more inclusive work environment where employees from diverse backgrounds feel valued and supported (Okatta, et al., 2024).

As the U.S. represents only about 4% of the world's population, fostering a diverse STEM workforce is crucial for maintaining leadership in technological innovation and scientific research. The absence of diverse perspectives can lead to blind spots in research and innovation, ultimately hindering progress and economic growth. Moreover, as the world faces complex challenges, such as climate change, public health crises, and technological disruptions, diverse voices are essential for developing comprehensive solutions. The absence of these perspectives can lead to blind spots in research and innovation, ultimately hindering progress and economic growth.

The importance of diversity in STEM cannot be overstated. The historical contributions of marginalized individuals to scientific advancement underscore the need for inclusive academic programs that support underrepresented groups. Addressing the disparities in STEM education and workforce participation is not only a matter of social justice but also a strategic imperative for the United States to sustain its competitive edge in the global economy. By fostering diversity in STEM, we can unlock new avenues for innovation and ensure that all voices contribute to shaping the future.

The Louis Stokes Alliance for Minority Participation

Higher education leaders have been empowered to develop programs that help underrepresented students. One such program, created in honor of the first African American elected to the United States House of Representatives, Congressman Louis Stokes, was established to support the matriculation of traditionally underrepresented students, particularly in

undergraduate STEM degree programs. The Louis Stokes Alliance for Minority Participation (LSAMP) is a nationally coordinated program that seeks to increase the number of underrepresented minority students earning degrees in STEM fields. Created by the National Science Foundation (NSF), LSAMP encourages collaborations among institutions of higher education and other organizations to enhance diversity in STEM through structured initiatives and funding opportunities.

LSAMP programs nationwide draw from the work of renowned theorist Vincent Tinto, who popularized a model for retention and extolled the benefits of academic and social integration for student success. Central to this framework is the assertion that addressing both academic and social support through intentional campus initiatives is vital for promoting student retention (Tinto, 1975, 1993, 2017). LSAMP programs across the country utilize various strategies including mentorship, financial aid, tutoring, summer bridge programs, and research experiences grounded in Tinto's theory to achieve their goal. The largescale success of these initiatives has been widely reported.

The Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP) serves as a localized branch of this national effort, uniquely tailored to meet the needs of Tennessee's educational institutions. While TLSAMP operates under the broader goals of LSAMP, it functions as a consortium of ten colleges and universities within Tennessee. This consortium operates as a unified body, committed to advancing STEM participation among underrepresented groups, while also granting member institutions the autonomy to design and implement programs that address their specific institutional dynamics and challenges (Middle Tennessee State University, n.d.; Tennessee State University, n.d.). This flexibility enables each participating institution to respond effectively to its unique student population, resource availability, and community context. For example, some institutions may prioritize mentorship programs, while

others focus on research opportunities or academic support initiatives. By aligning localized strategies with the overarching LSAMP framework, TLSAMP ensures that funding is used in ways that maximize impact at each institution. This structure reflects the broader LSAMP mission of increasing diversity in STEM while recognizing that the challenges and opportunities for underrepresented groups often vary significantly across institutions and regions (NSF, 2023). Through this dual emphasis on collaboration and customization, TLSAMP has become a model for how local alliances can successfully advance national diversity goals in STEM.

The Tennessee LSAMP (TLSAMP) program partnership consists of ten institutions of higher education across the state, including seven public and three private schools. TLSAMP aims to recruit minoritized STEM students, retain students to graduation, and increase the number of underrepresented STEM graduates that transition to graduate school. Two of the partner institutions are associate degree-level (community college), two are master's level, and six are doctoral-level institutions. Three of the institutions are designated as Historically Black Colleges and Universities (HBCUs); of those, two are private and one is public.

The TLSAMP alliance shares a collective interest in recruiting, cultivating, and developing the next generation of scientists, leaders, and a highly skilled workforce. Partners recognize this will ensure not only Tennessee's economic prosperity but also America's global preeminence. To achieve its aims, TLSAMP explored characteristics and factors involved in mentoring associate-level and undergraduate STEM students from underrepresented groups through this research study.

Although the dilemma of educating students in STEM fields persists, concerted efforts have been made that hold promise for positive change. The LSAMP program and a variety of others galvanize the collective academic and social resources in mentorship formats to impact student attrition. Mentoring in several forms has been associated with the successful

implementation of these operations. Many organizations have adopted the mission of equity, yet operational practices can be better understood and shared with the broader community.

Little is known about building STEM mentoring programs such as LSAMP from the unique perspective of higher education administrators. While the LSAMP program annually reports impressive statistics of program success, there remains a need to understand how these outcomes are generated. Program coordinators and principal investigators (PIs) responsible for developing initiatives through academic and social integration activities contain the requisite knowledge of best practices that lead to the successful support of underrepresented students. Learning from the perspectives of individuals responsible for attaining these outcomes bears great potential for revealing best practices of program development and informing the body of knowledge to support the establishment of new initiatives for STEM student success.

Purpose and Rationale of the study

This study examined the perspective of university administrators on the mentoring practices used within the TLSAMP alliance to engender success for underrepresented STEM students. This paper assessed the feedback provided by TLSAMP program administrators to understand how these leaders approach mentorship for programmatic success. Researchers collected data from administrators and LSAMP program coordinators with the goal of better understanding the dynamics that contribute to the successful matriculation of underrepresented students in STEM fields. It was believed that best practices of leadership and mentorship would emerge, enabling the team to produce suggestions for improvement of statewide STEM mentoring practices.

For this paper it was essential to focus on the administrative perspective because it highlights the unique and critical role that educational leaders play in advancing success in STEM disciplines for underrepresented groups. While faculty and student findings are integral to

understanding the dynamics of mentoring in STEM, separating these findings into distinct papers ensures that the responsibilities of administrators, who serve as program directors and principal investigators, are given the attention they deserve. Administrators are ultimately responsible for structuring programs, coordinating with faculty, and allocating resources to support student success. Their leadership is foundational to the success of initiatives like TLSAMP, as they are tasked with ensuring that mentoring programs align with institutional goals, meet the needs of underrepresented students, and justify the use of grant funding to broader stakeholders, including the National Science Foundation (NSF).

Educational leaders face the dual challenge of managing programmatic operations while fostering collaboration among faculty and staff to implement initiatives effectively. As program directors and principal investigators, administrators are charged with designing and overseeing systems that enable faculty mentors to engage with students and provide the critical support required for retention and graduation. They also play a pivotal role in distributing resources—such as funding for research opportunities, training for mentors, and academic support programs across their institutions in ways that maximize impact. Furthermore, administrators are accountable for ensuring that TLSAMP programs demonstrate measurable outcomes that justify the use of grant dollars. This accountability extends beyond individual institutions to the broader success of the alliance, as administrators must report on the collective progress of TLSAMP in meeting its goals of increasing diversity in STEM. By focusing on the administrative perspective, this paper emphasizes the essential leadership, vision, and accountability required to build equitable systems in STEM and underscores the importance of sustaining these efforts at the institutional and systemic levels.

Literature Review

The researchers engaged in a review of the literature to ascertain plausible activities that facilitate student success in STEM. The practices germane to underrepresented groups are of the most interest. Both faculty and administrators alike have grappled with applying solutions that significantly benefit this population. Students hailing from underrepresented backgrounds have presented unique challenges for administrators who often find educating them problematic. While solutions have been identified regarding this well-researched topic, there remains a need for continued focus as the disparities persist.

Mentoring and Institutional Support

Most studies on underrepresented groups have equity as a goal, and utilize metrics regarding student academic success, graduation, and job attainment. Often administrators are held accountable for ensuring these metrics reflect positive outcomes for students. Institutions can engage in many efforts that support the success of students. According to Tinto (2017), mentoring in various forms promotes the type of support mechanisms, institutionally, academically, and socially to encourage motivation in students.

Pioneering psychiatrist and educator Dr. James Comer produced groundbreaking research on mentorship and is highly regarded as a visionary among academics (Darling-Hammond, et al., 2018). The founder of the Comer School Development Program and the Maurice Falk Professor of Child Psychiatry at the Yale University School of Medicine's Child Study Center is credited with seminal research that established the dual need for attentiveness to students' academic and social supports. Subsequent writings of Tinto and others would buttress Comer's assertions regarding these constructs and encourage additional scholarship in this regard.

Beyond his appreciable contributions to the body of knowledge on early childhood development and educational leadership, Dr. Comer's statement regarding the type of

relationship needed to effectively mentor students from marginalized backgrounds have been frequently cited over time. Comer stated, “No significant learning occurs without a significant relationship (Porath, 2022)." Establishing a trusting, working relationship naturally precipitates goal attainment for a mentee. The type of trust relationship needed to facilitate a great mentor relationship need not be a deeply personal one, however, there must be mutual elements of respect and commitment. Mentees need to be comfortable with their mentor and vice versa. Often this occurs in informal discussions, where mentors and mentees can establish greater levels of connection based on common interests and values.

The constructs of identity, reflection and expectations are inextricable from the conversation on mentoring and consistent with the National Academies of Sciences, Engineering and Medicine (2020) framework, which is essential for student success. Most mentors understand that their role is to provide knowledge that the mentor does not possess. We are taught to instill a sense of purpose and value in the work that our students are doing, but it is also especially important that the mentor adopts purpose and vision. This is done both in the larger sense as a mentor needs to understand the gravity of their work and what it means to help usher in the next cadre of STEM professionals, but it is also important that leaders can communicate a vision to mentees that helps them to build confidence in the efficacy of their work. This shared vision helps create the trust conditions needed for a positive mentor-mentee relationship. Often students enter college striving for a sense of belonging and being unsure of how they will obtain their goals. Hence, through a trust relationship, they act as conduits for the success of the mentor, providing much-needed vision and ensuring accountability through expectations.

Mentors are often needed at pivotal times in the mentees' academic or professional careers. Trust relationships, intentionality and shared responsibility as noted by the National Academies of Sciences Engineering and Medicine (2020), can deliver students to new thresholds

of accomplishment. Mentorship, according to the authors, encompasses a variety of activities including introducing students to key individuals in one's network and exposing them to organizations that facilitate academic and professional success (National Academies of Sciences, Engineering and Medicine, 2020). Additionally, mentoring was associated with supporting scholars through exposure to university-level pedagogical practices, conducting research, writing grants, and publishing. Also included were activities that support the professional dispositions and interpersonal skills of students (National Academies of Sciences, Engineering and Medicine, 2020).

The seminal writings of Tinto (1975, 1997, 2010, 2017) espoused the constructs of academic and social integration as pillars of mentorship success with students. Subsequent literature emerged from scholars who expounded on Tinto's work. Crumpton-Young, et al. (2014) developed a best practices questionnaire from the top science mentors in the nation. The researcher’s findings on the best practices of mentorship for STEM students provide considerable insights applicable to the context of doctoral mentorship (Crumpton-Young, et al., 2014). Namely, the researchers attributed mentorship success in STEM to being passionate about mentees and their development, creating opportunities for mentees, setting elevated expectations of mentees' performance, providing needed support for mentees, and respecting the confidentiality of mentors. Kendricks, et al. (2019) acknowledged how creating a familial environment positively impacts underrepresented students. Specifically, the researchers noted that creating supportive social structures helped struggling students with academic preparedness, low self-efficacy, assurance of belonging, environmental isolation, lack of a network and impractical expectations of themselves and their college experiences (Kendricks, et al., 2019). Additionally, Mondisa, et al. (2021) discussed the need for evaluating STEM mentoring ecosystems to better understand how to adequately provide systemwide support for

underrepresented students. Moreover, Ovink, et al. (2024) concluded that to establish greater levels of equity in STEM fields, institutions must intentionally and actively build models of academic and social inclusion for underrepresented students.

Theoretical Framework

Tinto's theory of student engagement and persistence (1975, 1999, 2003, 2006, 2010, 2012, 2017) provided the overarching theoretical framework guiding NSF's LSAMP program model. Tinto espoused the central importance of academic and social integration toward student retention, persistence, and ultimate success (Tinto, 2010, 2012, 2017). Specifically, he recommended devoted attention to targeted student support in both academic and career domains (Tinto, 2012). Fostering equity necessitated intentional systems promoting underrepresented student support and success. Tinto and others posited integrating life lessons, ambitions and desires with classroom experiences through caring faculty mentorship relationships as integral (Tinto 1999, 2006). Overall, Tinto illustrated retention requiring institutional commitments addressing inclusion in both the academic and social realms, as seen in Figure 1 below.

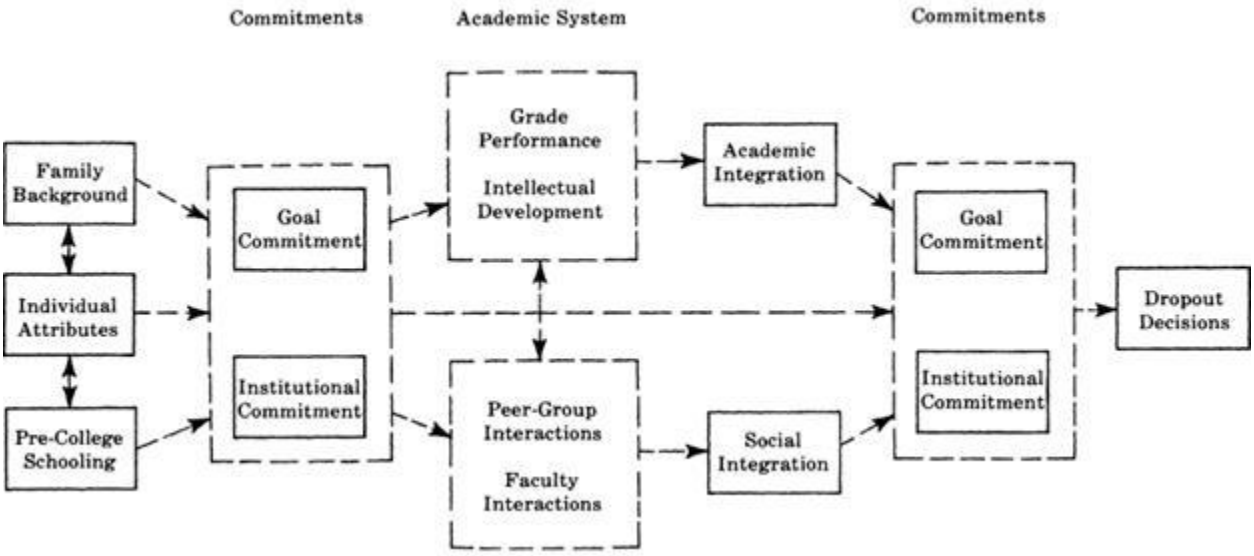

Figure 1: Tinto's Model of Student Retention (1975)

Tinto's framework has been broadly applied and adapted in academic conversations addressing efficacy, belonging and persistence for underrepresented STEM students (Burt, Stone, Motshubi and Baber, 2023; Johnson, 2022; Hansen, Palakal, White, 2023). Additional scholars established empirical links between belonging, sense of community and academic performance (Hansen, Palakal and White, 2023). These works reinforce the validity of Tinto's model for examining equitable supports and outcomes.

Research Questions

The success of the TLSAMP program prompted this research project. More information is needed to understand how the mentorship aspects of TLSAMP created the conditions for retention and graduation of students. The following questions, expected outcomes, and knowledge gained were proposed:

Research Question 1: What are the characteristics of mentoring across the TLSAMP Alliance that support the critical retention to graduation transition of URG in STEM?

Research Question 2: What mechanisms underlie mentoring operations across the TLSAMP Alliance that support the critical retention to graduation transition of students involved in STEM research?

The qualitative analysis of administrator interviews focused on addressing these questions to identify mentoring best practices and recommendations for strengthening programs supporting underrepresented STEM student success.

Methods

This study employed a qualitative research design to investigate the mentoring practices within the Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP).

Data collection involved two rounds of semi-structured interviews conducted over a two-year period. A total of 19 interviews were conducted with principal investigators (PIs), who were often accompanied by program coordinators or other administrators, representing all ten TLSAMP institutions. These administrators, who held critical roles in implementing and overseeing TLSAMP programs, provided valuable insights into effective mentoring relationships, programmatic approaches, and mechanisms for supporting the retention and graduation of underrepresented students in STEM fields. The inclusion of all consortium institutions ensured that the findings captured the breadth of experiences and strategies across the TLSAMP Alliance.

To strengthen the study's findings and provide a comprehensive analysis, additional data sources were integrated. Faculty and student focus groups offered context-specific perspectives on mentoring practices, while institutional data and annual TLSAMP reports provided quantitative and qualitative evidence of program outcomes. This triangulation of data sources enhanced the validity and reliability of the findings. For instance, institutional data offered statistical insights into retention and graduation rates, focus groups illuminated the lived experiences of stakeholders involved in mentoring relationships, and annual reports provided a longitudinal perspective on programmatic developments and outcomes across the consortium.

The qualitative data analysis followed a rigorous coding process, which was both deductive and inductive in nature. Four researchers participated in the coding process to enhance interrater reliability. Deductive codes were developed based on the study's research questions and theoretical framework, specifically Vincent Tinto's retention model, which emphasizes the importance of academic and social integration. Examples of deductive codes included "relationship-building," "communication," "institutional support," and "mentoring mechanisms." Inductive codes, on the other hand, emerged organically from the data during analysis, allowing

for the identification of unexpected patterns and themes. Frequent coder meetings facilitated the reconciliation of differences in interpretation and ensured that the coding process remained consistent, transparent, and reflective of the administrators' authentic perspectives.

The findings were derived through a systematic process of analyzing the coded data. First, raw data from the interview transcripts were segmented and assigned initial codes. These codes were then reviewed to identify patterns and recurring ideas that aligned with the deductive codes and theoretical framework. Patterns were further grouped into broader themes that addressed the study's research questions. For example, the theme of "relationship-building" emerged from codes related to trust, emotional support, and mutual respect in mentoring relationships, while the theme of "communication" encompassed clarity, expectation-setting, and the provision of feedback. Additional themes included "multiple layers of support," "peer-to-peer and faculty mentoring," "direct student involvement in research," and "mechanisms for addressing struggling students."

By employing a robust methodological approach that included multiple coders, triangulation of data sources, and iterative discussions to ensure alignment, the study produced findings that were both reliable and grounded in diverse perspectives. This multi-faceted approach provided a comprehensive understanding of the mentoring practices and mechanisms contributing to the success of underrepresented students in STEM fields within the TLSAMP.

Findings

The study provided a detailed exploration of mentoring practices within TLSAMP, focusing on the characteristics of effective mentoring relationships and the mechanisms that support the retention and graduation of underrepresented students in STEM. Two overarching themes emerged: the personal qualities and approaches that define successful mentoring

relationships, and the structural mechanisms embedded in TLSAMP programs that facilitate student success.

Research Question 1: Characteristics of Mentoring

Administrators emphasized the critical role of relationship-building and communication in fostering effective mentoring relationships. Participants described how trust and emotional safety are foundational to mentoring success. As one participant explained, "The student must feel safe to express their emotions. Some will do it naturally. Some need to know it's safe." This safety enables students to openly share their challenges and aspirations, allowing mentors to provide tailored guidance and emotional support.

Administrators frequently stressed the importance of prioritizing the relationship itself over academic productivity. For instance, mentors from one institution were encouraged to conduct an initial assessment of student goals to define the relationship's purpose and build upon the student's potential. In another case, a respondent highlighted the practical aspects of mentorship, stating, "Give them the tools and the access and exposure to what will get them on that track [to their goals]."

Mentors also play a crucial role in expanding students' horizons. They expose mentees to opportunities beyond their immediate academic environment, such as research, internships, or professional organizations. Additionally, mentors act as cheerleaders for student success, celebrating achievements and providing encouragement during difficult times. One participant described this dynamic as, "Sharing those moments with them. Being in those moments with them."

The personal qualities of mentors were another key focus. Characteristics such as patience, empathy, humility, and observance were frequently cited. According to one participant, "It's [a mentor] someone willing to admit that they might not know everything." Mentors were

also valued for their ability to draw from personal experiences. Sharing one's own challenges, mistakes, and successes was seen to inspire trust and provide relatable guidance. One administrator explained,

> (A mentor is) one who is willing and open and transparent to share that story, good, bad, and indifferent. Also, personal experiences are having walked the path the student is on (whether it's) engineering, math, science, or technology, you would like to see someone who's already traveled the path that you want to go down, and that will then help make a person feel at ease a little. (Administrator interview)

Representation in STEM emerged as a recurring theme, with several participants highlighting how shared identities between mentors and students can foster comfort and openness. One participant noted, "Students with similar identities with a faculty member may feel more comfortable or maybe more open or willing to approach that faculty member." Another emphasized, "Representation matters, regardless of what their representation is. It can be sexual orientation, it can be gender, it can be race."

Mentors' motivations and enthusiasm for mentorship were also vital. Many participants described mentorship as a deeply fulfilling and impactful endeavor. One participant reflected, "Mentoring goes far beyond academic performance because you're shaping an entire person. A great mentor gains satisfaction in knowing that they enhance the life of the person that they're mentoring."

Research Question 2: Mechanisms Underlying Mentoring

The study also uncovered various institutional mechanisms that support mentoring and contribute to student retention. Administrators highlighted peer-to-peer mentoring, faculty engagement, and structured research opportunities as central to TLSAMP's success. Programs

often connected students across academic levels, allowing them to mentor and learn from one another. One participant described this approach,

> We launched our mentoring task force this semester... One way of mentoring is through peer connection. Another way is through professionals such as our alumni and faculty members, exposing them to opportunities that would otherwise not be available to our students.

Research opportunities were noted as particularly impactful, providing students with practical experience and exposure to STEM careers. One administrator shared, "On the research side, we do have students who engage in undergraduate research through our Office of Undergraduate Research office through summer experiences, whether it's the summer internship for research, but also partner through Oak Ridge National Labs."

Academic interventions for struggling students also emerged as a significant theme. Administrators described bridge programs and supplemental instruction designed to address academic gaps and support student success. For example, "We have a math camp program designed to work with college algebra-ready students to improve their placement and to be more retained in their math studies." (Interview Participant)

Another participant discussed a program aimed at preparing pre-calculus students for calculus,

> We have a program within the College of Engineering called the summer engineering advancement program. It's designed for our pre-calculus ready students with the goal that they will become calculus ready by the end of a three-week bootcamp experience. (Interview Participant)

Proactive interventions, such as regular meetings to identify struggling students and provide support, were also emphasized. One respondent explained, "We meet regularly to talk

about if students are having issues.We offer supplemental instruction to connect students with resources if they're having academic difficulties."

Continuous Improvement and Collaboration

The participants also expressed a desire for continuous LSAMP program improvement. Administrators underscored the importance of continuous program improvement and cross-institutional collaboration. Sharing best practices across TLSAMP institutions was identified as a critical strategy for enhancing program effectiveness. One participant remarked, "Cross-institutional participation could strengthen opportunities for student research experiences and make up for programmatic limitations at one school."

Administrators mentioned several university initiatives (programs) that were designed to boost achievement and professional development for their students. Cross-institutional collaboration was agreed on as a plausible solution to strengthen the program's overall effectiveness. The sharing of best practices was deemed a good strategy to consider moving forward to raise the standard of LSAMP operations overall.

Discussion

The findings underscore the importance of mentoring relationships built on trust, communication, and shared experiences, coupled with institutional mechanisms that provide academic and social support. TLSAMP's approach aligns closely with Tinto's framework of academic and social integration, demonstrating the value of intentional mentoring practices and systemic supports in fostering success for underrepresented students in STEM fields. Administrative insights affirmed prior mentoring experiences directly informed leadership expectations and programmatic operations executed to retain underrepresented STEM students. Relationship-building and communication emerged prominently, consistent with seminal

retention theory stressing social integration commitments through faculty involvement (Tinto, 1975).

Research findings validated Tinto's retention framework through evidence of intentional mechanisms administered across multiple institutional layers providing academic and social support addressing disparities as recommended (Tinto, 2010, 2012, 2017). Strategies bolstering belonging, research experiences, networks and struggling student interventions implemented retention conditions. Analysis revealed a connection between leadership mentoring backgrounds experienced and varied levels of innovative practice across campus programs. Administrators advocated knowledge sharing to strengthen programs confronting limitations. Campus initiatives illuminate holistic inclusion establishing belonging and supports promoting academic success.

Findings and Themes from Research Question One

Research Question	Findings	Emergent Themes
Research Question 1: What are the characteristics of mentoring across the TLSAMP Alliance that support the critical retention-to-graduation transition of underrepresented students in STEM?	Administrators emphasized relationship-building and communication as foundational to effective mentoring. Trust, emotional safety, and individualized support were highlighted as critical elements. Mentors were described as patient, empathetic, humble, and motivated by a genuine desire to help students succeed. Representation was also emphasized, as shared identities between mentors and mentees fostered comfort and openness. Mentoring was seen as a holistic process, celebrating student achievements and shaping their personal and professional growth.	• Relationship Building • Communication • Emotional Safety • Representation and shared identities

Findings and Themes from Research Question Two

Research Question	Findings	Emergent Themes
Research Question 2: What mechanisms underlie mentoring across the TLSAMP Alliance that support the critical retention-to-graduation transition of students involved in STEM research?	Institutional mechanisms such as peer-to-peer mentoring, faculty engagement, and research opportunities were identified as key supports for student success. Administrators highlighted targeted interventions for struggling students, including bridge programs and supplemental instruction. They also praised the role of program coordinators in supporting students and expressed a desire for continuous program improvement. Cross-institutional collaboration was identified as a critical strategy for enhancing program operations and sharing best practices.	• Multiple layers of support (campus programs, peer mentors, program coordinators, advisors) • Direct student involvement in research • Support mechanisms for struggling students • Continuous program improvement • Cross-institutional collaboration

Conclusion

The LSAMP model based on Vincent Tinto's Theory of Student Retention (1975) has a long record of accomplishment with proven success in increasing the number of URM students who attain undergraduate and advanced degrees in STEM. The strategies and activities of the LSAMP model provide formal and informal opportunities to address the disparities that exist with STEM degree attainment from an institutional perspective in both the academic and social constructs. The emergent themes of relationship-building and communication are consistent with Tinto's seminal assertion that intentional focus on administrative and individual social supports

are vital to promoting retention of students (Tinto, 1975). Further, it appears through the data collected regarding research question two that mechanisms of mentorship implemented by the institutions (multiple layers of support, direct student involvement in research and building effective mechanisms for supporting students) also buttress the Tinto framework.

The data suggested that more effort could be made to engage undergraduate students in research. This is often an institutional limitation due to funding or other structural boundaries. The administrators posited that cross-institutional participation could strengthen opportunities for student research experiences and make up for programmatic limitations at one school. This is consistent with established literature from Beauchamp, Roberts and Tingley (2021) who emphasized the value of research mentoring for underrepresented undergraduate students. These are preliminary findings as part of a larger mixed-methods sequential study further examining mentorship practices within LSAMP participants. It is recommended that the insights revealed through this study are continually analyzed in new research contexts. More information is needed on how, relationship building, communication, multiple layers of support, involving undergraduate students in research, building effective mechanisms for supporting struggling students as well as program coordinators and cross institutional collaboration can promote greater levels of success for supporting the attainment of degrees in STEM for underrepresented students.

Limitations

As the research was conducted within a single statewide LSAMP program, the findings may not be generalizable to other states or regions with different student populations. Examining multiple programs across different locations could provide more broad insight. Additionally, the perspectives gathered were solely from administrators and did not include input from students or faculty directly involved in mentoring. This limits the understanding of mentoring experiences

from other viewpoints. The researchers of this project have generated other articles that explore the faculty and student dynamics.

There was also variation in program structures and supports across institutions that could have influenced administrator responses. A more consistent approach may be needed for clearer comparisons. This retrospective study relied on administrator recall rather than direct observation of current practices, therefore, some perspectives could be flawed by memory biases. Differences in administrators' mentoring backgrounds and leadership roles could have also influenced the perspectives shared.

Suggestions for Future Research

There are several approaches that could help advance understanding of effective mentoring practices for underrepresented STEM students. Broader studies involving multiple LSAMP programs across various states and regions would make the findings more generalizable. Employing longitudinal mixed-methods designs could provide deeper insight into long-term impacts of mentoring by examining academic and career outcomes over time. Larger, more diverse samples of administrators from different institutional contexts may uncover additional themes and variations in program implementation. Assessing faculty development and comparing approaches across programs experiencing different levels of structural support and resource availability may help strengthen mentoring capacity building. Piloting and rigorously evaluating new or modified mentoring models suggested by the present work could help strengthen minority student success in impactful ways. Pursuing this range of approaches would advance the evolution of mentoring frameworks.

References

Beauchamp, A. L., Roberts, S. J., Aloisio, J. M., Wasserman, D., Heimlich, J. E., Lewis, J. D., ... & Tingley, K. (2022). Effects of research and mentoring on underrepresented youths' STEM persistence into college. Journal of Experiential Education, 45(3), 316-336.

Burt, B. A., Stone, B. D., Motshubi, R., & Baber, L. D. (2023). STEM validation among underrepresented students: Leveraging insights from a STEM diversity program to broaden participation. Journal of Diversity in Higher Education, 16(1), 53–65. https://doi.org/10.1037/dhe0000300

Crumpton-Young, L. L., Elde, A. V., & Ambrose, K. (2014, June). Mentoring Practices Proven to Broaden Participation in STEM Disciplines. In *2014 ASEE Annual Conference & Exposition* (pp. 24-900).

Darling-Hammond, L., Cook-Harvey, C. M., Flook, L., Gardner, M., & Melnick, H. (2018). *With the whole child in mind: Insights from the Comer School Development Program*. ASCD.

Engstrom, C., & Tinto, V. (2008). Access Without Support is not Opportunity. *Change: The Magazine of Higher Learning*, *40*(1), 46–50. https://doi.org/10.3200/CHNG.40.1.46-50

Fast facts: Science, technology, engineering, and mathematics (STEM) education, by gender (899). (n.d.). National Center for Education Statistics (NCES), a part of the U.S. Department of Education. https://nces.ed.gov/fastfacts/display.asp?id=899

Flynn, D. T. (2016). STEM field persistence: The impact of engagement on postsecondary STEM persistence for underrepresented minority students. Journal of Educational Issues, 2(1), 185-214.

Fry, R., Kennedy, B., & Funk, C. (2021, April 1). *STEM jobs see uneven progress in increasing gender, racial and ethnic diversity*. Pew Research Center Science & Society. https://www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/

Hansen, M. J., Palakal, M. J., & White, L. J. (2023). The Importance of STEM Sense of Belonging and Academic Hope in Enhancing Persistence for Low-Income, Underrepresented STEM Students. Journal for STEM Education Research, 1-26.

Hofstra, B., Kulkarni, V. V., Munoz-Najar Galvez, S., He, B., Jurafsky, D., & McFarland, D. A. (2020). The diversity–innovation paradox in science. Proceedings of the National Academy of Sciences, 117(17), 9284-9291.

Inclusion across the nation of communities of learners of underrepresented discoverers in engineering and science (NSF includes) (nsf20569) | NSF - National science Foundation. (n.d.). NSF - National Science Foundation. https://www.nsf.gov/pubs/2020/nsf20569/nsf20569.htm

Jackson, L. M., McGuire, K., & Espinosa, L. L. (Eds.). (2019). Minority serving institutions: America's underutilized resource for strengthening the STEM workforce. National Academies Press.

Johnson, R. M. (2022). A socio-ecological perspective on sense of belonging among racially/ethnically minoritized college students: Implications for equity-minded practice and policy. New Directions for Higher Education, 2022(197), 59-68.

Kendricks, K. D., Arment, A. A., Nedunuri, K. V., & Lowell, C. A. (2019). Aligning Best Practices in Student Success and Career Preparedness: An Exploratory Study to Establish Pathways to STEM Careers for Undergraduate Minority Students. *Journal of Research in Technical Careers*, *3*(1), 27-48.

Middle Tennessee State University. (n.d.). *Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP)*. Retrieved from https://www.mtsu.edu/tlsamp/

Mondisa, J. L., Packard, B. W. L., & Montgomery, B. L. (2021). Understanding what STEM mentoring ecosystems need to thrive: A STEM-ME framework. Mentoring & Tutoring: Partnership in Learning, 29(1), 110-135.

National Academies of Sciences, Engineering, and Medicine. (2020). The science of effective mentorship in STEMM. National Academies Press.

National Science Foundation. (2023). *Louis Stokes Alliances for Minority Participation (LSAMP)*. Retrieved from https://www.nsf.gov/funding/opportunities/lsamp-louis-stokes-alliances-minority-participation

Okatta, C. G., Ajayi, F. A., & Olawale, O. (2024). Enhancing organizational performance through diversity and inclusion initiatives: a meta-analysis. International Journal of Applied Research in Social Sciences, 6(4), 734-758.

Ovink, S. M., Byrd, W. C., Nanney, M., & Wilson, A. (2024). "Figuring out your place at a school like this:" Intersectionality and sense of belonging among STEM and non-STEM college students. Plos one, 19(1), e0296389.

Palid, O., Cashdollar, S., Deangelo, S., Chu, C., & Bates, M. (2023). Inclusion in practice: A

systematic review of diversity-focused STEM programming in the United States. International Journal of STEM Education, 10(1), 2.

Porath, S. (2022). Significant Relationships. Networks: An Online Journal for Teacher Research, 23(2), 1.

Rodriguez, F., Rivas, M. J., Matsumura, L. H., Warschauer, M., & Sato, B. K. (2018). How do students study in STEM courses? Findings from a light-touch intervention and its relevance for underrepresented students. *PloS one*, *13*(7), e0200767.

Roulston, K. (2010). Reflective interviewing: A guide to theory and practice. *Reflective Interviewing*, 1-216.

Seidman, I. (2006). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. Teachers college press.

Taylor, O. L., & Wynn, M. E. (2019). Leadership dimensions for broadening participation in STEM: Increasing the role of HBCUs and MSIs. In *Growing diverse STEM communities: Methodology, impact, and evidence* (pp. 177-195). American Chemical Society.

Tennessee State University. (n.d.). *Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP)*. Retrieved from https://www.tnstate.edu/tlsamp/

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. Review of educational research, 45(1), 89-125.

Tinto, V. (1997). Classrooms as Communities: Exploring the Educational Character of Student Persistence. The Journal of Higher Education, 68(6), 599-623. doi:10.2307/2959965

Tinto, V. (1999). Taking student retention seriously: Rethinking the first year of college. *NACADA journal*, *19*(2), 5-9.

Tinto, V. (2003). Learning better together: The impact of learning communities on student success. *Higher Education monograph series*, *1*(8), 1-8.

Tinto, V. (2006). Research and practice of student retention: What next?. *Journal of college student retention: Research, Theory & Practice*, *8*(1), 1-19.

Tinto, V. (2010). From theory to action: Exploring the institutional conditions for student retention. Higher Education, 25, 51–89. doi:10.1007/978-90-481-8598-6_2.

Tinto, V. (2012). *Completing college: Rethinking institutional action*. University of Chicago Press.

Tinto, V. (2017). Through the eyes of students. *Journal of College Student Retention: Research, Theory & Practice*, *19*(3), 254-269.

United States. National Commission on Excellence in Education. (1983). A nation at risk : the imperative for educational reform : a report to the Nation and the Secretary of Education, United States Department of Education. Washington, D.C. :National Commission on Excellence in Education : [Superintendent of Documents, U.S. Government Printing Office distributor],

Velez, E. (2015). Administration and Faculty: How Relationships Create and Solve the Problems. Journal of Applied Learning Technology, 5(4).