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Support for STEM Students in Higher Education in Workforce Transition

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Abstract

STEM occupation growth is increasing continuously because of technological advancements, global changes, and rapidly expanding innovation. Promoting students' career aspirations in STEM has been a priority in many developed countries, including the U.S., U.K., Australia, and Germany. However, efforts to increase STEM awareness and interest have focused mainly on teaching and learning, while additional pressures now extend beyond teaching and learning to career education within STEM fields and career paths. Higher education institutions play an important role in improving access to effective career advice so that more students are aware of STEM career paths, enrol in STEM disciplines, and transition successfully into the STEM workforce. This paper highlights four areas for improving career transition for students in STEM fields, namely government and federal policies, higher education institutions, academic departments, and career centres. It also emphasises the role of students in engaging with resources and opportunities that support career readiness. The paper argues that collaborative mentoring, institutional support, industry partnerships, and students' active participation can strengthen STEM students' workforce transition and career success.

Keywords STEM students, STEM workforce transition, collaboration, higher education, student success

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INTRODUCTION

STEM (Science, Technology, Engineering, and Mathematics) fields play essential roles in improving a country's economy, growth, and global competitiveness. According to the U.S. Bureau of Labor Statistics (2025), STEM occupations are projected to grow by slightly more than 8 percent, compared with 2.7 percent growth for non-STEM occupations, from 2024 to 2034. The U.K. also observed 22 percent growth in employment within STEM occupations, compared with 11 percent growth in other occupations, between 2013 and 2023 (Department for Education, 2024). In Australia, jobs within STEM fields are projected to grow by 14.2 percent, twice as fast as non-STEM jobs, which are projected to grow by 7.4 percent (National Skills Commission, 2022). As global innovation expands rapidly, technological advancements such as AI, cybersecurity, engineering, and many other areas within STEM are also rising worldwide. It is therefore necessary to establish effective support systems and programmes to support students in STEM career paths.

Promoting students' career aspirations in STEM has been a priority in many developed countries, including the U.S., U.K., Australia, and Germany. Student success is measured through various

means, such as employment, student retention rates, supportive campus environments, student services, holistic development and wellness, sense of belonging, and academic achievement (Brown, 2024; Vugteveen et al., 2025). Despite the presence of various student success frameworks and programmes within higher education institutions, most of the focus has been on students' campus integration and academic support. Over the last decade, however, there has been an additional push to move beyond teaching and learning within classroom settings. Career education has become an important core element of student success in higher education institutions. Given the role that STEM disciplines play in global advancement and technological innovation, STEM fields and career paths have become a focal point for mentoring so that students can transition successfully into the workforce after graduation (Kitchen et al., 2024). Higher education institutions play an important role in improving access to effective institutional practices and services so that more students are aware of STEM career paths, enrol in STEM disciplines, and transition successfully into the STEM workforce. However, it is necessary to develop and implement targeted approaches to students' needs, such as career readiness and opportunities for STEM students to develop valuable skills through research, projects, presentations, and leadership roles.

Traditionally, academic disciplines and departments, including STEM programmes, have established mentoring practices and programmes in higher education (Hensel, 2012). Mentoring is usually considered to have a positive impact on students in higher education, especially within STEM fields, mainly because ample evidence shows that it supports positive outcomes for individuals navigating challenges (Dahlberg & Byars-Winston, 2019). Many definitions of mentoring exist within higher education, industrial organisations, businesses, and private and public sectors, along with formal and informal practices and approaches (Crisp & Cruz, 2009). Nuis et al. (2023) analysed the literature and defined mentoring as a "formalized process based on a developmental relationship between two persons in which one person is more experienced (mentor) than the other (mentee)" (p. 7). The mentor helps the mentee navigate career, emotional, psychosocial, psychological, and academic resources and support to promote student success, competence development, and career development (Crisp & Cruz, 2009; Nuis et al., 2023). The National Academies of Sciences, Engineering, and Medicine defined mentoring as "mentorship is a professional, working alliance in which individuals work together over time to support the personal and professional growth, development, and success of the relational partners through the provision of career and psychosocial support" (Dahlberg & Byars-Winston, 2019, p. 8). In this paper, mentoring for STEM students is defined as a developmental relationship and collaborative effort between a mentor and mentee designed to support professional and career development, career readiness, retention in STEM, and a holistic approach to supporting the mentee through the collaborative efforts of higher education institutions and their associated members. While mentoring within higher education institutions has become increasingly popular through first-generation mentoring programmes, buddy systems, academic departments, student support services, and other organisations and associations, higher education institutions must continue to revamp their mentoring programmes to better prepare STEM students for a globally competitive and rapidly changing workforce. Overall, although the higher education context is complex in its organisational structure, higher education institutions need to collaborate with other units and work towards better outcomes and workforce transition for STEM students.

LITERATURE REVIEW

This study employed a thematic literature review approach to identify articles through different databases, such as Scopus, ProQuest, Web of Science, ERIC, and Google Scholar. The main keywords used to identify peer-reviewed articles and reports from the early 1990s to 2026 were "STEM Students in Workforce," "STEM Student Success and Workforce Transition," "STEM Career Readiness," "STEM Mentoring," "Mentoring for STEM Students," "Mentoring in Higher Education for STEM," "STEM Workforce Success," and "Student Success for STEM Students."

Recent studies have shown that about a third of STEM students in higher education institutions leave STEM programmes (Chen, 2013; King, 2016). The reasons vary, including students' challenges and struggles in navigating mathematics, rigorous introductory courses, unwelcoming academic cultures, lack of support, and poor student-faculty relationships, which impede student success and STEM retention in higher education (Graham et al., 2013; Hedge, 2024; Stallsmith & Chavez, 2022; Stolle-McAllister, 2011). Students within STEM programmes need effective mentoring opportunities within their academic departments, student support services, and industry-specific professional networks to help them navigate challenges and obstacles (Beisler & Medaille, 2016; Johnson et al., 2022; Nabi et al., 2025). Dahlberg and Byars-Winston (2019) highlighted that mentoring experiences can be transformative for both mentors and mentees because mentorship is a collaborative effort that evolves through stages over time. Mentoring is used as a theoretical framework in this paper to highlight support systems and the multidimensional and multilayered complexities within higher education institutions that exist to support STEM students.

Wayman et al. (2024) initiated a mentoring programme at their institution, and as a result, most students showed higher confidence in their ability to succeed in a STEM career. The mentees' response was positive, as they reported that they were able to build connections with their mentors and peers and had a deeper understanding of themselves and potential STEM careers. Another study by Smith et al. (2025) demonstrated that the structure and quality of mentoring affected students' academic success. Their study emphasised the importance of mentoring and institutional support structures for students in STEM fields. Hutson et al. (2022) observed that participants perceived career advice in mentoring as beneficial, and Ganapati and Ritchie's (2021) study also confirmed that career support is essential in mentoring relationships. Participants preferred mentors among faculty members and industry-specific professionals mainly because of their experience, breadth of knowledge, currency and relevance of information, and possible position in hiring (Ganapati & Ritchie, 2021).

While mentoring has usually been observed as having a positive effect on students' success, many challenges remain, especially those rooted in access to and quality of mentoring programmes (Smith et al., 2025). Nkrumah and Scott (2022) emphasised that mentoring programmes and models usually do not account for the lived experiences of underrepresented students. Their study stressed the importance of addressing structural inequities within higher education institutions. In addition, institutions usually lack a mentoring culture within higher education, which makes mentoring programming, practices, and approaches inconsistent. Because of these inconsistent practices, students may or may not have effective mentoring relationships and the support they need to overcome their challenges. Another reason for these structural inequities in mentoring is weak collaboration among stakeholders, insufficient accountability measures, and a lack of regional and national strategies to support mentoring (Haberer et al., 2025). Bridging the gap between higher education institutions, departments, and student services can create a culture of mentoring practices

and programming and support the development of effective mentoring programmes across the institution. Collaborative efforts and mutual learning foster professional and personal development for individuals and stakeholders within higher education and can advance student success, especially workforce transition for STEM students (McLewis et al., 2025).

For mentees, it is usually difficult to provide honest and effective feedback to mentors who may serve as potential references for future employment opportunities (Burk & Eby, 2010). Anderson et al. (2012) highlighted that providing feedback can be difficult for mentees because their careers are often in the hands of their mentors. These scenarios can lead to mentoring approaches and practices that may not be effective, as mentees may be reluctant to provide feedback that might strain their relationship with their mentor. They may also worry about their career prospects. These challenges also arise because of a lack of formal mentoring training programmes for mentors within higher education (Hund et al., 2018). While mentors in higher education need to provide effective mentoring, they also need appropriate tools and training to build their own confidence and leadership skills (Tuck et al., 2025).

Although the literature identifies mentoring as essential and highlights the importance of structured mentoring support (Evans et al., 2025; McLewis et al., 2025; Ravishankar et al., 2024), significant gaps remain in understanding the complexities within mentoring programmes, from multidimensional support systems for students to successful workforce integration. In addition, workforce transition and career readiness are missing components within mentoring practices in higher education, and the literature has not fully captured STEM students' challenges and struggles in relation to workforce transition. Although literature is available on STEM retention and attraction within higher education (Sithole et al., 2017), workforce transition and career readiness for STEM students have been largely absent from mentoring frameworks. Current studies focus either on peer mentoring programmes or faculty mentoring but not on overlapping support systems from institutional contexts and collaborative efforts among different stakeholders. Because mentoring is dynamic, complex, and rooted in multilayered ecosystems within higher education, it is important to develop mentoring culture and organisational learning practices within higher education through collaboration and with a focus on building mentoring programmes that support STEM students' successful transition into the workforce. However, the literature has not yet explored the multilayered complexities, collaborative efforts, and organisational support needed for structured mentoring practices and programming that support career readiness and workforce transition for students in STEM programmes and disciplines.

This paper highlights four areas for improving workforce transition for students in STEM fields, with an emphasis on collaborative efforts and on different units within institutions working towards shared goals instead of working in silos. It also highlights the organisational support and change needed to support STEM students in career readiness and workforce transition. The first area concerns the role of government and higher education institutions and the importance of cultivating organisational culture and practices that provide resources and support to students and mentors in STEM disciplines and programmes. The second area concerns academic departments, with a focus on developing skills, faculty training, and providing opportunities for students to prepare for successful careers. Career centres are central pillars in helping students with career readiness, and professionals and staff need to develop opportunities for students so that they can transition successfully into the workforce. Lastly, students need to engage proactively and participate in

different activities and events so that they can continue to develop their skills, learn from their peers and professionals in the field, and prepare themselves to join the workforce and labour market.

Government and Higher Education Institutions

According to Ilori and Ajagunna (2020), higher education institutions play an important role in national development because they are considered a global source of innovation, technological development, and knowledge, and they prepare individuals for the workforce. Employability and career success are usually considered core elements of higher education because they highlight the need for students to develop competitive skills to meet employers' needs and workforce demands (Frankham, 2017; Mawson & Haworth, 2018; Oliver, 2015). The role of higher education institutions extends beyond equipping students with core technical skills in their specific academic disciplines (Cheng et al., 2022). Their role should also be emphasised in preparing students for career readiness and equipping them with the skills they need to excel in today's competitive global market. Mentoring practices and structured programming can help students gain different perspectives and insights into career paths, resources, and career goals, which can help STEM students prepare to transition successfully into the workforce.

While higher education institutions in many countries depend in some way on state, provincial, or federal funding, these institutions are vulnerable to policy shifts that limit the implementation of programming and services because of restrictive regulatory practices and rules imposed by governments and funding agencies (Gkrimpizi et al., 2023). Higher education institutions face challenging times because of political, social, and economic pressures, and many institutions across the nation are reducing staff, merging programmes, and even removing services and programmes that could benefit current and future students (Fitzgerald et al., 2016). Limited funding also restricts resources and support for higher education institutions, which can have ripple effects on student services, faculty development, mentoring programmes, and industrial partnerships and ultimately affect student retention and attraction. However, a clear relationship has been observed between adequate institutional funding and positive outcomes for students and services (Chen, 2012; Kelchen, 2024). It is important to develop policies and frameworks that support STEM initiatives, such as mentoring programming, with adequate funding opportunities to allocate resources towards STEM mentoring practices, evaluations, and feedback. Governments and higher education institutions need to set priorities and plan strategically to move forward cohesively, support STEM students effectively, and prepare them for the workforce. Governments usually support research capacity, per-student enrolment, and student success, but ongoing budget cuts have increased challenges within higher education and limited institutions' ability to provide services, especially mentoring opportunities for students. Institutions therefore need adequate government support and budgets, whether state or federal, for initiatives, collaborations, and partnerships that build mentoring structures and effective practices to prepare students for the workforce. Government funding plays an important role in higher education, which can also lead to better student retention and success outcomes in STEM disciplines.

Student retention and student success have recently shifted from students to higher education institutions (Tight, 2020), increasing the pressure at the institutional level to support students with opportunities to advance their technical and soft skills and overall development. Institutions have therefore been forced to revamp their services to provide adequate student support. Unfortunately,

tensions have emerged between academic and student affairs divisions because of budgetary decisions, resources, complexities around organisational learning and culture, and siloed working practices that disadvantage students (Arcelus, 2011; Kezar, 2006). Higher education institutions require core competencies to strengthen academic and student affairs, as well as other units and departments, so that mentoring opportunities are developed through partnerships and collaborations among different units to ease STEM students' transition into the workforce (Garcia-Alvarez, 2022; Mezinska et al., 2024). Executive leadership and administration within higher education need to provide institutional direction and strive towards developing a mentoring framework so that there is more coordination among different departments and centres to support student development, which would help students prepare for labour market transition. However, organisational culture plays an important role in mentoring practices, as administration and leaders should work as catalysts for academic departments, student services, and other support staff members in creating a mentoring culture (Dahlberg & Byars-Winston, 2019). Administration and leaders within higher education institutions should explicitly promote values related to mentoring practices to strengthen the mentoring culture within institutions at all levels (Myers et al., 2022).

Building partnerships with industry, bringing mentors on board from public and private businesses, and providing incentives to faculty members as mentors are needed to support STEM students. These mentors should be paired with STEM students according to their interests, skills, and career goals. This would help students gain insight into discipline-specific skills, labour market trends, and networking opportunities. Work on projects through internships or research assistantships would also help STEM students develop their skill set.

Role of Departments

Each unit within the institution, along with academic departments, plays an important role in supporting students in their learning, critical thinking development, workplace-ready skills, and overall growth. While the literature has argued that teaching and learning within the classroom are essential, research has also emphasised that learning outside the classroom, such as volunteer work, internships, service opportunities, and other co-curricular activities, is equally important for students' learning and growth (Dewsbury, 2020; Ejiwale, 2012; Lee & Matusovich, 2016; Lee et al., 2025). STEM departments are not only meant to support and train students in discipline-specific knowledge, but also to create workforce-related and career-related opportunities for STEM students. STEM students rely on faculty members and academic departments to equip them with technical skills, discipline-specific knowledge, and career-related opportunities. While mentoring within STEM fields has been identified as an essential component of performance, career advancement, success, and sense of belonging, effective mentoring practices are limited by various factors. Such factors include lack of training for faculty members as mentors, busy schedules because of many responsibilities, limited incentives for being a mentor, and insufficient feedback from mentees, all of which can result in limited or negative mentoring for students. Feedback is critical to improving and implementing mentoring practices that might support mentees more effectively, but students may be reluctant to provide feedback to their mentors (Burk & Eby, 2010; Hund et al., 2018). It is important to develop feedback and evaluation sessions in which feedback is anonymous and mentors can reflect, learn from each other, and implement feedback in their practices in a structured way. Faculty training is important for developing competencies to support students as mentees. It is especially important when combined with conflict resolution, best practices, relevant professional

development opportunities, workplace trends, and career support, as these can prepare mentors with different tools to support their mentees effectively. Mentor training with a core focus on workforce and career readiness is essential to refine outcomes for mentoring practices and student success in STEM disciplines (Dahlberg & Byars-Winston, 2019; Gandhi & Johnson, 2016).

Departmental and institutional culture plays an important role in supporting faculty development, which should focus on students' academic and professional success and support students more holistically (Biswas et al., 2022). Faculty training and professional development opportunities should include work with other units on campus, such as career centres, co-op centres, and experiential learning centres, to develop opportunities for students. Faculty members and academic departments usually work in silos, and collaborative opportunities with student affairs and other units and centres do not often occur because of organisational structures and cultures. However, collaboration is essential to support STEM students. Collaborative efforts should take place to prepare STEM students to transition successfully into the workforce. Establishing mentoring programmes and collaborative efforts among different departments within higher education institutions should also involve different stakeholders, including governments, industrial partners, and professionals. Bringing different stakeholders together with higher education institutions can improve mentoring programmes in STEM disciplines and strengthen mentoring practices.

Academic departments should work towards developing mentoring and coaching programmes for STEM students. Mentoring programmes should be developed for students at all stages, from first-year students to graduate students. Peer mentoring is another important mentoring tool within higher education, especially in STEM disciplines. Peer mentoring has been considered beneficial because it is tied to increased mentors' self-efficacy, career interest, leadership, and professional skills (Rockinson-Szapkiw & Wendt, 2021). In addition, for mentees, the benefits of peer mentoring may lead to a sense of belonging, self-perception, and academic achievement (Hayman et al., 2022). Peer mentoring programmes contribute to personal, professional, and educational growth, along with career planning, competence awareness, and moral support (Kalpazidou Schmidt & Faber, 2016; Tenenbaum et al., 2014). It is important to develop peer mentoring programming in which mentors are matched with mentees based on disciplines and career interests to achieve better outcomes and success.

Departments should also develop partnerships with industry professionals and organisations willing to mentor STEM students in specific fields and careers. STEM mentoring programmes in which faculty members, industry professionals, and alumni provide mentoring opportunities to students within STEM areas would help students develop their social skills, strengthen their communication, and expand career-related options to pave the way towards academic and professional success. Mentoring programmes are important for students because they can provide professional and career advice, help students build relationships, and serve as a source of encouragement and guidance along the way (Mushfiq, 2024). These mentoring opportunities should incorporate institutional core values to support and encourage students to display their work through research, presentations, work models, and other means that may expand the breadth and depth of mentoring practices and programming to support STEM students.

While academic departments are trained to provide students with discipline-focused knowledge through various teaching pedagogies and assessments, it is also important to take initiatives to

structure mentoring practices and training for faculty members, peers, and industry professionals as mentors. Collaborative efforts are needed among academic departments, student support services, and other units across campus towards a shared goal of supporting students in workforce transition. One important collaboration for academic departments serving STEM students should be with career centres to prepare students for workforce transition.

Career Centres

Career centres are central to higher education institutions, and these centres are also sometimes called Career Services, Career Services Offices, or Career Resource Centres (Herr et al., 2004). These offices and services vary across institutions but usually include career education, job interview training, workshops, resume preparation, mentoring programming, and employment opportunities (Harvey et al., 2017). Career centres also host job fairs and networking sessions. Career centres have recently become a strong pillar within higher education, where their main purpose is to support students in securing employment (Hawkins, 2022) and preparing for career readiness and planning. Research suggests that career services, especially mock interviews, resume preparation, and job shadowing, are extremely helpful for students seeking employment after graduation (Chin et al., 2018). Yet STEM students need targeted support in mentoring programmes, and strategic planning is needed to develop specific programming and services to support them.

While the typical role of career centres has revolved around preparing students for career pathways and career counselling, these centres have recently expanded and explored cross-sector partnerships between education and industry (Kelly et al., 2024), as well as collaborative efforts with other departments and units across campus (Supiano, 2013). One important consideration for career centres should be developing industry partnerships and collaborative efforts to bring industry-specific mentors on board for STEM students. These mentors should engage collaboratively with career centres and institutions to pave the way for students to transition into the workforce. This could occur through internships, informational interviews, and collaborative work on specific industry or research projects. These partnerships and collaborative efforts would result in mutually beneficial relationships in which students experience real-world, hands-on industry opportunities and observe workplace environments and realities. Similarly, employers would have the opportunity to assess skills, personality, knowledge, interest, and individuals' long-term goals. These partnerships may also be helpful in job fairs, industry days, career days, and other opportunities through which partners can support students' growth and career success in many ways.

Career centres should also emphasise collaboration with academic departments to support students in STEM disciplines through career workshops, panel discussions, and overall cooperation so that students are aware of different resources and support for career pathways and workforce transition. Academic departments and career centres should also introduce STEM career planning courses and mandatory STEM career pathway courses for freshman and sophomore students, with a structured curriculum that introduces students to different career pathways, provides resources to support career decision-making, and offers tools that help them navigate career planning by using other resources and support systems. In addition, career centres should develop internship programmes, experiential learning, and co-op programmes with academic departments and industry partners for STEM students interested in pursuing industry and academic employment opportunities. These opportunities would support students in gaining experience and developing useful skills in research,

laboratory work, and industrial operations through work-based learning experiences (Ross et al., 2020). These collaborative efforts would pave the way for STEM students to develop self-efficacy and self-determination, as they would become more confident in their abilities and more determined to achieve personal and professional goals.

While institutions and different units need to work collaboratively to support STEM students in workforce transition, it is also important for students to use the resources available to them across campus and outside their host institution. Resources and support services are designed to support all students, but students also have a responsibility to seek relevant opportunities and use support services and programming beyond structured offerings to build their skills and portfolios.

Role of Students in their Career Success

Job search strategies and career advice are important in finding employment, yet research has also strongly emphasised that social networking and referrals leading to professional jobs are equally important (Glass et al., 2023). It is important to build strong professional relationships with advisors, faculty members, mentors, and acquaintances. Students should stay engaged with peers, professionals, and faculty members through professional platforms where they can present themselves professionally and display their achievements and success stories. STEM students should develop their social networks, as this is considered essential in today's technological era. Many opportunities are usually announced through digital media, and having a strong presence on professional networks increases the possibility of standing out. Networking circles play a major role in career advancement and workforce transition. The larger the networking circle, the better the opportunities to enter the workforce (Glass et al., 2023).

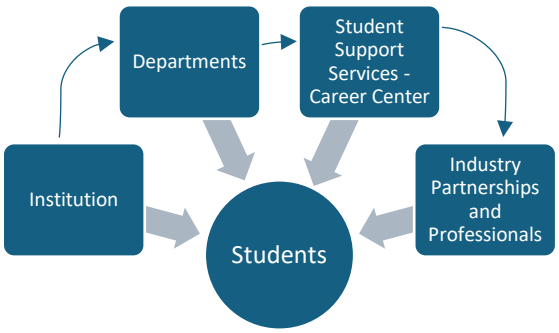
Across campus, there may be various resources, such as career centres, experiential learning, student wellness, different clubs and organisations, student employment opportunities, research projects, peer mentoring, teaching assistantships, research assistantships, and many other opportunities to build skills and gain valuable experience. There may be opportunities to move towards student leadership positions, take part in different initiatives, and receive support and mentoring from advisors, professors, and faculty members, all of which can lead to networking opportunities. However, students who are self-determined to explore opportunities and willing to work towards their career success are more aware of workplace and labour market trends and networking events. It is important to develop key relationships with mentors, professors, career advisors, peers, and industry professionals to understand the job search process, connect with employers, and explore different career paths and opportunities (Popadiuk & Arthur, 2014).

There are national and regional associations with local chapters, networking events, conferences, and webinars, and many associations and organisations also offer mentoring opportunities. Students need to engage proactively and volunteer in their discipline-specific national and regional associations and chapters to increase their networking opportunities. In addition, engaging in diverse ways and contributing to discipline-specific industries can help students get to know professionals and gain perspectives on different companies, career paths, and career success. Students themselves have a major responsibility to build their skills, learn from peers, and engage in different and multiple opportunities across campus and beyond. Students should use resources from academic departments and career centres, national and regional associations, other units and departments, and

any other external avenues. These opportunities help students observe different perspectives and gain diverse experiences and skills. Engaging in different opportunities supports professionalism, time management, organisational and interpersonal skills, leadership, and students' overall development (Pierard et al., 2022). Professional networking is considered important for sharing knowledge, mentorship, and access to the hidden job market, of which most STEM students may not be aware. Proactive work towards developing social connections would help these students transition into the workforce after graduation and support their career advancement and development (Jackson et al., 2024).

It is essential for STEM students to engage consistently in institutional forums, such as roundtables, student councils, surveys, and other participatory spaces that allow them to voice their perspectives and potentially show their skills and confidence. Continuous participation can enable students to articulate their skills and knowledge, use available services effectively, and actively contribute to organisational change and learning culture. By participating in these processes, students become key stakeholders in shaping policies and practices that directly affect their academic, professional, and personal development (Sun & Holt, 2022). Figure 1 below represents students at the centre because they ultimately need support from various units and professional systems. It highlights the importance of collaboration among different stakeholders in serving students in career planning, workforce transition, and career advancement.

Figure 1. *Placing Students at the Center - The Role of Mentoring in Higher Education*



DISCUSSION AND CONCLUSION

Mentoring programmes and mentorship usually provide mentees with opportunities from various perspectives, such as emotional and psychosocial support, career readiness skills, accountability measures, and shared responsibilities. However, mentoring programmes should also emphasise evaluation and feedback on mentoring programming from mentors and mentees and implement models that continue to improve (Dahlberg & Byars-Winston, 2019). Mentoring is widely considered to have a positive effect on student success, yet many challenges exist for STEM students. These students face challenges navigating the academic system, difficult introductory and first-year courses, and sometimes unwelcoming environments that create stress for STEM students and lead to dropout or changes of major from STEM disciplines to non-STEM majors (Graham et al., 2013).

Using the mentoring framework, this paper has highlighted the importance of mentoring layered within complex systems, organisational structures, and collaborative efforts among different units

and academic departments within the institution. Structured mentoring programming is needed for STEM students to integrate into the workforce after graduation through the collaborative efforts of higher education institutions, which can cultivate rich mentoring structures, training, and collaborations among different units to strengthen programming for career planning and workforce transition. While higher education institutions are responsible for providing broad educational experiences and preparing students for a competitive global market, it is equally important to enrich the mentoring culture within institutions. Mentoring practices and programming should be a collaborative effort by faculty and staff to support students, encourage them to engage in different activities, and develop a sense of belonging, intellectual growth, and social integration. Mentoring should also focus on student success, especially within career planning and advancement, which would support STEM students in transitioning successfully into their careers after graduation. This paper has also emphasised various roles that academic departments and career centres should continue to improve, as well as the need to develop new partnerships among different industries, professionals, and alumni for internships, mentorship, or engagement programmes to broaden participation for STEM students. While higher education institutions and various units and departments are important in supporting students in STEM disciplines and programmes, it is equally important for students to seek support and opportunities proactively so that they can learn, gain skills and experience, and achieve their goals and career aspirations.

REFERENCES

Anderson, L., Silet, K., & Fleming, M. (2012). Evaluating and giving feedback to mentors: New evidence-based approaches. *Clinical and Translational Science*, *5*(1), 71-77. https://doi.org/10.1111/j.1752-8062.2011.00361.x

Arcelus, V. J. (2011). If student affairs-academic affairs collaboration is such a good idea, why are there so few examples of these partnerships in American higher education?: Transforming our approach to education: Cultivating partnerships and dialogue. In P. M. Magolda & M. B. Baxter Magolda (Eds.), *Contested issues in student affairs* (1st ed., pp. 61-74). Routledge. https://doi.org/10.4324/9781003443650-8

Beisler, M., & Medaille, A. (2016). How do students get help with research assignments? Using drawings to understand students' help-seeking behavior. *The Journal of Academic Librarianship*, *42*(4), 390-400. https://doi.org/10.1016/j.acalib.2016.04.010

Biswas, S., Benabentos, R., Brewe, E., Potvin, G., Edward, J., Kravec, M., & Kramer, M. (2022). Institutionalizing evidence-based STEM reform through faculty professional development and support structures. *International Journal of STEM Education*, *9*(1), 1-23. https://doi.org/10.1186/s40594-022-00353-z

Brown, L. K. (2024). Introduction to the STEM student success model. In M. A. Ashraf & S. M. Tsegay (Eds.), *Education and human development*. IntechOpen. https://doi.org/10.5772/intechopen.112614

Burk, H. G., & Eby, L. T. (2010). What keeps people in mentoring relationships when bad things happen? A field study from the protege's perspective. *Journal of Vocational Behavior*, *77*(3), 437-446. https://doi.org/10.1016/j.jvb.2010.05.011

Chen, R. (2012). Institutional characteristics and college student dropout risks: A multilevel event history analysis. *Research in Higher Education*, *53*(5), 487-505. https://doi.org/10.1007/s11162-011-9241-4

Chen, X. (2013). *STEM attrition: College students' paths into and out of STEM fields* (NCES 2014-001). National Center for Education Statistics.

Cheng, M., Adekola, O., Albia, J., & Cai, S. (2022). Employability in higher education: A review of key stakeholders' perspectives. *Higher Education Evaluation and Development*, *16*(1), 16-31. https://doi.org/10.1108/HEED-03-2021-0025

Chin, M. Y., Blackburn Cohen, C. A., & Hora, M. T. (2018). *The role of career services programs and sociocultural factors in student career development*. University of Wisconsin-Madison, Wisconsin Center for Education Research. https://wcer.wisc.edu/docs/working-papers/Working_Paper_No_2018_8.pdf

Crisp, G., & Cruz, I. (2009). Mentoring college students: A critical review of the literature between 1990 and 2007. *Research in Higher Education*, *50*(6), 525-545. https://doi.org/10.1007/s11162-009-9130-2

Dahlberg, M. L., & Byars-Winston, A. (Eds.). (2019). *The science of effective mentorship in STEMM*. National Academies Press. https://doi.org/10.17226/25568

Department for Education (2024, May). *Supply of skills for jobs in science and technology*. GOV.UK. https://explore-education-statistics.service.gov.uk/find-statistics/supply-of-skills-for-jobs-in-science-and-technology/2023

Dewsbury, B. M. (2020). Deep teaching in a college STEM classroom. *Cultural Studies of Science Education*, *15*(1), 169-191. https://doi.org/10.1007/s11422-018-9891-z

Ejiwale, J. A. (2012). Facilitating teaching and learning across STEM fields. *Journal of STEM Education: Innovations and Research*, *13*(3), 87-94. https://www.jstem.org/jstem/index.php/JSTEM/article/view/1711

Evans, M., Gray, P., Glowinski, S., & Roesner, R. (2025). Multiple-mentors: The benefit of peer and faculty mentors for STEM majors. *Journal of STEM Education: Innovations and Research*, *26*(1), 49-57. https://doi.org/10.63504/jstem.v26i1.2699

Fitzgerald, H. E., Bruns, K., Sonka, S. T., Furco, A., & Swanson, L. (2016). The centrality of engagement in higher education. *Journal of Higher Education Outreach and Engagement*, *20*(1), 245-253.

Frankham, J. (2017). Employability and higher education: The follies of the 'productivity challenge' in the teaching excellence framework. *Journal of Education Policy*, *32*(5), 628-641. https://doi.org/10.1080/02680939.2016.1268271

Ganapati, S., & Ritchie, T. S. (2021). Professional development and career-preparedness experiences of STEM Ph.D. students: Gaps and avenues for improvement. *PLOS ONE*, *16*(12), 1-25. https://doi.org/10.1371/journal.pone.0260328

Gandhi, M., & Johnson, M. (2016). Creating more effective mentors: Mentoring the mentor. *AIDS and Behavior*, *20*(S2), 294-303. https://doi.org/10.1007/s10461-016-1364-3

Garcia-Alvarez, J., Vazquez-Rodriguez, A., Quiroga-Carrillo, A., & Priegue Caamano, D. (2022). Transversal competencies for employability in university graduates: A systematic review from the employers' perspective. *Education Sciences*, *12*(3), 1-37. https://doi.org/10.3390/educsci12030204

Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2023). Classification of barriers to digital transformation in higher education institutions: Systematic literature review. *Education Sciences*, *13*(7), 1-24. https://doi.org/10.3390/educsci13070746

Glass, J., Takasaki, K., Sassler, S., & Parker, E. (2023). Finding a job: An intersectional analysis of search strategies and outcomes among U.S. STEM graduates. *Research in Social Stratification and Mobility*, *83*, Article 100758. https://doi.org/10.1016/j.rssm.2023.100758

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science*, *341*(6153), 1455-1456. https://doi.org/10.1126/science.1240487

Haberer, J. E., Byakika-Kibwika, P., Gandhi, M., Bukusi, E. A., Kamya, M., & Boum, Y., II (2025). Mentorship: A critical metric for career development and advancing global health. *PLOS Global Public Health*, *5*(10), 1-8. https://doi.org/10.1371/journal.pgph.0005247

Harvey, A., Andrewartha, L., Edwards, D., Clarke, J., & Reyes, K. (2017). *Student equity and employability in higher education*. La Trobe University. https://www.ncsehe.edu.au/app/uploads/2018/06/73_LaTrobe_AndrewHarvey_Accessible_PDF.pdf

Hawkins, D. (2022). The importance of career centers: Providing resources and the human connection. *Hispanic Engineer and Information Technology*, *37*(2), 28-31. https://www.jstor.org/stable/48697257

Hayman, R., Wharton, K., Bruce-Martin, C., & Allin, L. (2022). Benefits and motives for peer mentoring in higher education: An exploration through the lens of cultural capital. *Mentoring & Tutoring: Partnership in Learning*, *30*(2), 256-273. https://doi.org/10.1080/13611267.2022.2057098

Hedge, B. (2024). Persistence of STEM majors in higher education. *Journal of Research in Science, Mathematics and Technology Education*, *7*(SI), 27-41. https://doi.org/10.31756/jrsmte.312SI

Hensel, N. (2012). *Characteristics of excellence in undergraduate research*. Council on Undergraduate Research. https://files.eric.ed.gov/fulltext/ED603274.pdf

Herr, E. L., Cramer, S. H., & Niles, S. G. (2004). *Career guidance and counseling through the lifespan: Systematic approaches* (6th ed.). Pearson.

Hund, A. K., Churchill, A. C., Faist, A. M., Havrilla, C. A., Love Stowell, S. M., McCreery, H. F., Ng, J., Pinzone, C. A., & Scordato, E. S. C. (2018). Transforming mentorship in STEM by training scientists to be better leaders. *Ecology and Evolution*, *8*(20), 9962-9974. https://doi.org/10.1002/ece3.4527

Hutson, J., Nasser, R., Marzano, M., Curtis, R., MacDonald, E., Edele, S., & Hosto-Marti, B. (2022). Bridge building in higher education: Multi-modal mentoring programs to support retention and career preparedness. *Creative Education*, *13*(09), 2811-2833. https://doi.org/10.4236/ce.2022.139178

Ilori, M. O., & Ajagunna, I. (2020). Re-imagining the future of education in the era of the fourth industrial revolution. *Worldwide Hospitality and Tourism Themes*, *12*(1), 3-12. https://doi.org/10.1108/WHATT-10-2019-0066

Jackson, D., Lambert, C., Tofa, M., Bridgstock, R., & Sibson, R. (2024). Career resources and securing quality work: Graduate perspectives. *Studies in Continuing Education*, *47*(2), 436-456. https://doi.org/10.1080/0158037x.2024.2410182

Johnson, C., Gitay, R., Abdel-Salam, A.-S. G., BenSaid, A., Ismail, R., Naji Al-Tameemi, R. A., Romanowski, M. H., Kazem Al Fakih, B. M., & Al Hazaa, K. (2022). Student support in higher education: Campus service utilization, impact, and challenges. *Heliyon*, *8*(12), 1-13. https://doi.org/10.1016/j.heliyon.2022.e12559

Kalpazidou Schmidt, E., & Faber, S. T. (2016). Benefits of peer mentoring to mentors, female mentees and higher education institutions. *Mentoring & Tutoring: Partnership in Learning*, *24*(2), 137-157. https://doi.org/10.1080/13611267.2016.1170560

Kelchen, R. (2024). The role of state higher education policy in student success and equity. *Journal of Postsecondary Student Success*, *3*(3), 4-24. https://doi.org/10.33009/fsop_jpss135047

Kelly, J., Gielstra, D., Oberding, T. J., Bruno, J., & Hadley, S. (2024). Uniting academia and industry to bridge the skills gap: Incorporating industry advisory councils in curriculum-to-careers programmatic mapping in undergraduate environmental science programs. *Industry and Higher Education*, *38*(2), 112-123. https://doi.org/10.1177/09504222231175413

Kezar, A. (2006). Redesigning for collaboration in learning initiatives: An examination of four highly collaborative campuses. *The Journal of Higher Education*, *77*(5), 804-838. https://www.jstor.org/stable/3838788

King, B. (2016). Does postsecondary persistence in STEM vary by gender?. *AERA Open*, *2*(4), 1-10. https://doi.org/10.1177/2332858416669709

Kitchen, J. A., Williams, M. S., Sonnert, G., & Sadler, P. (2024). A quasi-experimental study of the impact of college-run science, technology, engineering, and mathematics (STEM) career days on American students' STEM career aspirations. *International Journal of Science Education*, *46*(2), 109-130. https://doi.org/10.1080/09500693.2023.2220071

Lee, W. C., & Matusovich, H. M. (2016). A model of co-curricular support for undergraduate engineering students. *Journal of Engineering Education*, *105*(3), 406-430. https://doi.org/10.1002/jee.20123

Lee, M., Lee, A. A., Lee, G. A., Lira, A. K., Lawson, H. D., Freer, E., Briedis, D., Walton, S. P., & Linnenbrink-Garcia, L. (2025). Exploring supports for belonging as predictors of student outcomes: Different roles of co-curricular and extracurricular activities in engineering by students' year in college. *Journal of Engineering Education*, *114*(2), Article e70001. https://doi.org/10.1002/jee.70001

Mawson, M., & Haworth, A. C. (2018). Supporting the employability agenda in university libraries: A case study from the University of Sheffield. *Information and Learning Science*, *119*(1/2), 101-108. https://doi.org/10.1108/ILS-04-2017-0027

McLewis, C. C., Hurtado, S., Perez, E., Ortiz, D., & Jaimez Noel, N. A. (2025). Cross-institutional mentoring: A catalyst for advancing diversity, equity, and inclusion in STEMM interventions. *Science Education*, *109*(3), 745-768. https://doi.org/10.1002/sce.21930

Mezinska, S., Abolina, A., & Lubkina, V. (2024). Design-driven innovation in STEM disciplines in higher education: The role and impact of transversal competences. *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(4), Article 100429. https://doi.org/10.1016/j.joitmc.2024.100429

Mushfiq, M. (2024). Leadership in student affairs. In A. D. Tomlin (Ed.), *The handbook for aspiring higher education leaders* (pp. 193-199). Emerald Publishing Limited. https://doi.org/10.1108/979-8-88730-627-820251026

Myers, O., Sood, A., Dominguez, N., Helitzer, D., & Tigges, B. (2022). Organizations' mentoring culture is associated with mentoring climate and involvement. *The Chronicle of Mentoring & Coaching*, *6*(15), 598-603.

Nabi, G., Walmsley, A., Mir, M., & Osman, S. (2025). The impact of mentoring in higher education on student career development: A systematic review and research agenda. *Studies in Higher Education*, *50*(4), 739-755. https://doi.org/10.1080/03075079.2024.2354894

National Skills Commission (2022). *Projecting employment to 2026*. Australian Government, National Skills Commission. https://www.jobsandskills.gov.au/sites/default/files/2022-03/NSC22-0041_Employ%20Projections_glossy_FA_ACC.pdf

Nkrumah, T., & Scott, K. A. (2022). Mentoring in STEM higher education: A synthesis of the literature to (re)present the excluded women of color. *International Journal of STEM Education*, *9*(1), 1-23. https://doi.org/10.1186/s40594-022-00367-7

Nuis, W., Segers, M., & Beausaert, S. (2023). Conceptualizing mentoring in higher education: A systematic literature review. *Educational Research Review*, *41*, 1-22. https://doi.org/10.1016/j.edurev.2023.100565

Oliver, B. (2015). Redefining graduate employability and work-integrated learning: Proposals for effective higher education in disrupted economies. *Journal of Teaching and Learning for Graduate Employability*, *6*(1), 56-65. https://doi.org/10.21153/jtlge2015vol6no1art573

Pierard, C., Baca, O., & Schultz, A. (2022). Connecting student employment to student learning and post-graduation goals: Findings from a multi-semester study. *Journal of Library Administration*, *62*(5), 633-655. https://doi.org/10.1080/01930826.2022.2083441

Popadiuk, N. E., & Arthur, N. M. (2014). Key relationships for international student university-to-work transitions. *Journal of Career Development*, *41*(2), 122-140. https://doi.org/10.1177/0894845313481851

Ravishankar, S., Spencer-Drakes, T. C. J., Fernandes, I. H., Hayes, M. I., Coopwood, S., Spencer, I., & Neal, S. E. (2024). Empowering STEM students: A university-wide mentorship program fostering retention and belonging. *Journal of Cellular Physiology*, *239*(7), 1-27. https://doi.org/10.1002/jcp.31348

Rockinson-Szapkiw, A., & Wendt, J. L. (2021). The benefits and challenges of a blended peer mentoring program for women peer mentors in science, technology, engineering and mathematics (STEM). *International Journal of Mentoring and Coaching in Education*, *10*(1), 1-16. https://doi.org/10.1108/IJMCE-03-2020-0011

Ross, M., Kazis, R., Bateman, N., & Stateler, L. (2020). *Work-based learning can advance equity and opportunity for America's young people*. Metropolitan Policy Program at Brookings. https://www.brookings.edu/wp-content/uploads/2020/11/20201120_BrookingsMetro_Work-based-learning_Final_Report.pdf

Sithole, A., Chiyaka, E. T., McCarthy, P., Mupinga, D. M., Bucklein, B. K., & Kibirige, J. (2017). Student attraction, persistence and retention in STEM programs: Successes and continuing challenges. *Higher Education Studies*, *7*(1), 46-59. https://doi.org/10.5539/hes.v7n1p46

Smith, D., Hendricks, L., Stewart, D., Guerin, A., Smith, M., & Maiden, J. (2025). The role of mentorship and research experiences in shaping STEM careers. *American Journal of STEM Education*, *9*, 65-88. https://doi.org/10.32674/1pz4ya55

Stallsmith, V., & Chavez, E. (2022). Fostering a sense of belonging in STEM mentoring of underrepresented minority (URM) students through use of common factors. *The Chronicle of Mentoring & Coaching*, *6*(1). https://par.nsf.gov/biblio/10415981

Stolle-McAllister, K. (2011). The case for summer bridge: Building social and cultural capital for talented Black STEM students. *Science Educator*, *20*(2), 12-22.

Sun, X., & Holt, D. (2022). Student engagement and voice in higher education: Students' perceptions. *Journal of Learning Development in Higher Education*, (23), 1-21. https://doi.org/10.47408/jldhe.vi23.838

Supiano, B. (2013). *College career centers stretch to take on new roles*. The Chronicle of Higher Education. https://www.chronicle.com/article/career-centers-stretch-to-fill-new-roles/

Tenenbaum, L. S., Anderson, M. K., Jett, M., & Yourick, D. L. (2014). An innovative near-peer mentoring model for undergraduate and secondary students: STEM focus. *Innovative Higher Education*, *39*(5), 375-385. https://doi.org/10.1007/s10755-014-9286-3

Tight, M. (2020). Student retention and engagement in higher education. *Journal of Further and Higher Education*, *44*(5), 689-704. https://doi.org/10.1080/0309877X.2019.1576860

Tuck, M. E., Palomino, K. A., Bradley, J. A., Mohr-Schroeder, M., & Bradley, L. H. (2025). A coaching-based training for underrepresented mentors in STEM. *Education Sciences*, *15*(3), 1-15. https://doi.org/10.3390/educsci15030289

U.S. Bureau of Labor Statistics (2025, December). *Numbers, research, and discovery: STEM employment projected to take off!*. United States Department of Labor, U.S. Bureau of Labor Statistics. https://www.bls.gov/opub/ted/2025/numbers-research-and-discovery-stem-employment-projected-to-take-off.html

Vugteveen, J., Figueroa Esquivel, F., & Luijer, C. (2025). Defining student success as a multidimensional concept: A scoping review. *International Journal of Educational Research Open*, *9*, 1-10. https://doi.org/10.1016/j.ijedro.2025.100518

Wayman, A., Stolle-McAllister, K., & LaCourse, W. (2024). Developing a career-focused, diverse mentoring program for underrepresented STEM undergraduates. *The Chronicle of Mentoring & Coaching*, *8*(1), 23-34. https://doi.org/10.62935/yg5404