Mentoring Ecosystems to Recruit, Retain, and Advance Women in Technology

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Abstract— Mentorship remains one of the most frequently supported approaches for addressing persistent disparities in science, technology, engineering, and mathematics (STEM) education and professional practice. However, definitions and implementations of mentoring vary widely, and emerging research suggests that sponsorship, near-peer mentoring, group models, and culturally responsive approaches may serve equally critical roles in the recruitment, retention, and advancement of women in technology. The literature review synthesizes recent research on mentoring practices designed to support women across STEM pathways, with attention to psychosocial support, career advocacy, intersectionality, and program structure. Findings indicate that effective mentoring functions not as a singular, one-to-one relationship, but as a fluid ecosystem in which interconnected networks of peers, faculty, alumni, and industry partners collectively construct sustainable pathways into and through technology disciplines. The paper concludes by offering implications for institutions of higher education and industry partners seeking to expand mentoring from traditional models into inclusive, scalable ecosystem-based initiatives.

Index Terms—Engineering technology, technology, gender, women, mentorship, connectedness, innovativeness, belonging, career preparation, recruitment, students, universities.

Introduction

Women still remain underserved in terms of representation in technology occupations, with lingering challenges related to access, persistence, and progress [1]. While women are not underrepresented in all STEM disciplines, persistent disparities remain within engineering and technology fields, which are the focus of this study. Research evidence has continually revealed that students' sense of belonging, as well as access to mentoring relationships, is an essential factor that influences entry into, as well as persistence in, STEM fields [2].

Mentorship has been recognized as an essential tool in improving educational persistence, professional identity, as well as career mobility. However, traditional mentoring relationships have failed to sufficiently address the complex needs of women in technology education. An

emerging body of evidence supports the need to consider mentoring as a networked, developmental, and cultural process [3].

This paper aims to provide an integrated perspective, as well as an applicable model, that combines literature with an institutional model aimed at demonstrating how mentoring can be used in addressing the issue of women in technology.

Literature Review: Mentoring Ecosystems for Women in Technology

Defining Mentorship and Why It Matters in STEM

In both higher education and technology circles, mentoring is identified as being consistently associated with more educational persistence, mental/social well-being, skill buildup, and workplace success on behalf of mentees, as well as professional growth on behalf of mentors. Some early syntheses in higher education reveal both generally positive outcomes and considerable variance in terms of program quality, definition, and conceptual frameworks [4].

Within the realm of STEM education, the components of successful mentorship as described by the National Academies of Sciences, Engineering, and Medicine [2] in their report, the National Research Council's report, relate to setting goals, cultural competence, and mentoring training that is focused on mentor development as well as multiple mentees. These components of effective mentorship are linked to increased entry into STEMM occupations and persistence. Emerging post-pandemic research highlights the expansion of hybrid and digitally mediated mentoring networks following the COVID-19 pandemic, increasing access to mentors and reshaping traditional mentoring structures [2].

Implication

For campuses like Purdue Polytechnic Columbus, this body of research suggests that mentorship programs must go beyond technical advising. Students benefit most when mentors intentionally support identity development, belonging, and navigational capital.

Embedding these elements in both formal and informal mentorship programs will help women students not only succeed academically but also feel connected to the larger community, improving recruitment and long-term retention [1].

Sponsorship as a Mechanism for Career Advancement

Sponsorship goes beyond mentoring by using positional influence to secure sponsorship in terms of opportunities, visibility, and progression. Empirical research suggests that while women have access to mentoring, they are significantly less likely to have sponsors, which affects career

mobility and access to leadership positions [5]; [6]. Sponsorship can directly improve access to internships, research, professional networks, and leadership development.

Near-Peer Mentoring and Identity Formation

Near-peer mentoring provides relatable role modeling and reduces hierarchical barriers. Research has shown that exposure at the beginning of a trajectory to peers who have recently completed a similar pathway contributes to the development of a STEM identity, increases self-confidence, and increases persistence, especially during the initial stages of education [7].

Group-Based and Networked Mentoring Models

The group and network-based mentoring styles align with the collaborative nature of STEM environments. These styles provide redundancy of support, exposure to diverse views, and a sense of belonging through learning with others. The empirical evidence suggests that students show increased persistence when receiving consistent and affirming cues through multiple mentoring relationships and developmental networks [1]; [8].

Culturally Responsive and Intersectional Mentoring Approaches

Intersectional identities have been shown to affect mentoring experiences and outcomes [9]. Culturally responsive mentoring focuses on the validation of lived experiences, preparation of mentors, and the awareness of barriers. These practices have been shown to increase feelings of belonging, engagement, and persistence among women who are trying to succeed in male-dominated technology disciplines [2]; [10].

Synthesis: Toward a Mentoring Ecosystem Framework

The literature has documented those mentoring outcomes are influenced by factors such as psychosocial support, identity affirmation, access to opportunity structures, and relational networks [11]. The evidence base thus supports a move towards mentoring ecosystems, as opposed to mentoring programs, which include sponsorship, near peer mentoring, group mentoring, and culturally responsive mentoring, among others, across educational and professional transitions [2]; [3].

Closing Synthesis and Implications for Ecosystem Design

With the benefit of the preceding research, the literature review suggests that effective mentorship of women in technology does not occur strictly within individual relationships or isolated programmatic initiatives, but rather within coordinated mentoring ecosystems. These are typified by patterns of support around transition, inputs from a variety of relational figures, and the strategic alignment of psychosocial support, identity expression, and opportunity structures [7]; [10]. The empirical evidence clearly suggests a strong correlation with continued progress to

completion of the undergraduate degree and progress to a career trajectory typified by redundancy, challenge, and purposeful structuring to achieve the experience of belonging, as opposed to the experience of the one-off relationship [2]; [3].

Even from these studies, it is clear that if institutions aspire to attract and retain female technology scholars, there is a need for a paradigm shift in how institutions think of mentoring female scholars, not only as an auxiliary process but also as an infrastructure of an institution right from recruitment, governance, and preparation phases. The meta-analytical syntheses and longitudinal studies show many mentoring initiatives lack intentional design, alignment of goals, and cultural consistency in mentoring programs, and the results show them ineffective or limited in their illustration of positive outcomes among female scholars who are struggling to carve their space in heavily male-dominated areas [4]. This is, however, contrary to those mentoring infrastructures that are integrated via applied notions of its processes [9]; [12].

Significantly, both literature and findings highlight sponsorship as a crucial mediating factor for the effectiveness of mentorship in skills and career advancement. Even though mentorship impacts skills acquisition and psychosocial management, sponsorship seems a more crucial determinant in achieving career visibility and influence [5]; [8]. In circumstances where a lack of sponsorship/networking opportunities is imminent or uncertain, it becomes more daunting for women from a marginalized social background [6]. Taken together, these results provide a body of conceptual work in relation to mentoring ecosystems and allow one to apply these ideas in interventions focused on promoting women in technology. The following section translates these findings into a conceptual mentoring ecosystem and demonstrates how these principles can be operationalized within an institutional setting.

Conceptual Framework

Fig. 1 serves as a demonstrative model that translates the four literature-derived components of the framework into an applied mentoring ecosystem design. While this model follows a secondary to undergraduate transition pathway, the mentoring ecosystem is conceived to be flexible enough to support various transition points, including undergraduate persistence, transition to the technology workforce, and advancement.

In this model, the labels “Juniors” and “Seniors” indicate the final two years of high school. Career advancement, from this perspective, is stage-appropriate advancement, which includes enrollment in STEM degree programs, persistence to degree completion, and advancement to internships, co-ops, and full-time technology positions.

This model of mentoring is conceived as infrastructure, rather than a mentoring program. Camps, preview programs, curricular mentoring, and industry mentoring, for example, are conceived of as entry points to the mentoring ecosystem, rather than programs.

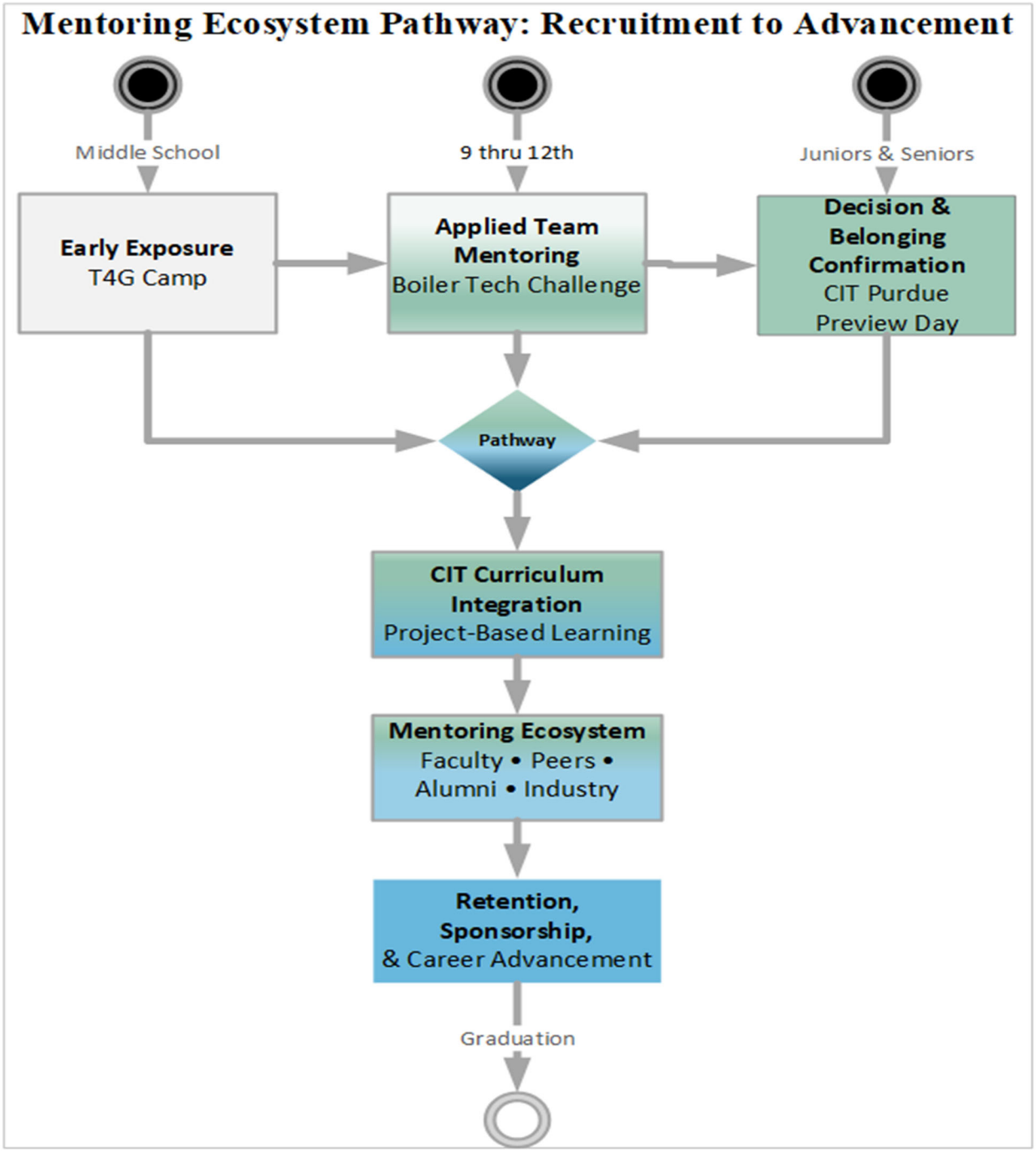

Fig. 1. Mentoring Ecosystem Pathway: Recruitment to Advancement. A conceptual model illustrating how sponsorship, near-peer mentoring, group mentoring, and culturally responsive mentoring interact with one another across various developmental stages to support the participation, persistence, and advancement of women in technology.

Discussion

Operationalizing the Mentoring Ecosystem in Practice

Research literature indicates that mentoring for women in technology is a networked, long-term, and integrated approach [3]; [11]. The following literature-informed model of mentoring in an institutional setting illustrates the application of mentoring ecosystem principles in the areas of recruitment, curriculum, and career preparation. In Purdue Polytechnic Institute Columbus, this is achieved through the creation of a mentoring system that focuses on early introduction, application, decision-making in academic and career pathway selection, integration of curricula, and long-term development. This section illustrates how a mentoring ecosystem can be operationalized within an institutional context.

Early Exposure and Identity Formation

Early engagement programs allow participants to become familiar with technology-related fields of study by interacting with near peers, working on projects, and becoming part of a community. These programs act as a gateway to the mentoring system. For example, the T4G: Tech for Good Summer Camp engaged 48 middle and high school participants, including 21 female participants and 19 participants from underrepresented groups, from eight regional high schools. Ninety-two percent of the participants expressed their interest in majoring in STEM programs after the event, with many of them becoming part of other mentoring programs. This experience serves as a first point of entry into the mentoring ecosystem, helping to establish a sense of identity, belonging, and technology pathways, which will inform further engagement with applied mentoring and curricular experiences [1]; [2]; [7].

Applied Team-Based Mentoring

Collaborative project experiences enable students to interact with faculty members, industry mentors, and peers, thus enhancing identity and confidence levels prior to college entry. The Boiler Tech Challenge (BTC), a regional engineering event, engaged 140 students from seven high schools, along with 18 educators and 15 industry professionals. A hundred percent of the students showed increased interest in a STEM-related career path, and post-event follow-up activities included 29 students scheduling advising or campus tours and five students submitting institutional applications. This stage, within the ecosystem, further develops a sense of technical identity, collaboration, and peer networking, as well as connections with faculty and industry mentors, to support recruitment and transition experiences [3]; [8].

Mentoring-Informed Decision Point

Recruitment and transition events serve as mentoring touchpoints, integrating faculty engagement, alumni insights, peer interactions, and application support to reduce uncertainty and build navigational capital. The Purdue Preview Day hosted 49 total participants, including 34 prospective students and 15 parents, teachers, or counselors. Following the event, 28 prospective students-initiated follow-up inquiries or applications, and participants reported an 89% increase

in understanding of technology-related career pathways. This stage functions as a transitional node within the mentoring ecosystem, enabling informed decision-making and strengthening the connections between the early exposure experiences and mentoring programs within the curriculum [2]; [11].

Curriculum Integration and Progression to Sponsorship

The integration of mentoring within the curriculum is a step forward to create a sense of continuity and to facilitate students to take advantage of sponsorship opportunities. The involvement of faculty and industry professionals can create a pathway to internships, research opportunities, and professional advancement. As students' progress through the curriculum, continuous interaction with mentors and professionals can create a smooth transition from a mentorship to a sponsorship opportunity, increasing the chances of experiential learning and professional opportunities for students [5]; [6].

A clear example of an institution that offers a curriculum-integrated mentoring program is the "Go Baby Go (GBG)" adaptive mobility program. GBG is a semester-long capstone course integrated within the curriculum of "ENGT 18200 Gateway to Engineering Technology." The program is a multilayered mentoring environment involving students from various disciplines, including electrical, mechanical, manufacturing, and computer information technology. The program focuses on the design and construction of ride-on vehicles for children with mobility and adaptive needs.

The program offers technical and professional learning outcomes to prepare students for workforce readiness. Students learn to design and build ride-on vehicles involving wiring, sensors, power systems, and structure while developing professional skills such as project management, teamwork, and ethical reasoning through direct interaction with families and industry professionals. The program has resulted in over 11 adaptive vehicles, over 50 students, and over 1,000 volunteer hours to date, along with partnerships with multiple industry organizations.

The GBG program acts as a conduit between academic learning and sponsorship opportunities. Industry professionals and engineers act as mentors and collaborators to evaluate and interact with students to identify opportunities for internships, co-op programs, and professional opportunities through the demonstration of technical knowledge, professionalism, and problem-solving skills. In such a way, curriculum-integrated mentoring can lead to sponsorship opportunities, and students become visible to faculty and industry professionals through purposeful and goal-oriented engineering activities to benefit children and families

Mentoring Ecosystem as Institutional Infrastructure

As the participants progress through the system, the mentoring network extends to include faculty, students, alumni, and industry professionals. The structure is useful for promoting persistence, preparation, and progression. Research on early engagement, recruitment, and transition programs indicates that when students have opportunities to be mentored at various stages, they show more interest and understanding of their careers. The success of the ecosystem is measured by student success in different stages, including the development of STEM identity, persistence, completion of degrees, opportunities to obtain internships and sponsorship, and career mobility.

Conclusion

The most effective form of mentoring for women in technology is not simply a dyadic relationship between two mentors and mentees, but a coordinated ecosystem of sponsorship, near-peer mentoring, group mentoring, and culturally informed practices [2]; [3]. As shown in Fig. 1, the framework is a demonstrative example of the interplay of these components within the recruitment, persistence, and advancement of women in technology.

The institutional model of mentoring informed by the literature, as presented within this study, is a demonstrative example of the operationalization of mentoring ecosystems through a layered and sequential implementation of various initiatives. These range from early exposure through the T4G: Tech for Good Summer Camp, applied learning through the Boiler Tech Challenge, transition and decision support through Preview Days, and curriculum-based mentoring and sponsorship through the Go Baby Go initiative. These programs create a continuum of development that can be used to progress students from initial interest formation to academic progression and professional preparation.

This progression of a mentoring ecosystem presents a more nuanced view of mentoring within institutions, not simply a singular program, but a collective and coordinated effort to create a sustainable mentoring ecosystem to enhance the recruitment, persistence, and advancement of women within technology disciplines.

The collective findings of this study reframe the concept of mentoring within institutions and presents a more nuanced view of mentoring not simply as an individualized program, but a strategy that can be used to sustain the participation, persistence, and advancement of women within technology disciplines, while providing a scalable model for implementation within various and diverse educational and institutional settings. The model presented here provides a replicable framework for institutions seeking to expand mentoring beyond individual relationships toward systemic infrastructure supporting women in technology.

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