Thriving in STEM: A holistic model for postdoctoral training through the Cultivating Outstanding Researchers and Educators (CORE) training program (STEM Ed PRF)

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Introduction

The goal of this project is to enact a postdoctoral training program that will expand the nation's capacity to advance STEM teaching and learning, broaden participation in STEM fields, and improve STEM workforce development by supporting participating fellows in developing new research skills in STEM education while facilitating their development in areas that are critical to thriving in the academy. The PIs on this NSF grant designed a two-year postdoctoral program that scaffolds fellows' engagement in the higher education academic community through the lens of five hidden competencies needed for success in academia [1]. This paper is guided by the research question: *What are the early-iteration perspectives of key stakeholders (PIs and fellows) on a collaboratively designed THRIVE fellowship program centered around hidden competencies?*

Literature Review

Academic Preparedness

Sixty-five percent of life science and engineering postdoctoral scholars enter the academy at the conclusion of their training, with 37% and 25% entering tenure-track and non-tenure track lines, respectively [2]. The success of these new faculty members depends not only on their research training but also on their ability to navigate the complexities of academia. Historically, STEM doctoral programs have been singularly focused on training the next generation of researchers, neglecting the reality that those researchers who join the academy will have a variety of roles beyond research, including teaching, mentoring, and service. In response to this disconnect, programs that prepare future faculty members have begun providing opportunities for scholars to develop skills in teaching and other responsibilities typical of faculty roles [3]. These more holistic efforts began nearly 30 years ago and have provided a strong body of knowledge for best practices to support postdoctoral scholars to pursue academic careers [4]. These programs often include professional development in effective teaching [5] and navigating the academic job market [6]. Recent programs have also included a focus on resilience [7], acknowledging that having technical and teaching skills is not sufficient to persist in faculty positions.

Thriving in the Academy

Thriving is not a stagnant state, but rather an ongoing process characterized by an ability to navigate adversity while also experiencing personal growth [1]. Literature suggests that thriving individuals "are less susceptible to burnout and more likely to take an active role in developing a successful career path" [8]. Zerbe et al. [1] proposed the Model for Graduate Engineering Thriving (MGET) to describe the complex nature of thriving for graduate students, which we adapt to intentionally design professional development programming for our fellows. The MGET includes four interrelated categories: context features, agentic behaviors, produced resources, and hidden competencies (HCs) [1]. Each of these categories is complex, but it is the hidden competencies category that is most likely to lack specific attention in postdoctoral training and disproportionately affect scholars with marginalized identities [9]. This program was designed around five HCs: HC1) research fundamentals, HC2) career growth, HC3) disciplinary communication, HC4) managing mental health, and HC5) managing social health [1].

Structure of Program

The THRIVE Program is a two-year postdoctoral fellowship aimed at training Fellows to thrive in the academy. Over the course of the program, the goal is for Fellows to gain independence through scaffolded experiences that support their ability to achieve their professional goals while maintaining their well-being. Using the HCs, the PIs planned activities for the Fellows to engage in throughout the program. In addition to the first-year activities outlined in Table 1, Fellows also participated in weekly meetings with the PIs to discuss teaching, research, and any other aspects of the hidden curriculum of higher education that the Fellows encountered through their program experiences. These discussions influenced the iterative evolution of the THRIVE Program to better meet the needs of Fellows and PIs.

Table 1. Year 1 activities to address elements of hidden competencies that influence thriving

	HC1	HC2	HC3	HC4	HC5
Year	**Research Fundamentals**	**Disciplinary Communication**	**Career Growth**	**Managing Mental Health**	**Managing Social Health**
1	Participate on an existing research project with one of the PIs.	Engage in a reviewers' workshop; submit a manuscript with mentoring; write a proposal for the Year 2 research project.	Participate in Teaching Excellence Training and NCFDD; Attend conferences alongside PIs.	Engage in NCFDD and Thrive Interactive Training Sessions to provide skills for managing stress	Engage in Monthly social events with CoP; Use a dedicated "channel" for PEER fellows on the ExEEd department's Slack.

Research Methods

This study is part of a larger design-based implementation research (DBIR) [10] that investigates the outcomes of an iteratively co-designed professional development program for early career scholars. DBIR includes four principles: 1) focus on persistent problems of practice from multiple stakeholders' perspectives; 2) commitment to iterative, collaborative design; 3) concern with developing theory related to both school (or university in our case) learning and implementation through systematic inquiry; and 4) concern with developing capacity for sustaining change in systems [11]. DBIR has been implemented in engineering education contexts before [12], [13]; however, to our knowledge it has yet to be applied to postdoctoral programs in engineering education research. To begin, the PIs and fellows discussed the intended design of the THRIVE Fellows program using the NSF proposal to ground conversations. The PIs then reflected on the initial intentions and goals for each HC as well as the resulting realities of how this co-constructed program evolved. Notes from these discussions were then provided to the fellows who reflected on how their experiences aligned or conflicted with the goals for each HC outlined by the PIs. For this paper we focus on HC1, 4, and 5. In future publications, we will discuss HC2 and 3, the program overall, and future iterative cycles of program development. Below we present summaries of the reflections from PIs and Fellows for the HCs of interest.

The experiences in this program are greatly informed by the backgrounds and experiences of the PIs and Fellows. While our identities are expansive, here we highlight key aspects that have had a salient impact in shaping the THRIVE Program. PI1 has a background in Environmental Engineering and began engaging in Engineering Education Research, with a particular focus on faculty development and first-year engineering programs, in 2018. She serves as department

chair and graduate program chair for the department where she has been a faculty member for 12 years. PI2 completed a PhD in Biomedical Engineering in 2022 with a dissertation focused on Engineering Education Research. She joined the faculty in Fall 2022 directly out of her PhD. She has brought her recent experiences transitioning into a faculty role to many of the conversations in the THRIVE program meetings. With a PhD in Curriculum and Instruction (2001, mathematics cognate), PI3 brings 35 years' experience as a maths and STEM educator to THRIVE-STEM's design and implementation. This proximity offers insight into key program decisions while requiring reflexivity about bias and institutional dynamics, checked through co-authors' perspectives. She identifies as a queer woman and attends closely to how inclusion, belonging, and power shape mentoring and professional learning. Fellow 1 has a background as a museum educator and a doctorate in science education. This is her professional transition into engineering education while maintaining her expertise as a qualitative researcher. Fellow 2 has a background in mechanical and aerospace engineering. While she has participated in ASEE for several years as a graduate student, this is her first formal training in engineering education research methods. Both Fellows identify as queer women.

Results

The grant PIs spent the first year of the grant preparing the programming that would support the THRIVE Fellows' development of the Hidden Competencies (HCs). The PIs' approach to three HCs and the Fellows' experience with that approach are described below.

HC1: Research Fundamentals

PI Approach: As part of the onboarding process, each Fellow was asked to rank five project options and provide justification for their rankings. Using this data, the PIs assigned a research project and mentor to each Fellow. In the past several months, the Fellows have actively engaged with the research project and the existing research teams supporting those projects. This engagement has been in the form of weekly meetings with the PI and/or the research team, developing and executing research protocols, and disseminating the research findings. The Fellows also were invited to participate in professional development to strengthen their research skills as needed (e.g., auditing a graduate-level foundational Engineering Education course, attending guest speaker talks in a graduate-level Research Fundamentals course).

Fellow Outcomes: Fellows identified the meetings with project PIs and research teams in addition to their informal discussions with each other as helpful. Fellow 1 found it useful to apply the lessons learned from their dissertation study around data management and protocol design, has learned new softwares, and was introduced to some new theoretical frameworks. Fellow 2 found the guidance and hands-on help from their PI the most helpful in developing her growing EER skillset. Both Fellows found the guest speaker events helpful, but Fellow 1 specifically notes it as the most helpful aspect in growing HC1, as it has been "a way to learn about new methods and theoretical framings to integrate into other projects." For Fellow 2, who did not have any formal training in education research, the Research Design in Engineering Education course was most helpful. She reported that the course was "a little disorienting at first because it felt like the goals of the course (to develop a project proposal) were out of sync with the THRIVE goals of divergent thinking of projects for Year 2". However, she was able to step into a more supportive role in the course and leaned into her positionality as a postdoctoral researcher to voice critical perspectives of research presented, despite her relative newness to the

field. Fellow 2 indicates that the biggest outcome from this course has been learning how important theoretical frameworks are and intentionality around research design principles.

HC4: Managing Mental Health
PI Approach: We have leveraged our weekly professional development meetings to include a weekly discussion on either an NCFDD Training video or on a reflection question based on Schlossberg's transition theory [14]. Schlossberg's theory includes four S's (Situation, Self, Support, and Strategies) and we have discussed questions related to each of these. For example, "How are your relationships with faculty, peers, and students shifting now that you're in a postdoctoral role?" or "What skills did you use or learn during various life transitions that are supporting your transition to being a THRIVE Fellow?". In addition, the PIs very explicitly established expectations for expected number of hours of work each week and have made a commitment to not having any required THRIVE-related obligations on Fridays to allow Fellows to use Fridays in ways that help them thrive.

Fellow Outcomes: Both Fellows' mental health benefitted from building close relationships with the PIs and having open and honest conversations about the struggles of academia. Fellow 1 notes that coming into the postdoc, faculty they had worked with in the past kept their personal struggles hidden– "I felt that I couldn't have any vulnerabilities or weaknesses in order to succeed in academia; whereas watching and discussing the THRIVE team navigate their anxiety, insecurities, and stress and getting to have vulnerable conversations about it all has helped with my imposter syndrome, and created a more welcoming environment where I feel I can succeed and be myself (mostly) without giving up my humanity." Fellow 2 is genuinely much happier now in their postdoc than ever before in their academic career. Part of this is due to the supportive team environment, where they are encouraged to be open with each other about struggles and take care of each other and themselves. An equally important aspect is positioning her scholarly work to align more closely with her values. By the end of her graduate program, she was burnt out and disconnected from her work. THRIVE has given her the opportunity to dream up who she wants to be and act upon what she really wants to do. She already had a strong sense of that coming into the program, but THRIVE has helped her feel she is on the best path to actually achieving it. Feeling celebrated for who she is while also being gently pushed to become the best version of herself is a significant sustainer of her improved mental health.

HC5: Managing Social Health
PI Approach: Support for THRIVE fellows' social health has come from existing department networking opportunities (i.e., research group meetings that gather all research-active faculty and graduate students in discussions, professional development activities, collaborations, department celebrations), a shared work space to encourage organic interactions in person, and a dedicated, private channel in our department's Slack for fellows to easily communicate with each other. Our weekly PD meetings have also opened opportunities for the PIs to facilitate introductions to faculty across campus and our external network to support the Fellows' pursuit of connections.

Fellow Outcomes: The Fellows feel that the biggest social health gain is their relationship with each other. Their skillsets, interests, and personalities are remarkably compatible, and their bond is growing stronger throughout the THRIVE program. Both Fellows greatly valued the flexibility around working from home, finding a good balance between the somewhat overstimulating

office time surrounded by graduate students and restorative home time surrounded by pets. Both Fellows benefited from using free Fridays to maintain social connections and collaborations with peers outside of the University.

Discussion

Overall, Fellows feel that this program has supported their sense of thriving within academia and provided adequate support in their transition out of graduate school. The design of the program around the five hidden competencies provided intentional structure, but the PI's flexibility and responsiveness to the Fellows' individual needs allowed the program to evolve to support the Fellows in areas they felt were most relevant to their professional goals. This program serves as an example for how other postdoctoral programs can leverage the hidden competency framework [1] to strengthen support for their fellows. Future work will investigate how the program iteratively evolves through stakeholder collaborations, how Fellows continue to develop within each hidden competency, as well as design considerations for professional development programs for early-career scholars that support thriving within academia.

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