

Forward Fellows: An extended onboarding program to foster a sense of belonging and research self-efficacy in incoming graduate students

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Abstract

The Wisconsin Materials Research Science and Engineering Center (MRSEC) works to retain graduate students by providing the support they need to be successful, including financial, academic, and psychosocial support. The Center also encourages collaboration, close relationships with faculty, and immersion in research. As part of this work, the MRSEC developed a novel, limited-time intervention designed to promote students' sense of self-efficacy in research and belonging at the university through a funded campus onboarding program held prior to the start of their graduate programs. The MRSEC's Forward Fellows (FF) program, launched in 2024, funded students who were admitted to graduate programs in departments affiliated with the MRSEC. These students engaged in mentored research for one month prior to their official matriculation date and participated in both professional development and community building activities.

A few months prior to launching the FF program, the planning committee gathered input from faculty, staff and current graduate students from eligible departments to determine how to design an impactful program that fits the diverse departmental and student needs. The input from the departments led the committee to implement a rolling application process that included both mentor and student applications, a flexible end date to accommodate different graduate program orientation start dates, and an appointment type that ensured the students received both funding and health insurance with no gap between the program and matriculation. Input solicited from current science and engineering graduate students informed the design of the professional development and community building sessions that served as the backbone of the month-long FF program. Professional development content delivered during two to three lunch meetings per week, covered a range of topics that addressed mentoring, research skills, and social belonging. Social events enabled the fellows to informally meet current graduate students and faculty outside their home departments.

In the 2024 pilot program, the MRSEC funded 10 graduate students from nine different departments. Participant input during a mid-program feedback session highlighted program successes and suggestions for improvement that were used to shape the remainder of the program. Data collection also included a post-program feedback session, and a post-program survey designed to elicit students' reflections on the utility of program activities related to their current graduate experiences. FF participant feedback highlighted how useful students found the extra time to start research, professional development sessions, extra time to adjust to campus life, and the opportunity to connect with their FF cohort. Student feedback, along with insights from observation data, and the experiences of the FF planning committee, will be used to shape the 2025 program with a long-term goal of expanding the program beyond MRSEC affiliated departments.

Introduction

As part of its mission to broaden participation of people who are historically underrepresented in science, technology, engineering, and mathematics (STEM) fields, the National Science Foundation (NSF)-funded Wisconsin MRSEC works to retain graduate students by providing the support they need to be successful, including financial, academic, and psychosocial support. The Wisconsin MRSEC also promotes multidisciplinary collaboration, close relationships with faculty, and immersion in research. In support of this mission, the Center developed Forward Fellows (FF), a funded, extended onboarding program, longer than a typical departmental onboarding or orientation, designed to help new students develop self-efficacy in research, a sense of belonging at the university, and a community of peers from multiple STEM disciplines. The FF program targets incoming STEM graduate students who would benefit from additional onboarding (e.g. students from historically underrepresented groups, first generation students, students returning to academia after time in industry, etc.). We also intend FF to serve as an incentive to attract potential graduate students and, in the long term, to help retain students through the completion of their graduate degrees. Due to the type of funding used, the program was only open to students who were U.S. citizens or permanent residents. By recruiting underserved students to our graduate programs and retaining them through completion of their graduate degrees, the FF can ultimately help broaden participation of these students in STEM. In this paper, we describe how the 2024 FF program experience affected participants' research-self efficacy and sense of belonging.

One of the fundamental goals of the FF program is to help students develop research self-efficacy by giving them the opportunity to engage in research without the distractions of classes and other stresses associated with starting graduate school, combined with professional development around research skills. Research self-efficacy has been identified as one's confidence in successfully performing tasks associated with conducting research and has an influence on research-oriented goals, expectations of performing research, and effort spent on conducting research [1], [2]. Importantly, the research training environment is a predictor of students' self-efficacy beliefs. Critical is the student's belief that their training environment supports and promotes research and independence [3]. Mentorship has been found to be a significant predictor of self-efficacy regarding general research methods, which is a component of overall research self-efficacy for graduate students [3]. Recent research shows that peers and mentors have a "deep impact on the level of self-efficacy and persistence" for underrepresented graduate students in STEM majors [4]. Similarly, research at our institution has linked having a greater research self-efficacy with students' commitment to complete an engineering degree [5].

A second goal of the FF program is to help students from groups that are historically underrepresented or face other challenges in transitioning to graduate school develop a sense of belonging in STEM fields. Supporting students in developing a sense of belonging in their research environment and at the institution is one strategy to promote retention, which in the long-term will help broaden participation in STEM fields. Research on engineering graduate students at our institution has identified that feeling welcomed and included is connected to students' commitment to completing their engineering degree [6].

Strayhorn explains that most definitions of sense of belonging "deal with students' psychological experiences and, importantly, their subjective evaluation of the integration in a particular context

(e.g., School, college) [7]”. Recognizing that many, somewhat different, definitions of “sense of belonging” exist, Strayhorn distills these down to “a basic human need and a motivation, sufficient to influence human behavior.” Basic needs are at the core of Strayhorn’s theory about sense of belonging, which builds directly on Maslow’s hierarchy of needs [8], [7] p.41. Strayhorn’s research about graduate students’ sense of belonging is closely tied to socialization theory [9], which involves interaction with agents such as faculty and peers in both formal and informal experiences. Results from Strayhorn’s survey and interview studies show that socialization positively relates to the confidence students have in themselves to complete academic tasks and is linked to a sense of belonging. Strayhorn recommends four approaches for promoting a sense of belonging in graduate students: 1) Introduce graduate students to the norms, values and expectations of their program through promotional materials, orientations, and skill-building workshops. 2) Advise graduate students about what is required to complete their degree and to obtain the professional positions they would like. 3) Provide meaningful opportunities for them to create a community that allows them to engage with peers, staff, and faculty in informal social settings and structured collaborations outside of the classroom. 4) Celebrate students, their backgrounds, and achievements. Though of short duration, the content of the FF program and its emphasis on interpersonal connections both within the cohort, and with the larger university community, was designed in line with these approaches to help students develop a sense of belonging.

Prior to designing the FF program, we looked for existing programs on our campus with similar goals and structures. Though we did not find any identical programs on our campus, we drew upon the success of the Meyerhoff Scholars program, the graduate research scholars programs, and bridge programs to guide the development of FF. Programs to help youth transition to undergraduate college environments, especially in STEM fields, have been around since at least the 1990s, and were part of a push that gained momentum in the 2000s to increase the diversity of STEM professionals [10]. A well-known example is the Meyerhoff program, established in 1988 at the University of Maryland, Baltimore County (UMBC), as an undergraduate bridge program whose model centers on community building and mentoring outreach opportunities [11]. An example of a similar program at the graduate school level is the Graduate Engineering Research Scholars Program (GERS), started in 1999 at the at University of Wisconsin-Madison College of Engineering, with a core focus on student peer-mentoring, community building activities, cohort meetings, professional development opportunities, mental health and wellness events, faculty discussions, and career coaching [12]. The relatively newer Bridge programs, which support students’ transition to graduate school by bridging educational and developmental, have been developed extensively for students studying sciences disciplines such as chemistry and physics. Many such programs are linked with the Inclusive Graduate Education Network (IGEN), such as the American Chemical Society Bridge Program (ACS-BP), which is an effort to increase the number of chemical science PhDs awarded to underrepresented students (ACS, 2024). Themes of self-efficacy, and the related challenges students face with feelings of being “imposters” who do not have what it takes to do research, and a sense of belonging are central to these graduate school bridge programs [11], [13], [14].

Based upon the literature around research self-efficacy and belonging, as well as the exemplar transition programs described above, we created FF to be a relatively low-cost program that gives students an opportunity to start research a month early, learn professional development skills to

begin building their research self-efficacy, and to develop a community of peers from multiple disciplines at the same career stage to help their sense of belonging. To achieve the program's goals, the MRSEC provided financial support for graduate students to work in research labs for four weeks immediately prior to their matriculation. In addition to their research, the students participated in two to three required professional development/community building lunch meetings each week. There were additional community building events that the students were encouraged but not required to attend. The program evaluator led two in-person group feedback sessions, observed two of the professional development sessions, and administered a post-program survey to evaluate the efficacy of the program in achieving its stated goals.

Program Development

To design a program that achieved the Center's objectives and leveraged existing successful efforts around broadening participation, a program planning committee was assembled a year before the program launched. The team included the co-leads of the MRSEC's education and outreach efforts, an external evaluator, administrative staff, a staff member from the college's office of Inclusive Excellence and Educational Innovation (IEEI), and the Directors of the College of Engineering's GERS program [12]. GERS is one of several Graduate Research Scholars communities at UW-Madison designed to support underrepresented students throughout their graduate school career using a range of social, academic, professional development, and research-related activities [15]. Including GERS leaders in the planning stages enabled the committee to leverage best practices from GERSs' 25+ years of working with underrepresented graduate students. Demographically, the team consists of four women and two men, two people of color, five US citizens, and one person with dual citizenship. Together, the team members have > 50 years combined experience working with graduate students and equity and inclusion efforts in the college, which makes the planning committee well and uniquely qualified to develop and implement the FF program.

Because FF is unique to our institution, is a brand-new program, and involves multiple departments, the committee solicited information from several key informants during the development process. For example, we interviewed faculty and academic staff who work on graduate student admission from all ten eligible departments (Appendix A) to determine how the program could be designed to fit the needs across these STEM programs. The findings led the committee to implement a rolling application process to accommodate the various graduate student recruitment schedules and to select a fixed start date and a flexible end date to accommodate different graduate program orientation schedules. The selection of research advisor and topic choice was dependent upon the graduate program to which the student was admitted – some of the eligible departments admit students directly into research labs while others have a rotation process to select lab placement.

The FF planning committee used the GERS application process as a template to develop the FF application process. In the two-part application process, a faculty mentor from the student's graduate program completed a short nomination form outlining why they were nominating the student and what they hoped the student would gain from participating in the three components of the program: research experience, professional development, and community building. Once the nomination was submitted, the student received a link to complete their part of the

application form which asks what they hoped to gain from the three components of the program and what lived experiences they would bring to the FF community. This process allowed the application review committee to do a holistic review of nominees and thereby identify students who would most benefit from an extended onboarding program for reasons not limited to gender identity, ethnicity, or race. Although most incoming graduate students come from institutions outside of our own, that was not a requirement of the program. The two-part application process also ensured that all FF participants had a research mentor throughout the duration of the program and that the nominated student was interested in and able to join the program. The committee reviewed the applications on a rolling basis and informed faculty mentors as soon as a student was accepted, so the program could be used as a recruiting tool as prospective students were making choices about what admission offer to accept. The program began accepting applications as early as December 2023 to facilitate student enrollment.

Once these logistical aspects of the program were established in Fall 2023, the FF committee began developing the program content for implementation in Summer 2024. Following advice from the external evaluator, the team drafted a logic model (Fig 1). This theory of action was useful in formulating guiding evaluation questions and informed development of interview and survey instruments (instruments show in Appendix).

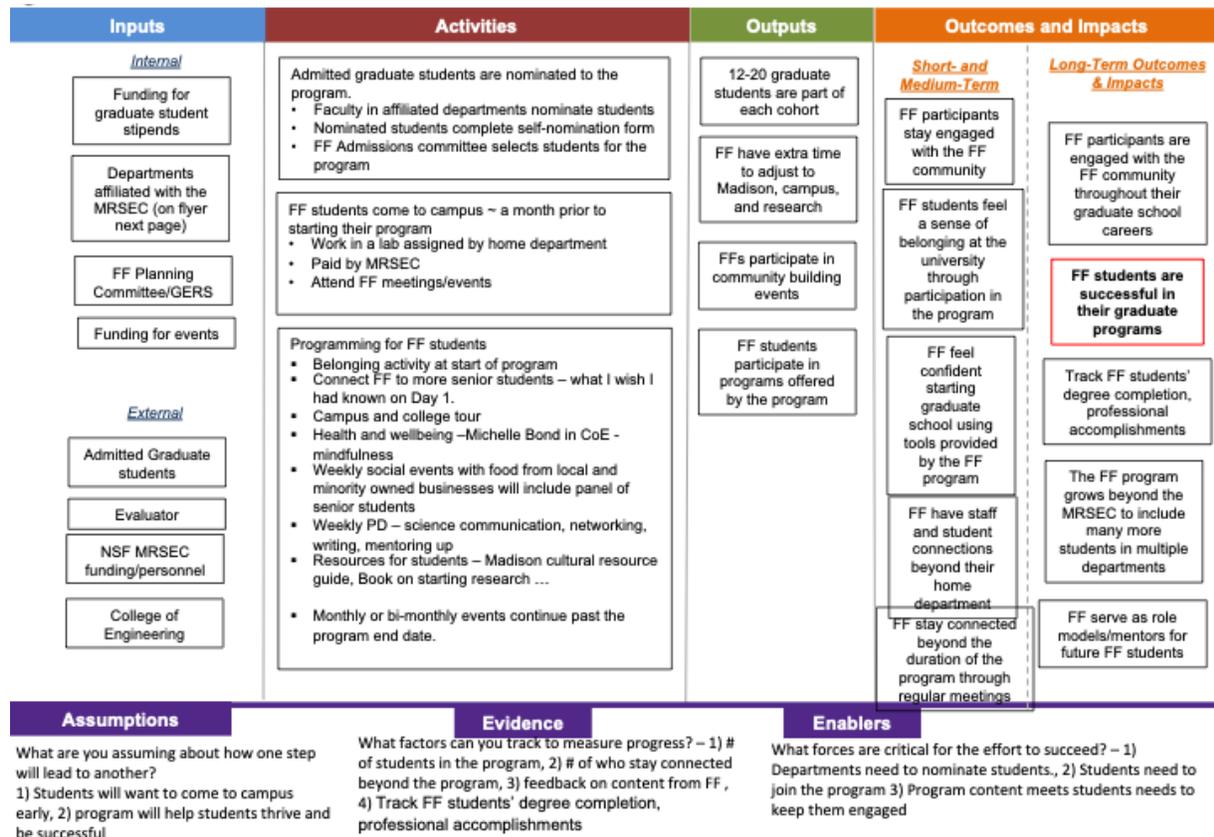


Figure 1. Logic model developed by FF planning committee for the program.

Next the evaluator and committee created a pre-program survey to collect data from current GERS and MRSEC graduate students. Findings, described below, helped with designing the professional development and community building activities that students thought would be most useful for graduate students just prior to starting their graduate programs. The committee also conducted informal interviews with GERS program staff, the Assistant Dean for Graduate Students in the College of Engineering (CoE), and the CoE's evaluator who studies faculty, staff and students' sense of belonging, to learn from their experiences to inform development of content for the FF program. In total, nine graduate students from GERS or the MRSEC as well as two staff members were interviewed to inform program design. Based on input from these key informants the committee planned a program with two to three professional development sessions each week, all of which were mid-day and included lunch from a variety of local restaurants that served food from different cultures. Four members of the committee served as the program coordinators which included contacting speakers, reserving space, ordering and setting up food, and other logistical details.

Program Structure

Frequent communication between the FF planning committee and FF students was one component of building community in the program. For example, as soon as a student was accepted, the applicant and their mentor were sent an offer letter with their stipend and benefit information, start and end dates, program expectations, and a draft outline of the program schedule. A month prior to the program start date, the planning committee chair sent e-mails to all the students welcoming them to the program, offering more detailed information about what the program would entail, asking about dietary restrictions, and offering to serve as a resource if they had any questions. The committee continued to send out weekly e-mails throughout the duration of the program so that students received regular communication from the committee. At least one, and typically two to three coordinators were present during each of the professional development sessions, except for the panel discussions with current graduate students. Several sessions began with a check-in question to gauge how the students were doing in their labs, at the university in general, and with their move to a new city. This allowed the coordinators to address questions and issues students were facing. Although most of the community building occurred during the lunch sessions, there were also optional social outings led by faculty.

Because the eligible departments all had different start dates for their graduate student orientations, we front-loaded the program with the more professional development sessions in the first two weeks and offered fewer as the program progressed. Table 1 shows a week-by-week description of the content of FF professional development sessions.

Week 1

First day in the lab

Program Introduction and Welcome Reception: After a short presentation on program logistics and time for questions, the FF, who were meeting in-person for the first time, engaged in activities focused on learning about other program participants. Following the meeting, the Fellows attended a Welcome Reception that included the planning committee, their primary mentors, and their lab mates.

PD Workshop on Social Belonging: This lunch session was based upon the work of Walton and Cohen [16] and adapted from the Project for Education Research That Scales (PERTS)[17]. The planning committee asked current graduate students from GERS and the MRSEC to submit a short, written story about a challenge they had in graduate school and how they dealt with that challenge. The FF were given the stories to read and asked to discuss which stories stood out to them and whether they would have done something differently. Then the students were asked to write their own reflection about a challenge they have experienced in a prior transition to something new and how they dealt with that challenge.

Current Graduate Student Panel: Students from the GERS program had lunch with the FF and had a panel discussion about their experiences around belonging at UW-Madison and in Graduate school.

Week 2

PD Workshop on Introduction to Campus Resources: At this lunch session a panel of representatives of UW-Madison campus resources offices presented some of the college and university resources available to graduate students. Panelists included: a Research Services Manager at the Science & Engineering Libraries, the Engineering Focus Mental Health Provider, the Assistant Dean for Graduate Affairs in the College of Engineering, and the Assistant Dean for Diversity, Inclusion and Funding in the Graduate School.

PD Workshop on Mentoring Up: The co-leads of MRSEC's diversity, equity, and inclusion efforts, who have decades of experience training research mentors and mentoring students, led a lunch session for the FFs about how to elicit effective mentoring from their PIs. The content was adapted from the CIMER Project's mentoring up curriculum [18] and one of the co-lead's books [19]. During the workshop, the students reflected on what they most need from their mentors at this stage of their training and practiced how they would request that from their mentors. The FF participants also worked on creating a "constellation of mentors" by listing the mentors they already have (including the planning committee members), the areas they wanted to find additional mentoring, and strategies for how they might find and contact those mentors.

Current Graduate Student Panel: Students from both GERS and the MRSEC had lunch with the FF and a panel discussion about what it means to thrive in graduate school.

Week 3

PD Workshop on Imposter Phenomenon: – The Engineering Focus Mental Health Provider led a lunch session focused on what imposter phenomenon is and gave the students strategies for how to mitigate its effects.

Faculty Panel: Faculty from the MRSEC met with students over lunch to talk about the role of faculty in the students' success and give perspectives on what faculty expect from their new graduate students.

PD Workshop on How to Read the Literature: A planning committee member who is an engineering faculty member provided a lunch session on the basic anatomy of journal articles, strategies for reading them critically, making notes and annotations while reading, and citation management systems.

Week 4

PD Workshop on Financial Literacy: A local credit union staff member talked with the students over lunch about how to create and maintain a budget on a graduate student's salary and how to improve their credit score.

PD Workshop on Science Communication: A planning committee member who teaches a science communication course for STEM graduate students led a workshop following lunch on how to effectively communicate about their research.

8 weeks post-program

Celebration Dinner: Approximately two months after the students officially began their graduate programs, the coordinators arranged a group dinner to celebrate their participation in FF and successfully completing the first month of graduate school. Nine out of the 10 Fellows joined the coordinators at this optional dinner.

Table 1: The 2024 Forward Fellows program schedule

Program Participants

Of the 21 applications that were received, 10 students were admitted to and accepted a place in the program. The students came from nine different departments: Mechanical Engineering, Nuclear Engineering and Engineering Physics (2), Biomedical Engineering, Materials Science and Engineering, Pharmaceutical Sciences, Physics, Civil and Environmental Engineering, Electrical and Computer Engineering, and Chemistry. Due to the small cohort size, this paper does not include demographic information about the students to protect their identity and privacy.

Evaluation Methods

The evaluation activities, designed to examine the fidelity of implementation and examine how the program performed with respect to its intended outcomes of promoting research self-efficacy, helping students develop a sense of belonging, and building a community of peers, were carried out by an external evaluator. She worked in close collaboration with FF program planning committee members to develop surveys, group interview protocols, and observation instruments, and to interpret results. For each activity the evaluator carried out, Table 2 shows the timing, purpose, and number of participants.

Results

Pre-Program Input: To collect advice about designing the program, the FF planning committee solicited input from some key informants in March 2024. Nine current graduate students recruited from the MRSEC research groups and from the GERS program offered written input

Program Activity 2024	Evaluator activity	Purpose	n
March Pre-program Input for program design	Surveyed 9 current graduate students; Interviewed GERS program leader	Elicit advice for use in designing program	10
July 30 Kick-off	Attended by evaluator	Establish rapport with students	NA
August 1 Social Belonging Workshop	Observed by evaluator	Characterize program implementation and student engagement	10
August 7 Mentoring Up Workshop	Observed by evaluator	Characterize program implementation and student engagement	8
August 8 Feedback Session	Facilitated group feedback session with FF program students	Mid-program feedback that FF planning committee could act on during 2024 intervention	9
August 22 Feedback Session	Facilitated group feedback session with FF program students	Elicit feedback for use when planning FF 2025	10
October Post Program Survey	Post program survey of FF program students	Elicit feedback for use when planning and recruiting for FF 2025	8

Table 2: Program Evaluation Outline

through a survey, and the GERS Program Manager provided input through an interview. Advice included:

- Make students aware of useful resources and ways to connect. For example, share ways to find and use campus resources, insights about what to expect with graduate school, and ways to connect with key community supports: mentors, friends, support groups, social and study areas.
- Provide activities to promote a sense of belonging and community focused on professional networking, social connecting, and getting to know the Madison area.
- Focus skill-building activities on communicating about their research, both formally and informally.
- Normalize the challenges that graduate students often face.
- Explain how many students have the same kinds of experiences, and make sure they can get resources and support when they need them, which is key to helping students navigate these challenges.
- Avoid portraying the participants as needy.

In addition to offering suggestions, current graduate students highlighted their top challenges which focused on time management, particularly how to balance research and coursework, and on social-emotional challenges, especially dealing with imposter syndrome. Additionally, respondents shared surprises that they encountered with graduate school including how isolating the experience can be, how tough it can be to motivate themselves especially with the amount of autonomy graduate students have, and how complex and political the academic system can be.

Observation Findings: The evaluators' observations of selected program activities showed that, overall, these workshops were an engaging, enjoyable experience for all. The content was delivered with an informal, up-beat energy that got people talking, both during structured activities and informally. The FF attendees paid attention to the presentations and were active in small groups.

Feedback from Group Interview Sessions: At the mid-point and at the end of the month-long FF program intervention, fellows shared their views through two group feedback sessions. The goal was to understand their experiences with the program, to learn about how the program was valuable to them, and to elicit suggestions for improvement. Student feedback highlighted the significant value they received from the program. Specifically, they explained that program offered opportunities to get ahead with research, to train on professional research science skills, and to socialize and connect with their FF cohort. Table 3 is a summary of the interview feedback from FF students, organized by thematic categories.

Post-Intervention Survey: In October 2024, about eight weeks after the FF began their respective graduate programs, students from the 2024 FF cohort completed a survey. Survey findings gave us insight into how the program equipped students to navigate the transition into graduate school:

- All respondents indicated that they would recommend the FF program to others.
- Connecting with the FF cohort was a major advantage of the experience.
- Connecting with the FF cohort, and networking in general, supported students' sense of belonging. These connections helped them find their place in a new city, work environment, research network, and peer group, and even helped them feel more capable.
- The extra time before the semester was helpful for settling into their home and work rhythms before the busy time of graduate school officially started.
- They highly valued the head start they got on their research.
- The professional development midday workshop sessions, especially those that targeted research skills, such as science communications and learning to read literature, were valuable opportunities to build these capabilities as well as interpersonal connections.

Two specific suggestions echoed feedback from the group interviews: 1) more support with finding housing and 2) more customized advising on managing their finances. FF program leaders have already taken steps to address these issues for the 2025 program (see Future Directions).

To get an idea about how useful several core aspects of the program were to students as they navigated the first weeks of graduate school, we asked students to rate them: starting research early, the professional development sessions, and community building. All found starting research early to be “extremely” useful (Fig. 1). Students also found community building and professional development lunches to be useful but offered more mixed ratings.

Themes	Group Feedback Summary (n=10)
Overall great value	<ul style="list-style-type: none"> -Head start on research was invaluable. -Professional development (PD) sessions. <ul style="list-style-type: none"> -valuable training on communicating their science, mentoring, and reading literature. -useful orientation to campus life. -PD and social events fostered cohort community building.
Cohort community was most valuable	<p>The most important aspect of the FF program that students will take into their graduate school experience is connection with their FF cohort community, a group of graduate students from a variety of disciplines who are facing many of the same experiences and challenges.</p>
Their FF experience depended on their discipline and their mentor’s attitude	<ul style="list-style-type: none"> - Experimental research students began orientating to the lab basics (procedures and equipment) and work independently in their labs - Computational research students began learning the background of their field without the distraction of classes. - Pharmacy and chemistry students who are not directly admitted into labs had more time to figure out which lab rotations they wanted to pursue. - The group observed that there was wide variation among their research mentors regarding the amount of time spent on mentoring and communicating expectations. Most students wanted more structured mentoring and for their research mentor to understand more about the FF program content.
Suggestions for improvement	<ul style="list-style-type: none"> - Provide students with more support in securing housing. - Encourage research mentors to actively mentor and to learn about FF program content. - Customize the financial literacy workshop so it addresses graduate student life. - Offer fewer formal graduate student panels.

Table 3. Summary of feedback from two group interview sessions.

We also wanted to understand the degree to which the program fostered students’ sense of belonging in graduate school, so we asked them about five dimensions of ‘affiliation and sense of belonging’ identified by a recent survey of the education climate at our institution’s College of Engineering [6]. Students rated how often, after two months in graduate school, they felt

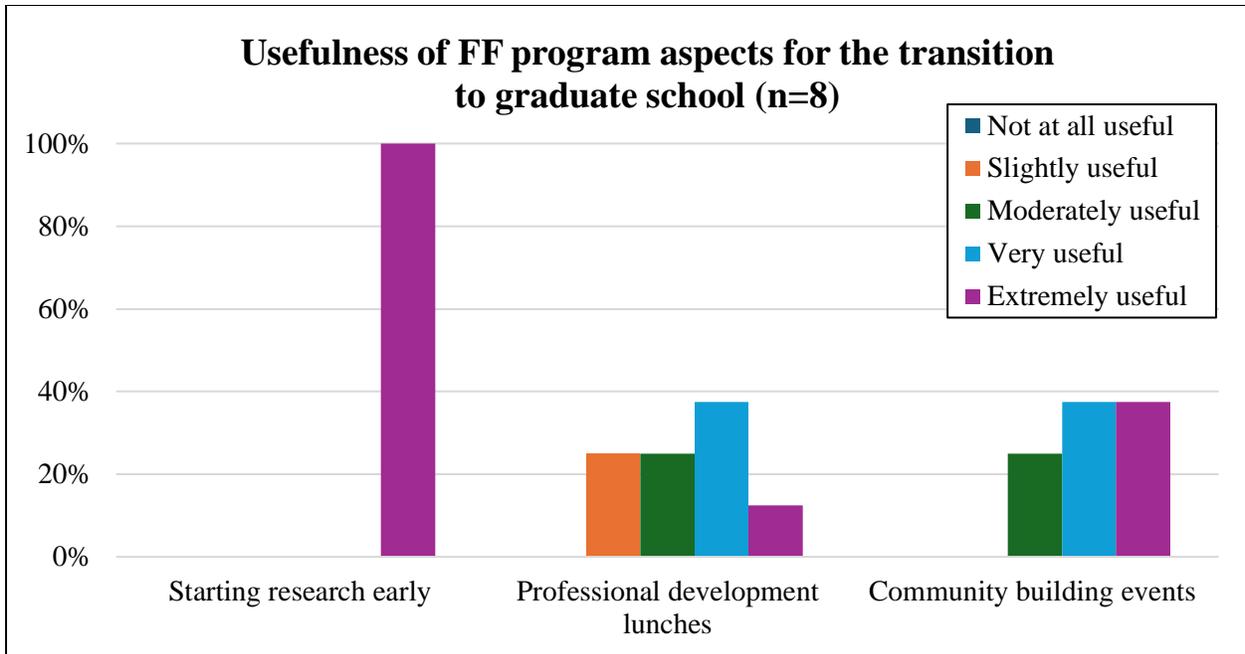


Figure 1. Responses to Post-intervention Survey item, “Please rate how useful the following aspects of the Forward Fellows (FF) program have been in supporting your transition into graduate school at UW-Madison, so far.”

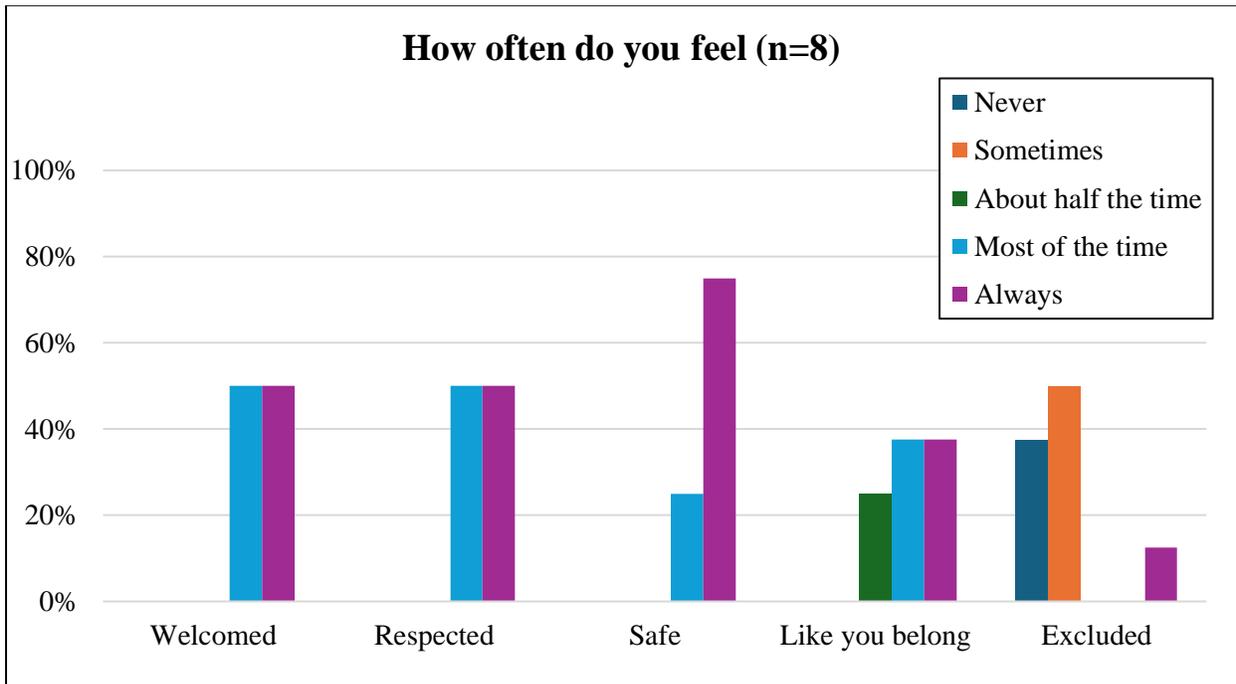


Figure 2. Student ratings on Post Intervention Survey item, “Thinking about your graduate school experience so far, how often do you feel welcome, respected, excluded, safe, like you belong.”

welcomed, safe, respected, excluded, and like they belong. Results show all students frequently felt welcome, respected, and safe in graduate school. Their feedback about how often they felt like they belong and like they were excluded was more mixed (Fig. 2).

The FF participants’ written comments about how the program affected their sense of belonging in graduate school revealed more about the impact of the program. Students wrote that FF program helped them to find their place in graduate school and, in cases of students new to the geographic area, in the city. Other responses described how the FF program helped students feel more included and helped them find a “work-life balance” before their first semester started. We elaborate on how students’ written comments relate to the rating scales for different dimensions of sense of belonging in the Discussion section.

We were also interested in how the FF experience supported students’ perceived capabilities associated with research self-efficacy and for navigating graduate school. Most students felt capable (somewhat or extremely) in the following areas: Communicate about my science, Read academic literature, Network with professionals who support my career path. Ratings were more mixed for Connecting with people who I can turn to for support (Fig. 3).

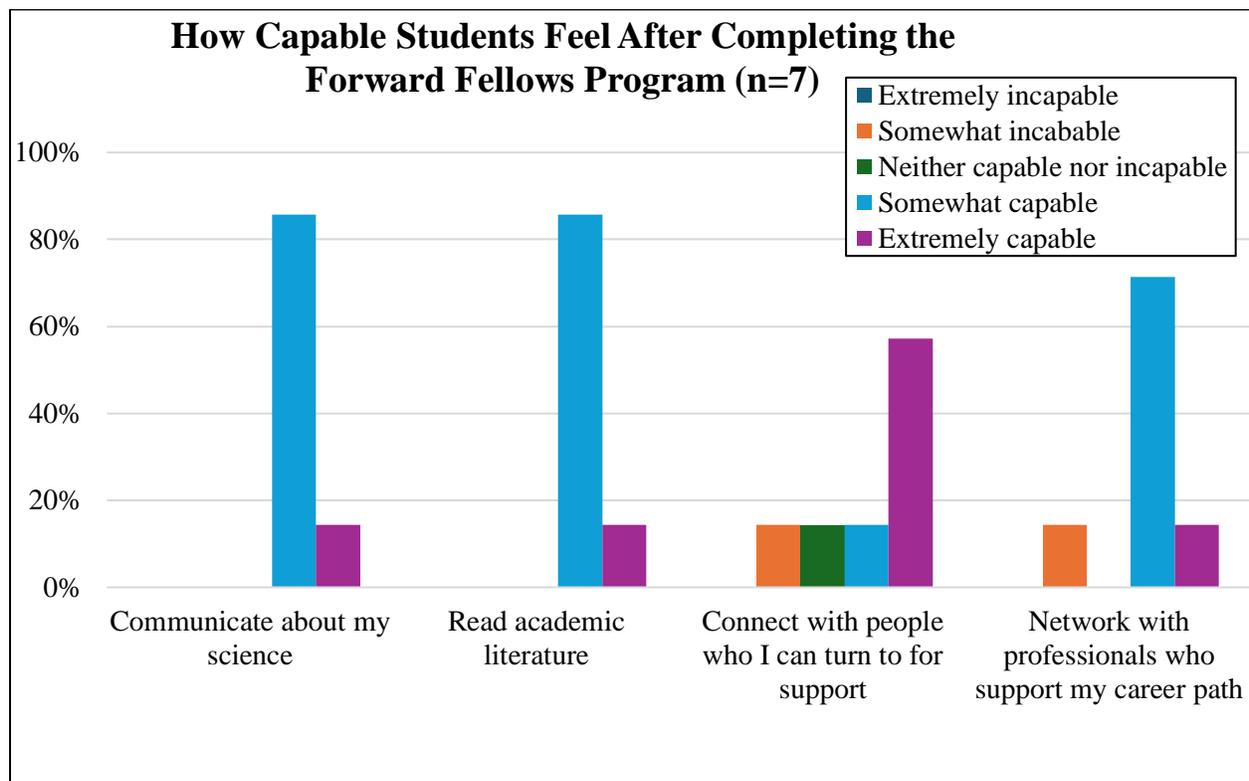


Figure 3. Responses to Post Intervention Survey item, “As your graduate school experience begins, how capable do you feel in the following areas?”

Students’ written comments revealed how some professional development workshops helped some respondents feel more capable as graduate students, especially the faculty panel discussion, imposter phenomenon workshop, and reading scientific literature workshop. Additionally,

starting early helped students feel more comfortable and settled in their situations, and connecting with peers supported development of their research self-efficacy and capabilities around navigating graduate school.

We also wanted to understand to what degree students are maintaining their connection with the other students in their cohort after completion of the program. We learned that students are staying connected with the FF community through social media and through meeting up on and off campus. Peer relationships are valuable for maintaining motivation, evident by one student's description about how "having FF peers near me means if I am frustrated with research, I can meet up for lunch or coffee with a peer, shake off the mental block, and go back to the lab, feeling reinvigorated."

Discussion

Overall, the first iteration of the Forward Fellows program was successful in giving students a funded opportunity to start research early, gain professional development skills, connect with a community of peers, and start finding their place in the graduate school environment during the challenging transition into graduate school. Confidence in successfully performing tasks associated with conducting research is the cornerstone of research self-efficacy. Enhanced research self-efficacy is indicated by the positive ratings students gave to their capability in communicating science, reading academic literature, and networking with professionals who support their career path.

Evaluation findings also shed light on the advantage students felt from having the opportunity to begin their research experiences prior to the start of their class work. For example, some students valued time to train on instruments or techniques they needed for their research before there was a large demand for training from other new students in their graduate program. Similarly, students valued additional time to make some early progress with research, connecting with their advisor, and mastering their field of study:

"By beginning research a month ahead of time, I was able to tackle some of the more challenging material in my research early on, setting a strong foundation and making a positive impression on my research advisor."

In addition to research self-efficacy, results suggested that students began to build a sense of belonging through the FF program, which was supported by their interactions with the FF cohort, other students, faculty, and staff throughout the program. One student described how the "faculty workshop helped me feel comfortable reaching out to other PIs for help or guidance." This relates to research that shows being more connected and comfortable with faculty has been linked to feeling safe in academia [20] and feeling equipped to navigate challenges in graduate school [7], p 83.

Student feedback suggests that the development of these two factors associated with graduate school success – research self-efficacy and sense of belonging – was sometimes intertwined for FF students. This is captured in a written reflection:

“I believe that researchers (or anyone) are best at their professional/academic roles when they are happy in their personal roles; having a strong network of peers has been fundamental to feeling capable in grad school.”

This echoes prior research on the importance of peers and mentors on an individual’s self-efficacy [4]. The links FF students made between sense of belonging and understanding how to work with new environments, people, and ways of doing things in graduate school align with Strayhorn’s findings about the importance of socialization to sense of belonging [7]. This is further supported by reports from FF students, who found that the program reduced the emotional stress of transitioning to graduate school:

“Starting research early was completely invaluable to my transition. I think the hardest part of starting grad school is developing a support network and a routine. Being able to accomplish both of those things before classes started saved me a lot of stress. I believe the positive effects from this opportunity have only just begun to show.”

Student feedback from the post-intervention survey provided insight into how the FF program affected their sense of belonging in graduate school. Results were in two forms: ratings of dimensions of sense of belonging and written responses about how the FF program influenced students’ sense of belonging. Rating results (Fig. 2) show that students felt “welcomed,” “respected,” and “safe” very often during the first two months of their graduate school experience. Their ratings about the other two dimensions of sense of belonging, feeling “like you belong,” and “excluded,” were more mixed.

Written comments provide additional nuance about how the FF program affected their sense of belonging. These responses can be linked to five dimensions of sense of belonging we explored through the survey, expanding our understanding of their experience. For example, some students wrote that the program helped them find a place in the community, as well as in a new school and city; this suggests that the FF program helped students feel *welcomed* in graduate school. Feedback also shows that the FF program supported students’ transitions by helping them get to know a new place, new people, and new ways of doing things, which one could also interpret as *welcoming*. Moreover, research has linked feeling more connected to feeling *safe* [20]. One student’s feedback captured how the FF program enabled them to orient themselves, explaining how the FF experience “allowed me to feel I have a place in my group, whereas without the program I would feel extremely behind and left out,” getting at feeling included, or not *excluded*. Another student described how the FF program enabled them to establish a work-life balance before the semester started: “I was able to feel 'settled' before the semester started and find a rhythm before classes took over. It helped me establish a better work-life balance.” Also noteworthy is how, during both group feedback sessions and also in the post-program survey, FF students stated that feeling *included* was important for thriving in graduate school. These results are early evidence that the FF program cultivates dimensions of a sense of belonging – feeling welcome, safe, and included – that can help promote graduate student retention to degree completion. Similar findings are seen in recent research in our College of Engineering, which attributes feeling welcome and included to a greater likelihood that graduate students intend to complete their graduate degrees [5].

Observations by FF program facilitators underscore how motivated students are to keep in touch with their cohort. Although the committee planned activities to promote community building, we were pleased to see the extent to which the cohort connected outside of the official FF programming. For example, cohort members started their own text chain and planned group activities beyond what the program provided. At the Celebration Dinner, held eight weeks after the program ended, students told the coordinator that they had been meeting regularly for social activities such as group meals or rock climbing.

Limitations

Drawing conclusions from the results of this investigation are limited due to the study's small sample size. For example, survey data from eight Forward Fellows students is strongly subject to influences from random variables, such as one or two students who received more funding or other support to make starting graduate school easier. Unlike the recent study about the education climate at our institution's College of Engineering, which surveyed 1099 undergraduates and 392 graduate students [6], any statistical tests on our FF program data would have such a large margin of error that the results would have limited meaning. More meaningful statistical analysis about the program's impact may be possible after several more years of data are collected from future FF program cohorts. Another limit comes from a *social desirability bias* in student responses. An example of this bias was seen in this cohort's feedback about sense of belonging. Ratings from the Post Intervention Survey (Fig. 2), indicated students felt welcomed, respected, and safe very often and this was reinforced by positive written responses. However, students did not elaborate with written responses about their more negative or mixed ratings for the other two dimensions of sense of belonging: 'like you belong' and 'excluded' in their graduate school experience. This may be due to a hesitancy to provide negative written responses. A final limiting factor on sense of belonging results has to do with the *design of the survey instrument*. That is, the multiple-choice item on the survey asked students to rate five specific dimensions of sense of belonging in graduate school. In contrast, the open response item that followed these questions asked students to write about how the FF program has affected their sense of belonging in general, which led to a wider variety of responses by the survey respondents based upon their individual interpretations.

Future directions

It is important to note that research self-efficacy is not achieved in one specific timeframe but is rather a "mobile construct" that needs to be reestablished over time [4]. This has been shown to be the case particularly for racial minorities and first-generation students whose self-efficacy reports have less stability over the course of their graduate program than non-minority and continuing generation students [4, 21]. As a long-term goal, we are interested in investigating whether students who participate in both the FF and a graduate research scholars program continue to develop their research self-efficacy and successfully complete their degree programs at a higher or similar rate to students who do not participate in these programs. Additional evaluation measures will also be introduced to measure students' perceived gains in capabilities, by asking students to compare before and after, regarding perceived research self-efficacy.

The program coordinators are making efforts to stay connected with the 2024 cohort through e-mail communication, LinkedIn, and invitations to social outings (ex. a coffee outing in January 2025). Marketing and recruitment efforts are underway for the 2025 program and the members of the 2024 cohort will be invited to interact with the new cohort during some of the professional development events, including asking them to write additional stories for the belonging workshop in week 1. We will also invite the 2024 cohort members to provide advice to the incoming students prior to the start of the program with information and advice around moving to CITY and starting graduate school. Care will be taken to ensure that undue burden is not placed on current students.

A long-term goal of maintaining these connections is to create a larger community of students over the years and to track their progress through graduate school. This will enable us to measure the success of the FF program in retaining students through degree completion relative to students who have not participated in FF. We recognize the challenge of these longer-term plans, given the six-year grant lifetime of the Center, thus the goal is to eventually institutionalize the program and embed the tracking data collection into the College of Engineering itself. Given the relatively low cost of the program (one month of graduate school stipend per student plus funds for 10 lunches per student with staff time paid by the MRSEC), we aim to attract additional funding from individual departments to expand the number of students who can participate, beyond the 12/year the MRSEC can currently support.

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References

- [1] M. Forester, J. H. Kahn, and M. S. Hesson-McInnis, "Factor structures of three measures of research self-efficacy," *Journal of Career Assessment*, vol. 12, pp. 3-16, 2004.
- [2] D. M. Szymanski, J. J. Ozegovic, J. C. Phillips, and M. Briggs-Phillips, "Fostering Scholarly Productivity Through Academic and Internship Research Training Environments," *Training and Education in Professional Psychology*, vol. 1, pp. 135-146, May 2007.
- [3] S. Chesnut, K. O. Siwatu, H. Young, and Y. Tong, "Examining the relationship between the research training environment, course experiences, and graduate students' research self-efficacy beliefs," *International Journal of Doctoral Studies*, vol. 10, p. 399, 2015.
- [4] L. Charleston and R. Leon, "Constructing self-efficacy in STEM graduate education," *Journal for Multicultural Education*, vol. 10, pp. 152-166, 2016.
- [5] M. E. Fitzpatrick, S. G. Burrows, and J. A. Yonker, "An Exploratory Study of Engineering Graduate Student Persistence: Self-Efficacy and Contextual Influences," *Journal of Career Development*, vol. 50, p. 23, June 2023 2023.
- [6] M. Fitzpatrick, "E3, Educational environment in engineering. 2022 survey results," College of Engineering, University of Wisconsin-Madison, Madison, Wisconsin 2022.
- [7] T. Strayhorn, L. , *College Students' Sense of Belonging: A Key to Educational Success for All Students*, Second ed. New York, NY: Routledge, 2019.

- [8] A. H. Maslow, *Toward a psychology of being*. Princeton, N. J. : Van Nostrand, 1962.
- [9] S. K. Gardner, "Contrasting the Socialization Experiences of Doctoral Students in High- and Low-Completing Departments: A Qualitative Analysis of Disciplinary Contexts at One Institution" *Journal of Higher Education*, vol. 81, p. 21, Jan-Feb 2010 2010.
- [10] M. Ashley, K. M. Cooper, J. M. Cala, and S. E. Brownell, "Building Better Bridges into STEM: A Synthesis of 25 Years of Literature on STEM Summer Bridge Programs," *CBE Life Sci Educ*, vol. 16, Winter 2017.
- [11] N. R. C. U. C. S. Roundtable, "Minorities in the Chemical Workforce: Diversity Models that Work: A Workshop Report to the Chemical Sciences Roundtable," Washington, DC2003.
- [12] V. Zavala, E. Williams, K. Burton, and M. Fitzpatrick, "GERS Self-Study Report," College of Engineering University of Wisconsin-Madison, Madison, Wisconsin October 27, 2024 2024.
- [13] I. G. E. Network. (2023, December 12). *IGEN Year 5 Progress - WestEd Evaluation Report Student Infographic*. Available: <https://igenetwork.org/index.php/resource/igen-year-5-progress-wested-evaluation-report-overall-infographic>
- [14] A. C. Society. *About ACS Bridge Program*. Available: <https://www.acs.org/education/students/graduate/bridge-project/about-bridge-program.html>
- [15] G. S.-. UW-Madison. (November 2024). *Graduate Research Scholar Communities (GRS)*. Available: <https://grad.wisc.edu/funding/graduate-research-scholars/>
- [16] G. M. Walton and G. L. Cohen, "A Brief Social-Belonging Intervention Improves Academic and Health Outcomes of Minority Students," *Science*, vol. 331, pp. 1447-1451, Mar 18 2011.
- [17] T. P. f. E. R. T. S. (PERTS). (2024, May 16). *Social Belonging for College Students*. Available: <https://www.perts.net/programs/cb>
- [18] C. f. t. I. f. M. E. i. Research. (2024, June 2024). *CIMER Center for the Improvement fo Mentored Experiences in Research*. Available: <https://cimerproject.org/>
- [19] W. C. Crone, *Introduction to Engineering Research* 1ed. Springer Nature Switzerland AG 2020: Springer Cham, 2020.
- [20] P. Boynton, *Being Well in Academia Ways to Feel Stronger, Safer and More Connected* 1st ed. New York: Routledge 2021.
- [21] K. Litson, J. M. Blaney, and D. F. Feldon, "Understanding the transient nature of stem doctoral students' research self-efficacy across time: Considering the role of gender, race, and first-generation college status," *Frontiers in Psychology*, vol. 12, p. 617060, 2021.

Appendix A: Program Logistics

Eligible Departments: All faculty from the ten departments that are affiliated with MRSEC were able to nominate students who had been accepted to their programs, whether or not those students would be directly affiliated with a MRSEC lab. Eligible departments include Biomedical Engineering, Chemical and Biological Engineering, Chemistry, Civil and Environmental Engineering, Electrical and Computer Engineering, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering & Engineering Physics, Pharmacy, and Physics. Due to the funding source, all program participants are U.S. citizens or permanent residents.

Fixed Start Date: July 28, 2024

Flexible End Date: The program ended the day before each individual FF graduate program began. At this point, their appointment was transferred from Materials Science (the department that houses the MRSEC) to their graduate program department.

Appointment Type: Research Interns, a designation that secured their funding and health insurance but did require them to pay additional fees and did not impact their ability to apply for the NSF Graduate Research Fellowship since they were not officially enrolled as students at the university until their graduate program's official start date.

Stipend: Each FF was paid at the same rate as their graduate program department's rate. The committee worked with departmental administrators, payroll, and human resources professionals to determine the type of appointments the FF would have to ensure they receive both funding and health insurance with no gaps between the FF program and the start of their graduate programs.

Housing: One issue the planning committee anticipated, but was unable to address in the pilot year, was housing for the students who participated in the program. Typically, graduate students at our institution arrange for and fund their own housing and the year-long leases around campus start two weeks prior to the beginning of the school year. However, since the FF started 4 weeks before classes started finding housing proved to be a challenge. During the group feedback sessions, students provided some suggestions the committee will implement in 2025 including connecting students who want roommates to one another, connecting students to campus housing resources, and providing information about extended stay hotels and short-term rentals.

Faculty Mentoring: We received mixed feedback on faculty mentoring. In the group feedback sessions, we heard that the involvement and accessibility of their research mentors differed, sometimes by quite a lot. However, the subsequent survey feedback reflected no such disparity in mentoring. Communications from faculty mentors for most students has been (somewhat or extremely) clear. Mentoring takes place at mentoring meetings and at research meetings and, for most, comes as often as students would like it. The differences between group interview and survey responses could reflect the more private nature of survey responses; perhaps a few loud interview voices in the group painted a more wide-ranging picture of mentor behavior. It could

also reflect an adjustment on the students' part to becoming used to when they will receive faculty mentoring.

Group feedback session data suggested that the coordinators provide more information or training around mentoring for the faculty mentors. While this training is available in our college and faculty are strongly encouraged to participate, it is not a requirement for the mentors. Given the potential for unevenness in faculty mentoring, the committee is creating an expectations document for all faculty who mentor a student in the 2025 program. This document will give a more thorough outline of the program and its goals, including expectations for mentors and students than we provided to the mentors in the 2024 program.

Appendix B: Evaluation Instruments

Pre-program Input Survey Questions, March 2024

1. When thinking about graduate school, what do you wish you knew/ knew about/ were connected to from the beginning? E.g., how to use the library, how to find a good grocery store, how to find mentors.
2. What kinds of activities should we consider when developing this program, so that it promotes belonging and community?
3. Thinking about what graduate students experience when starting graduate school, what are the top 3 to 4 challenges they might run into? For each challenge, what are supports that would help them navigate these challenges?
4. What types of activities and skill building would you have benefitted from early in graduate school? What surprised you about graduate school?

Informal Group Feedback Session Questions, August 8, 2024

1. What's working?
2. Suggestions for making it 'better'?
3. How could program leaders make changes for this year and for future years?
4. What specific feedback do you have about the social belonging workshop?

Structured Group Feedback Session, August 22, 2024

I want to hear about your experiences with the FF program. The team is interested in learning about your experiences w FF, so they can make the program better serve incoming grad students.

1. What was valuable about starting research early? How has it supported your transition into graduate school?
2. What was valuable about the professional development lunches (e.g., mentoring up, campus resources, science communication, etc.)? How were these aspects valuable?
3. How have you, or do you, anticipate using what you took from the Forward Fellows experience?
 - a. e.g. Resources, information, relationships, strategies.
4. What parts of the FF program do you think could be improved? How would you do it?

Post-Intervention Survey Questions, October 2024

Your First Weeks in Graduate School

Q Please rate how useful the following aspects of the Forward Fellows (FF) program have been in supporting your transition into graduate school at UW-Madison, so far.

Starting research early
Professional development lunches

Community building events (reception, ice cream, coffee, etc.).

Choices: Not at all useful, Slightly useful, Moderately useful, Very useful, Extremely useful

Q Now that you have been in school for a few weeks, please rate how useful the following FF professional development sessions were for your transition to graduate school, so far.

Making the transition to grad. school better (with stories from current students),
First meeting with current graduate students
Introduction to campus resources (libraries, mental health resources, etc)
Mentoring Up Workshop
Second meeting with current graduate students
Imposter Phenomenon Workshop
Meeting with faculty
Reading Academic Literature Workshop
Financial Literacy Workshop
Science Communication Workshop

Choices: Not at all useful, Slightly useful, Moderately useful, Very useful, Extremely useful

Q Could you please share any specific suggestions you have for improving these professional development sessions?

Q Are there any topics you wished we had covered?

Q How likely are you to recommend the FF program to new students entering graduate programs next year?

Choices: Extremely unlikely, Somewhat unlikely, Neither likely nor unlikely, Somewhat likely, Extremely likely

Q Thinking about your graduate school experience so far, how often do you feel:

Welcome, Respected, Excluded, Safe, Like you belong

Choices: Never, Sometimes, About half the time, Most of the time, Always

Q How did participating in the FF program affect your current sense of belonging in graduate school?

Mentoring

Q How clearly has your PI/ Faculty Mentor communicated what they expect from you as a member of their lab?

Choices: Extremely unclear, Somewhat unclear, Neither clear nor unclear, Somewhat clear, Extremely clear

Q How often does your PI/ Faculty Mentor provide you with advice or mentoring? Check all that apply.

Choices: Never, Not as often as I'd like, At regularly scheduled meetings about multiple research priorities, At regularly scheduled meetings designated for research mentoring, Anytime I request it, Other _____

Impact

Q As your graduate school experience begins, how capable do you feel in the following areas?

Communicate about my science, e.g., presentations
Read academic literature
Connect with people who I can turn to for support
Network with professionals who support my career path

Choices: Extremely incapable, Somewhat incapable, Neither capable nor incapable, Somewhat capable, Extremely capable

Q In what ways has the FF program experience enabled you to feel more capable in graduate school? Name one or two parts of the program that have made a difference and describe how each has helped you.

Q In what ways, if any, do you continue to stay connected with the FF community? Check all that apply.

Choices: Meet up with several members of my FF cohort on campus, Meet up with several members of my FF cohort off campus, Social media contact with my cohort, Other _____.

Q What were your favorite parts of the program and why?

Q What other feedback do you have about how your August 2024 FF experience has made a difference in your transition into graduate school, so far? We are interested in suggestions about what program aspects made a difference and what to improve!

Demographics

Q What gender do you identify yourself with now? Choices: Man, woman, other _____, prefer not to say

Q Do you identify yourself as a lesbian, gay, queer or questioning, transgender or transsexual (LGBTQ+) person? Choices: Yes, No, Prefer not to say

Q Do you identify yourself as a person with disability? Choices: Yes, No, Prefer not to say

END Thank you for your feedback! Please click the right button below to submit your resp