Assessment and Support of Advisor-Student Mentoring for Graduate Engineering Students at a Land-Grant Institution

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Emily Garcia is an Industrial Engineering PhD student at Purdue University where she served as a Graduate Mentoring Fellow under the Mentoring Fellows Program, a 5-year initiative by the Graduate School to improve mentoring at Purdue. As a Graduate Mentoring Fellow, Emily represented graduate students in the College of Engineering and worked with others to improve mentoring relationships between engineering faculty and graduate students.

Emily earned her bachelor's degree from the University of California, Berkeley in 2020 in Industrial Engineering and Operations Research. She now focuses on optimizing decision-making support systems for long-term care through her research.

Emily has also been an advocate for minorities in STEM at Purdue as the founder and graduate advisor of the Society of Hispanic Professional Engineers (SHPE) graduate chapter on campus, graduate student recruiter for the Industrial Engineering department, and as a panelist for the Early Discovery Mini-Conference and Minority for Engineering Program. She also continues to be active in service for the Purdue community as the incoming graduate advisor for Tau Beta Pi Indiana Alpha chapter.

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Stephen McBride is the Assistant Director of Graduate Student Success for the College of Engineering. With a strong background in leadership development and career preparation, he received many of the highest honors in the National 4-H and National FFA Organizations. During his year of service as the National FFA Southern Region Vice President, Stephen was trained as a professional facilitator and keynote speaker while representing the National FFA Organization on his visits to more than 30 states and Japan. He is passionate about student development and connecting students with the resources and training they need to achieve their career and professional goals.

Joseph Vincent Rispoli, Purdue University

Joseph V. Rispoli graduated from Punahou School in Honolulu, Hawaii, in 1998, earned the BS degree in Electrical Engineering, BS degree in Computer Engineering, and Minor in Chinese History from the University of Virginia in 2002, and earned the PhD degree in Biomedical Engineering from Texas A&M University in 2015. During the nine-year interim between degrees, he was a development engineer with Dell in Austin, Texas, where he worked on high-speed digital design and virtualization technology for multiprocessor servers. He joined Purdue in 2015 as an Assistant Professor, and he was promoted to Associate Professor with tenure in 2022.

Dr. Rispoli's research focuses on novel hardware and methodology for magnetic resonance imaging (MRI). He is particularly interested in anatomically-tailored radiofrequency coil design for high-field studies, methodology for parallel-transmit MRI, in vivo spectroscopy of multiple NMR-active nuclei, and electromagnetic modeling for patient safety and design evaluation.

Dr. Rispoli taught the core biomedical engineering undergraduate course BME 305 Bioinstrumentation Circuit and Measurement Principles. He also developed and teaches the graduate-level course BME 555 / ECE 595 Magnetic Resonance Imaging Theory.

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Abstract

The faculty advisor-student mentee relationship is often the most influential aspect of the student's experience during their graduate education. In an effort to optimize graduate student mentorship experiences, Purdue University launched the Mentoring Improvement Initiative (MII). This three-year program aims to research mentorship and implement positive changes across various levels within the university. The MII included the inception of the Mentoring Fellows Program (MFP), a student-led and faculty-advised initiative aimed to research current relationships and design improvements at the college level.

The College of Engineering Mentoring Fellows began by evaluating existing data collected through surveys from the Graduate Student Experience in the Research University (gradSERU) online service. The fellows recognized several gaps in Purdue's graduate mentoring experience that needed to be addressed: an engineering-specific individual development plan (IDP), surveys of faculty members, and educating students about taboo mentorship topics.

An IDP was created for PhD or master's students in the College of Engineering. The document is intended to guide students through four steps: a skillset self-assessment, goals for Year 1 of graduate school, a meeting between student and advisor, and progress updates after the first year. The IDP was published on the university website and distributed among the engineering departments in August 2022 and has since received 1,292 views. In September, a workshop was held to teach students and faculty members how to utilize the document most effectively.

The anonymous faculty survey was designed to evaluate five areas of mentoring graduate students: (a) faculty's prioritization of time, (b) considerations when mentoring, (c) expectations set by the College of Engineering, (d) interests in using an IDP, and (e) interests in incentives for effective mentorship. A brief series of demographic questions, including years of mentoring experience and tenure status, concluded the survey. Out of the 103 engineering faculty that completed the online survey, 36% currently use an IDP and an additional 39% would be interested in using one if a template were provided to them. Of the faculty that had an opinion on the level of consideration given to graduate student mentoring for tenure, 47% stated that it should be a more important consideration.

A four-part seminar series was held over the Fall 2022 semester to inform students about mentorship resources on campus and address complex topics. The series included: (1) IDP creation, implementation, and other vital resources for graduate student success; (2) guest speaker on the topic of Navigating Toxic Mentoring Environments; (3) discussion on effective

mentorship with a panel of Purdue mentoring awardees; and (4) panel discussion on the importance of diversity, equity, and inclusion considerations in mentorship. Follow-up surveys after each seminar showed that 91% of attendees gained new perspectives about mentorship.

This first year of the Engineering MFP focused on providing practical resources for students and surveying faculty members to evaluate their mentorship perspectives. The upcoming year will focus on the opposite; a survey will be created to evaluate the advisor-student relationship from the mentee's point of view, and practical resources for faculty will be implemented.

Introduction

Recognizing the importance of students engaging in healthy, stable mentoring relationships during graduate school, Purdue launched the Mentoring Improvement Initiative in January 2022. This initiative aims to pursue evidence-based and culturally responsive research and training for faculty, students, and staff at the university over the course of three calendar years. Included in this initiative was the launch of the Mentoring Fellows Program, a student-led and faculty-advised group tasked with researching and improving mentorship at the college level. During the first year of the Mentoring Improvement Initiative, the fellows were tasked with focusing on the relationship between a graduate student and their committee head or primary advisor.

The College of Engineering Mentoring Fellows, composed of three graduate students, two faculty, and one staff member, prioritized analyzing existing data collected by the graduate Student Experience in the Research University (gradSERU) online service. The fellows recognized that while most students stated they were content with the relationship they had with their primary advisor, many students did not know about existing resources on campus. In addition, no data had been collected about faculty perspectives on mentoring their graduate students. As a result, the fellows identified three projects to tackle during the 2022 calendar year: creating an engineering-specific individual development plan, surveying faculty members about mentorship, and educating students about healthy and toxic mentorship.

Literature Review

The most influential factor on a graduate student's doctoral experience is their primary research advisor [1] – [4], yet most institutions lack formal guidelines for the structure of this relationship. Identifying a mentor should be a major priority for graduate students early in their education [5], but students are typically unaware that advisor and mentor are often not synonymous despite the overlap in responsibilities. An advisor is an integral part of the doctoral student's academic experience and career path as advisors will write recommendation letters, provide a network, assist in publishing, provide funding, and can increase long-term job satisfaction [3], [6]. But in

addition to these responsibilities, doctoral students require customized mentorship from their advisors based on individual characteristics and progress toward their degree [7].

A high-quality, effective mentor will provide both career-related and psychosocial support, offering guidance and resources for the mentee's professional development, self-efficacy, self-worth, and professional identity [8]. One study found that authentic mentorship from an advisor includes presence (both physically/virtually and psychosocially), approachability, sympathy, confidence while maintaining humility, contribution to professional growth, and a positive attitude [7]. Yet the success of a graduate student is rarely defined by their growth as a mentee, but instead by the rate of degree completion and job prospects upon graduation. While effective mentorship does lead to enhanced career development and job opportunities [9] – [11], a positive faculty mentor promotes graduate students' motivation for research [12] – [14], publications [13], [15], [16], and sense of fulfillment from their graduate program [16].

The effects of negative mentorship from an advisor can be detrimental to the student's doctoral degree. Attrition rates for PhD completion are at approximately 50% [17] – [19]. A study from 2021 conducted an in-depth analysis of negative mentorship experiences from PhD advisors and found the most common issues to be: social undermining, limited career support, limited psychosocial support, inaccessibility, limited interpersonal abilities, and mismatched supervisory styles [20]. To decrease attrition and improve the doctoral education experience, a change needs to be made at lab group, department, college, and university levels on how advisors are not just encouraged but expected to mentor their graduate students.

For the purposes of this paper, the term "advisor" refers to the committee head of a graduate student. A "mentor" may or may not be synonymous with an advisor considering that the two roles are not required to overlap.

Individual Development Plan

An individual development plan (IDP) is a structured document that allows students to optimize the success of their graduate education by planning and organizing their academic and career goals. While two of the schools within Purdue's College of Engineering (COE) had already implemented their own IDP, the remaining twelve did not provide this type of guidance for their graduate students. Students are more likely to achieve their goals by writing them down in a detailed, organized manner, and this format is provided by the IDP [21]. The fellows recognized that a detailed, organized document was needed to promote student success. An IDP specific to the COE was designed in Spring 2022 and reviewed by COE faculty. Two IDPs were published on the university website and distributed to students in August 2022, version 1 being for new students and version 2 for those who have already completed their first year of graduate school.

Document Structure

The IDP was designed specifically for students pursuing an engineering PhD while keeping in mind that every student has a different graduate experience. Guidelines were written to be explicitly that: simply a guided recommendation with no expectation that every student will adhere to the timelines or checkpoints listed. The first page outlines the purpose of the document and recommendations for how to best utilize it as a resource.

The next two pages include a generalized timeline for engineering PhD students for years 1, 2-3, and 4+, all within the categories of learning and research, communication, and career development. These timelines were finalized after many iterations as well as feedback from each engineering department. Students are encouraged to view these as potential goals to keep in mind as they consider career paths and the skillsets they will require.

Step 1 of the IDP is to complete a self-assessment of various skillsets, including communication, leadership and classroom management, diversity and inclusion values, research and scientific skills, and personal and career development. Again, students are reminded that someone pursuing an industry position will have no need for the ability to design a syllabus, but teaching a workshop may be valuable at some point in their career. Keeping an open mind and making the IDP individualized for one's career goals is highly encouraged.

The second step prompts students to write their IDP for their first year of graduate school. Ideally, this document is completed during one's first semester, but students filling out the IDP for the first time later in their studies can use version 2. This step requires students to identify a skill they want to improve, define its importance, and then write specific opportunities or goals concerning the improvement of that skill. An example page is included to display how to fill the document if one focuses on the research and scientific skills of statistical analysis, creativity and innovation, ethical research, and technical skills (Figure 1).

Research and Scientific Skills

Skill	***Importance***	***Opportunities/Goals***
Statistical Analysis	Data should be analyzed to determine if it is statistically consistent and can be reported. Statistical analysis of data should be reported in journal publications.	Take STAT 511 next semester and earn an A so I am prepared to do statistical analyses when the time comes.
		Take STAT 512 within the next three semesters
Creativity and Innovation	Creative problem solving is vital in engineering. Improving creativity and innovative approach to research will be beneficial for improving knowledge in my field of study.	Read at least 2-5 journal articles per week to learn how other researchers have approached solving problems
		Talk with my advisor about working toward the Purdue Entrepreneurship and Innovation Certificate
Ethical Research	If research is not conducted ethically, it is worthless. Everything from safety protocols to consideration of affected individuals must be evaluated.	Email advisor or lab manager about safety training
		Attend the Engineering Ethics Seminar being offered next month. Take notes and revisit them twice per year.
Technical Skills	In order to collect data, I need to understand how to operate relevant software and instruments. I also need to improve my ability to conduct literature reviews efficiently.	Ask my advisor/lab group what instruments, procedures, or software I need to learn in order to be successful. Schedule relevant trainings.
		When reading literature, take note of the Methods section to learn about relevant resources in my field.

Figure 1: An example of how to write an IDP for research and scientific skills, taken from the Purdue University College of Engineering Individual Development Plan

The third step is for the student to meet with their PhD advisor to discuss the IDP and identify guidelines for their relationship. Brief paragraphs are included for what makes a good research mentor and mentee to remind each party about honesty, communication, and mutual respect (Figure 2). During this meeting, the student and advisor should answer each of the seven sets of questions to set expectations for their relationship. These questions were designed to prevent miscommunication that may lead to misunderstandings, missed deadlines, or unclear expectations. The questions ask:

1. What courses are department requirements? What elective courses are relevant to your research?
2. What is the expectation for balancing coursework and research responsibilities? Note: this may change over time. Revisit as needed.
3. How often will you meet one-on-one? As a lab group? With your funders (if applicable)? Other?
4. How should the student report progress or data to the advisor? Written reports, raw data, calculations and plots, PowerPoint summary, verbal conversations, etc.
5. Is there any safety or other training required prior to conducting research? If so, how often?
6. Who should the student consult first if there is a research question? Is there a more senior graduate student in the group, postdoc, or lab manager? Or should they go straight to the mentor?
7. What are mentor expectations for publishing and conference presentations?

What makes a good research mentor?

A mentor is a guide for your academic discipline, an expert in your area of research, a networking resource, and an example/role model for research, teaching, and professional development. While your research advisor should be your primary mentor, it is important to have other mentors to assist in your growth, development, and support. Research mentors should know their advisees and tailor their mentoring style to each student, recognizing the differences in their needs. Mentors should know their students' short-term and career goals and provide resources and advice as to how to achieve these objectives. Advisors are not responsible for the mental health of their students but are encouraged to be as sensitive and understanding as possible when it comes to this issue, directing students toward appropriate campus resources and offering adjustments to workload when necessary and feasible.

What makes a good research mentee?

Mentees should be respectful of the advisor's time while also advocating for oneself and ensuring they have the resources necessary to be successful. Ask questions and ask for help when needed to avoid unnecessary mistakes or delays in progress. Work hard to achieve objectives and goals but take time to relax when needed. Work-life balance is vital to avoiding burnout and making progress on graduate research; mentees should keep in mind that different career path goals (e.g., academia vs. industry) may have different implications on work/life balance flexibility during their graduate studies. Keep in close communication with your advisor to keep them updated on progress, results, and plans. An advisor cannot help you if they do not know there is an issue. Be open, honest, and ask questions to work together toward your goals.

Figure 2: Guidance for students and advisors on how to be a good research mentor and mentee, taken from the Purdue University College of Engineering Individual Development Plan

The fourth step is to revisit the document once or twice per year to update it with progress and accomplishments. Finally, the last page has space for notes from the advisor/student meeting, as well as the option for both parties to sign and date the document. The IDP explicitly states that this is optional and may be skipped.

Faculty Surveys

To learn about Purdue University COE faculty members' attitudes and approaches towards mentoring, a Qualtrics survey was designed centering on faculty priorities, needs, and motivations. The IRB approval process was completed in August 2022 (IRB-2022-646), and the survey was distributed via email with help from the Graduate Engineering team, including periodic reminders until the survey closed.

To incentivize participation, faculty members who completed the survey could choose to be entered in a drawing for one of three $600 travel grants. These travel grants were created using $1800 of the Mentoring Fellowship funding provided by Purdue Graduate School and were distributed to three randomly selected participating professors. The mentoring survey was designed to allow the faculty members to remain anonymous and did not ask participants to disclose their engineering school.

A total of 111 responses were submitted though not all 111 faculty answered every single question. The findings of the survey are summarized below.

Demographics

At the beginning of the survey, faculty members were asked the following two questions:

- Are you a tenured faculty member?
- Approximately how many years have you been advising grad students?

Table 1 shows the breakdown of the 111 responses divided into 5-year increments. As Purdue determines faculty tenure status after seven years, it was not surprising to see that 20 of the 27 faculty members who did not have tenure had less than eight years of experience. The survey did not distinguish between tenure-track and non-tenure-track faculty. There was a good distribution of experience levels meaning results were more likely to give answers representative of the faculty as a whole.

Table 1. Breakdown of mentoring experience and tenure status of 111 survey respondents

Mentoring Experience	***With Tenure (n = 84)***	***Without Tenure (n = 27)***	***Total (n = 111)***	***% of Total***
1-5 Years	3	14	17	15.3%
6-10 Years	13	9	22	19.8%
11-15 Years	13	1	14	12.6%
16-20 Years	16	0	16	14.4%
21-25 Years	13	0	13	11.7%
25-30 Years	15	1	16	14.4%
31-35 Years	6	1	7	6.3%
36-40 Years	3	0	3	2.7%
41-45 Years	2	1	3	2.7%

The end of the survey included four optional questions, two of which had multiple-choice style answers and two of which had free-form text answers that were then parsed into appropriate groups:

- Did you earn your graduate degree(s) in the US?
    - Yes
    - No, but there was a similar academic culture (e.g., Canada)
    - No, and there was a noticeably different academic
- Is English your first language?

    - Yes
    - No
- What is your gender identity?
- What is your race/ethnicity?

Table 2 shows the responses to questions about educational background and language broken down by race/ethnicity.

Table 2. Breakdown of race and ethnicity as well as educational culture and first language of the 111 survey respondents

Race/Ethnicity, Culture, and Language	***Culturally similar school & ESL[1]***		***Culturally different school & ESL***		***Culturally similar school, not ESL***		***Chose not to respond***	
	(n = 21)	***% total***	***(n=3)***	***% total***	***(n=76)***	***% total***	***(n=11)***	***% total***
Asian/Asian-American	5	4.5%	-	-	7	6.3%	-	-
Black / African-American	-	-	-	-	1	0.9%	-	-
Hispanic/White-Hispanic	5	4.5%	1	0.9%	-	-	-	-
Multi-racial	-	-	-	-	1	0.9%	-	-
White/Caucasian	1	0.9%	-	-	41	36.9%	1	0.9%
Chose not to respond	10	9.0%	2	1.8%	26	23.4%	10	9.0%
[1]*ESL – English as a Second Language*								

Approximately 44% of respondents chose not to disclose either their race/ethnicity, background, language, or race. What should be noted here is that less than 3% of faculty members indicated they had experienced a different graduate school culture. This small fraction emphasizes the importance of cultural awareness and diversity training for faculty members, with a particular focus on interacting with students from a variety of educational backgrounds.

Table 3. Breakdown of race and ethnicity by gender identity of the 111 survey respondents

Race/Ethnicity and Gender	***Male***		***Female***		***Chose not to respond***	
	(n=41)	***% total***	***(n=21)***	***% total***	***(n = 49)***	***% total***
Asian/Asian-American	9	8.1%	3	2.7%	-	
Black / African-American	1	0.9%	-		-	
Hispanic/White-Hispanic	3	2.7%	2	1.8%	1 (0.9%)	
Multi-racial	-	-	1	0.9%	-	
White/Caucasian	27	24.3%	14	12.6%		
Chose not to respond	1	0.9%	1	0.9%	48	43.2%

Table 3 shows the responses to questions about gender identity broken down by race/ethnicity.

Approximately 46% of respondents chose not to disclose either their gender identity, their race, or both. 37% of respondents identified as male, while 18% identified as female. While the ratio of women to men is higher than expected, it is difficult to draw conclusions about participation, with so many respondents choosing not to disclose. While the survey allowed faculty to enter whatever text they desired, no responses indicated gender identities other than male or female.

Time Prioritization

One set of survey questions addressed time and priorities:

- How do you prioritize your time and work? Click and drag to reorder from highest to lowest priority.
    - Classes & office hours
    - Time spent advising and mentoring graduate students
    - Service to school and college
    - Your own research (e.g., managing research grants).
- Do you wish you could prioritize your time differently?
- If yes, how would you ideally prioritize your time? Click and drag to reorder from highest to lowest priority.
    - Classes & office hours
    - Time spent advising and mentoring graduate students
    - Service to school and college
    - Your own research (e.g., managing research grants).
- If yes, what is preventing you from prioritizing your time the way you would prefer?

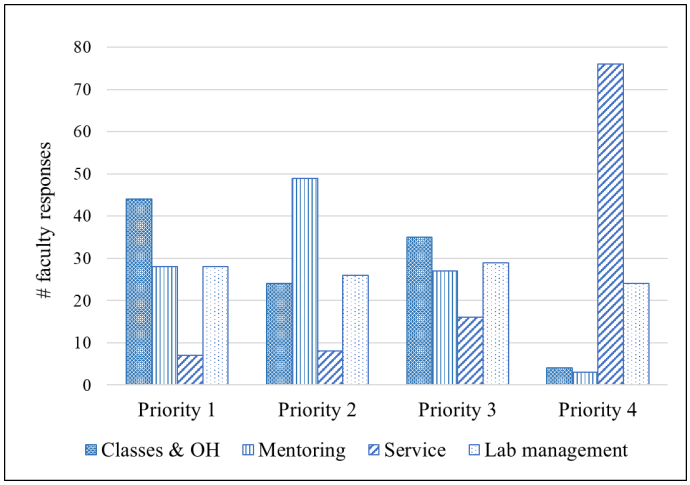

Figure 3. Prioritization of time at work by faculty members

Figure 3 shows how faculty ranked their priorities at work. A close examination of the responses resulted in the following observations:

(1) Of the total 107 faculty responses:
- 28 (26.1%) listed mentoring as their top priority
- 49 (45.7%) listed mentoring as their second priority
- 38 (35.5%) expressed they would ideally prioritize their time differently
- 20 (18.9%) would ideally prioritize mentoring more highly
- 7 (6.6%) would ideally prioritize mentoring less highly
- 85 (80.2%) ranked, or would like to rank, mentoring as one of their top two priorities.

(2) Comparing tenured faculty (82 responses) to non-tenured faculty (25 responses)
- 19 (23%) tenured faculty rank mentoring as their top priority
- 9 (36%) non-tenured faculty rank mentoring as their top priority
- As most non-tenured professors responding to this survey had fewer than 10 years of experience mentoring graduate students, is there may be a correlation between years of experience and prioritization of mentoring, but interrogating the data showed no conclusive trends.

(3) Of the 38 (35.5%) of faculty who expressed a desire to prioritize their time differently
- As most non-tenured professors responding to this survey had fewer than 10 years of experience mentoring graduate students, is there may be a correlation between years of experience and prioritization of mentoring, but interrogating the data showed no conclusive trends.

The 80% of faculty who expressed that mentoring their graduate students was one of their top two priorities (either ideally or actually) show a generally good attitude towards mentoring exists amongst faculty, though room for improvement exists. Only two faculty members listed graduate student mentoring as their lowest priority without also indicating they would like to prioritize mentoring more highly.

Perhaps not surprisingly, the priorities of faculty members satisfied with their priorities closely aligned with what dissatisfied faculty members listed as their ideal priorities. Faculty preferred a greater emphasis on mentoring and managing their labs, and lower emphasis on classes and service. Within the subset of faculty who indicated they were unable to prioritize mentoring but would like to prioritize it more highly, the faculty overwhelmingly referenced the number of courses they were required to prepare and teach, as well as the class sizes were their largest obstacles. Administrative duties, lack of support staff, and service commitments were also mentioned.

COE Expectations

One set of questions focused on the mentoring expectations of Purdue College of Engineering and solicited feedback.

- Do you feel the COE and your school have set clear expectations on how to advise grad students?
- If yes, what has the COE and/or your school done well in terms of communicating expectations?
- If no, what could the COE and/or your school do better in terms of communicating expectations?

Analysis of the results showed:

(1) Of the 103 total responses
    - 38 (36.9%) said that the COE and/or their college provided clear expectations

(2) Effect of faculty years of experience
    - 38 (36.9%) said that the COE and/or their college provided clear expectations
    - 12 (58%) of faculty with greater than 30 years of experience felt that expectations were clear
    - 38 (35%) of faculty with 30 or fewer years of experience felt that expectations were clear

Faculty cited their school's implementation of IDPs as well as mentoring workshops at the college and university level as being great resources. Faculty often cited their specific schools as having good initiatives and best practices for encouraging and guiding mentoring initiatives. Positive comments often included mention of clear communication (often specifically from the Head of their school) and receiving clear feedback on a regular basis. Negative comments mentioned a lack of clear and regular feedback.

It was clear that not all faculty were aware of resources that already existed, as some comments expressed a desire for mentoring workshops and a mentoring reference guide, while other faculty expressed their appreciation for the ongoing mentoring workshops and mentoring reference guide provided by the COE or the Purdue Graduate School at large.

Faculty expressed concerns that some training and guidance on mentoring did not consider the reality of the time limitations and large number of expectations placed on the faculty. Time-intensive best practices left faculty feeling frustrated, and they expressed a desire for mentoring resources to acknowledge and address how to work within the confines of the available time.

IDP Use and Interest

With the development and introduction of the IDP to COE students, a survey question was included to determine how familiar with IDPs the faculty members were, and whether they were open-minded about their use. The survey question was:

- An individual development plan (IDP) is a tool to assist students in career and personal development during their time in their graduate degree program. Its primary purpose is to help students identify and reach short- and long-term career goals, as well as improve current performance as researchers and students. An IDP is not a performance evaluation tool or a one-time activity.

  Have you ever used an Individual Development Plan (or something similar) with your students?
  - Yes, I do this regularly
  - Yes, but I stopped because I didn't think it was beneficial
  - No, but I would be interested if a template was available
  - No, and I do not think it would be beneficial

Analysis of the results showed:

(1) Of the 100 total responses
- 37 (37%) use an IDP regularly
- 40 (40%) would be interested in an IDP
- 9 (9%) have used an IDP in the past and would not use one again
- 14 (14%) haven't tried an IDP and are not interested in using one

(2) Effect of faculty years of experience
- 6 (54.5%) faculty with >30 years of mentoring experience had no interest in using IDPs
  - 0 of 6 of these faculty have used an IDP before
- 9 (23.1%) faculty with 16 to 30 years of mentoring experience had no interest in IDPs
  - 4 of 9 of these faculty have used an IDP before but didn't like it
- 8 (16%) faculty with ≤ 15 fewer years of mentoring experience had no interest in IDPs
  - 5 of 8 of these faculty have used an IDP before but didn't like it

Overall, the faculty showed receptiveness to the idea of using an IDP with their students, with 37% of respondents already using IDPs regularly. The additional 40% of faculty who expressed

interest in using an IDP if a template was provided highlights the importance of the IDP development and distribution that was described earlier in this paper.

There is, however, a stark difference in attitude of the faculty members and their receptiveness to an IDP when comparing faculty of different experience levels. Faculty become less receptive to the idea of an IDP as time goes on, and the likelihood of them having tried using an IDP also decreases. These trends can be seen in Figure 4.

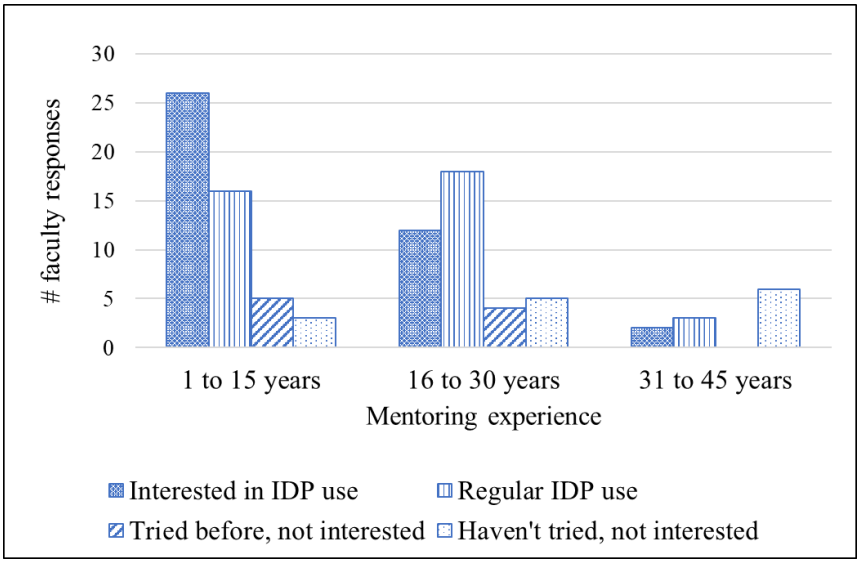

Figure 4. IDP use and receptiveness amongst faculty

Consideration of Mentorship for Tenure Candidates

One survey question asked the following:

- With respect to tenure applications, how do you feel about the current level of consideration given to a professor's commitment to grad student mentoring?
  - It should be a less important consideration
  - It is appropriate
  - It should be a more important consideration
  - Unsure

Analysis of the results showed:

(1) Of the 103 responses

- 3 (2.9%) felt it should be a less important consideration
- 44 (42.7%) felt it was appropriate
- 41 (39.8%) felt it should be a more important consideration
- 15 (14.6%) were unsure

(2) Effect of faculty years of experience

- 9 (75.0%) faculty with >30 years of mentoring experience said it was appropriate
  - 3 (25.0%) said it should be more important
  - 0 (0.0%) felt it should be less important or were unsure
- 22 (55.0%) faculty with 16 to 30 years of mentoring experience said it was appropriate
  - 15 (37.5%) said it should be more important
  - 2 (5.0%) felt it should be less important
  - 1 (2.5%) was unsure
- 13 (25%) faculty with ≤ 15 fewer years of mentoring experience said it was appropriate
  - 23 (45.1%) said it should be more important
  - 1 (2.0%) felt it should be less important
  - 14 (27.4%) were unsure

The overall survey responses indicate that a plurality of faculty feel that mentorship is considered appropriately for tenure applications, but a nearly equal number of faculty feel that mentorship should be a more important consideration. The desire to increase the amount of consideration given to graduate student mentoring decreases as the years of experience of the survey respondent increases.

Incentives

One set of questions focused on how the COE could incentivize faculty members. Figure 5 shows how the faculty members ranked these incentives.

- If the College of Engineering were to incentive good advisor-grad student mentorship, which of the following forms of recognition would appeal to you? Click and drag to reorder from most appealing to least appealing.
  - Personal financial award
  - Recognition or publicity
  - Discretionary funding for you to use
  - Discretionary funding earmarked for your students to use for research, publications, conferences, etc.

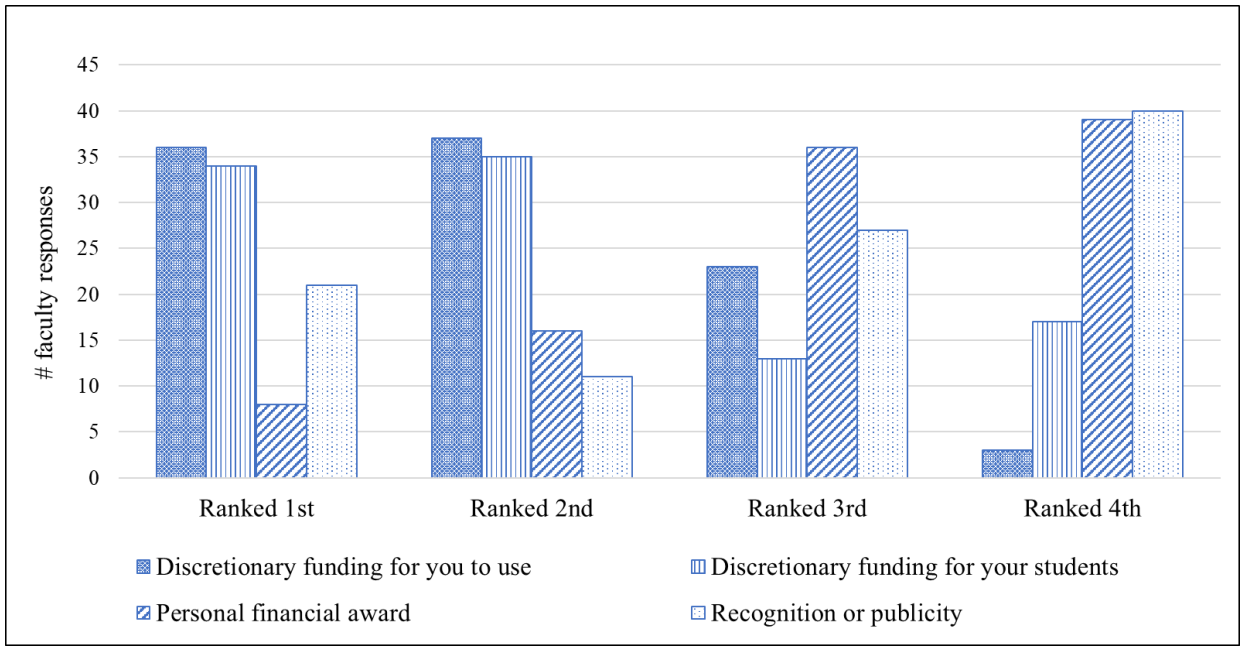

Figure 5. Ranking the attractiveness of incentives for good mentorship

Analysis of the results showed:

(1) Of the 100 total responses
- 70 (70%) ranked discretionary funding (either for the faculty member or earmarked for students) as the most attractive incentive.
- 21 (21%) ranked recognition or publicity as their preferred incentive.
- 8 (8%) of faculty members chose a personal financial incentive as their first choice

(2) Effect of faculty years of experience
- Regardless of years of experience, ~20% of faculty members ranked recognition or publicity as the most attractive incentive
- Personal financial awards were more attractive to more experienced faculty
  - 2 (4.0%) faculty with 15 or fewer years ranked it as the preferred incentive
  - 4 (10.5%) faculty with 16-30 years of experience ranked it as the preferred incentive
  - 2 (18.2%) faculty with greater than 30 years of experience ranked it as the preferred incentive
- Discretionary funding (either for the faculty member or earmarked for students) was ranked as the preferred incentive by more than 65% of respondents regardless of years of experience

Discretionary funding was clearly the preferred incentive, though the tendency to choose "discretionary funding earmarked for students" over "discretionary funding for you to use"

increased over time. It's possible that the more experienced faculty members are well-established in their careers and are less concerned about funding and publicity for their work, which may also explain why the personal financial incentive because more a more popular incentive amongst experienced faculty members.

Additional Observations

When comparing responses across various survey questions, it became clear there existed a small fraction of faculty members whose survey answers indicated they were less interested in mentoring their graduate students than most of their peers. There were eight faculty members who ranked a personal financial award as their preferred incentive. Analyzing the survey responses of just those eight faculty members, the following observations were made:

- All ranked discretionary funding earmarked for students as their 3rd or 4th (i.e., least preferred) choice.
- All ranked funding for themselves higher than funding earmarked for students.
- The group included the only two faculty members who had ranked graduate student mentoring as their lowest priority (see section XX) and expressed no interest in changing that.
- Four of eight were uninterested in using an IDP
- None of the eight faculty members thought that mentoring should be more important for tenure applicants (seven said it was considered at an appropriate level, while one was unsure).

In looking at the available demographic information for these eight faculty members:

- Mentoring experience ranged from 2 to 40 years, with a median of 16 years
- Six of the eight were tenured faculty
- Five of the eight identified as male, the remainder chose not to specify
- Three of the eight identified as White, one as Asian, and the remainder chose not to specify

While these observations point towards a subset of faculty who do not consider mentoring a priority, it should be noted that they were at least interested enough in mentoring or incentivized sufficiently by the travel grants earmarked for students to have bothered completing this voluntary mentoring survey.

Mentorship Seminar Series

To enable successful mentor-mentee relationships between graduate students and faculty members, it is important to first understand how to start, build, and maintain one as well as recognize what factors can contribute to failed mentoring. However, graduate students, especially minority graduate students, often lack this knowledge, significantly impacting their research productivity, academic and research self-efficacy from experiencing unsatisfying mentoring without the ability to advocate for unmet needs from their mentoring relationships or resources to initiate relationship improvements. On the other hand, faculty members may lack the tools to assess their mentoring effectiveness over their graduate students or resources to improve their roles as graduate student mentors. To address these situations, the College of Engineering Mentoring Fellows decided to develop and implement a four-part Mentorship Seminar Series over the Fall 2022 semester with the objectives of (1) educating graduate students and faculty members in the College of Engineering about how to build and maintain effective mentoring relationships, and (2) generating awareness of resources and tools, like the IDP, that can help improve existing mentoring relationships or be used throughout a mentorship experience.

Development

The first decision was to set the topics for the Mentorship Seminar Series. The College of Engineering Mentoring Fellows reflected on the gradSERU data findings, unmet needs post-developing the IDP, and personal mentorship experiences during the brainstorming phase, with the final topics being elected on a majority-vote basis. Topics elected to be pursued through the Mentorship Seminar Series included: (1) creation, implementation, and other vital resources for graduate student success under the title “Creating Individual Development Plans,” (2) “Navigating Toxic Environments, (3) “Building Healthy Mentorship Relationships, and (4) “Mentoring, Managing and Diversifying Graduate Student Research Groups. With the first mentorship seminar, the goal was to introduce the College of Engineering Mentoring Fellows, the purpose behind the Mentorship Seminar Series, explain how important the state of graduate student-faculty member relationships can be, give a break-down of mentor and mentee roles and responsibilities, introduce the IDP as a tool for mentorship and teach graduate students how create their own IDP. The second seminar aimed to initiate the discussion about poor mentorship relationships, what it might look like, for example in a laboratory space, what factors can contribute to inefficient mentoring, and educate attendees on how to improve their reactions towards any mentoring problem that may arise to avoid creating further conflicts. The third seminar topic was placed to follow-up on the second seminar’s topic and provided a spectrum of how to build and maintain good mentoring either as a mentor or mentee. The last seminar aimed to amplify the importance of diversity and inclusion in mentorship.

In terms of structure, it was elected that the Mentorship Seminar Series would be held from mid-September through early November 2022 with 1-1.5-hour long seminars. This structure accommodated for new graduate student transitions into graduate school, major engineering-related conferences, academic vacation breaks, holidays, final exam periods, availability of the College of Engineering Mentoring Fellows, room space availability, and the availability of either guest speakers or panelists were included. To further accommodate seminar attendees, the seminars were held in a hybrid mode, meaning in-person and online via Zoom. Seminars were also recorded and uploaded to Purdue's Engineering Graduate Program YouTube channel to increase the availability of each seminar's content for graduate students or faculty members interested in the seminar series but unable to attend live. Given the goals of the first seminar, it was only run by the College of Engineering Mentoring Fellows. With the second seminar, the Associate Vice Dean for Diversity, Equity, and Inclusion from the University of Pennsylvania, was invited to serve as a guest speaker due to her background in graduate student advocacy, coaching, counseling, and experience in giving similar workshops beforehand on navigating toxic environments. For the third seminar, a panel-style structure was selected to consist of faculty members and graduate students who have previously earned a Purdue College of Engineering Outstanding Mentoring Award and a moderator. This criterion was placed to have seminar attendees learn from panelists that have been recognized for their successful contributions to mentorship and mentoring relationships as well as enable an easier in-person attendance of the panelists themselves. Similarly, the last seminar also had a panel style structure, but because it was co-coordinated with Purdue's College of Engineering Faculty Professional Development Workshop organizers, the panel was structure to consist of three faculty members, one graduate student who serves as the current Purdue National Society of Black Engineers (NSBE) Graduate Chair and a moderator. For the last two seminars, one of the College of Engineering Mentoring Fellows graduate students served as the moderator, and the set of questions for each panelist was developed prior to the seminars and distributed to panelists beforehand for preparation.

Communication about the Mentorship Seminar Series was enabled via the creation of flyers, one for the entire series and individual flyers for each seminar. Flyers were distributed to College of Engineering graduate student and faculty member email listservs, graduate advisors within each engineering department, and student-led organizations.

For evaluation purposes, graduate students attending a seminar were asked to fill out a single anonymous feedback survey regarding the seminar's topic and content presented, and they were compensated by being entered into a gift card raffle. The seminar series feedback survey asked graduate students questions about their level of satisfaction with their current graduate student-faculty member mentorship, topics discussed within their mentorship-related meetings, things they wished could be improved in their existing mentoring relationships, number of mentors, engineering field, graduate program track, lessons on mentorship gained from the seminar, and

their ratings on a 5-Likert Scale on the seminar's usefulness and satisfaction with the seminar. It was decided that graduate students would be able to fill out the survey anonymously to allow responders to feel comfortable in voicing any negative mentorship experiences without the fear of being traced or called out. Only one survey was developed as opposed to individual surveys for each seminar.

Major Findings

Here, results and observations obtained from the seminar series feedback survey are presented for the seminar series in general, given that graduate students could anonymously fill out the survey and the same feedback survey was used after each seminar. In total, there were 66 responses collected from the four-part seminar series, of which 55 survey participants identified to be enrolled in either a Master's or PhD program. Table 1 further describes the demographics of survey participants. Note that the sample sizes within each demographic feature and throughout our analysis vary due to either incomplete survey responses or omitted question responses on behalf of the survey participants.

Table 4: Demographics of seminar student attendees that participated in the seminar series feedback survey

Seminar Series Feedback Survey Student Participant Demographics

Graduate Program	**(n = 57)**	*%*
PhD	35	*61.4%*
Masters	20	*35.1%*
Post Doctorate	2	*3.5%*
Graduate Program Year	**(n = 56)**	*%*
1st Year	31	*55.4%*
2nd Year	10	*17.9%*
3rd Year	3	*5.4%*
4th Year	7	*12.5%*
5th Year+	5	*8.9%*
College Type	**(n = 57)**	*%*
College of Engineering	56	*98.2%*
College of Science	1	*1.8%*
Engineering Field	**(n = 58)**	*%*
Aeronautics and Astronautics Engineering	5	*8.6%*
Agricultural and Biological Engineering	2	*3.4%*
Biomedical Engineering	4	*6.9%*
Chemical Engineering	3	*5.2%*
Civil Engineering	11	*19.0%*
Electrical and Computer Engineering	13	*22.4%*
Engineering Education	5	*8.6%*
Industrial Engineering	1	*1.7%*
Materials Engineering	5	*8.6%*
Mechanical Engineering	9	*15.5%*

From questions inquiring specifically about the dynamics of survey participants' mentorship relationships, it was found that:

(2) Out of 49 responses:
- 34 (69.4%) students met with their primary research advisor at least once a week.
- 9 (18.4%) students met with their primary research advisor at least twice a month.
- 6 (12.2%) students met with their primary research advisor once per month or less.

(3) Out of 49 responses:
- 20 (40.8%) students had at least more than one mentor besides their primary research advisor.
- 29 (59.2%) students could only identify their primary research advisor to be their only mentor.

(4) Out of 49 responses, the distribution of topics discussed between students and their primary advisor is illustrated by Figure 6. The most predominant topic discussed between students and their primary advisor relates to research updates. The majority of the graduate students lacked support or discussions about leadership, whether it be in a lab group, a project, or on-campus through a student-led organization. Discussions about personal and professional development goals were also not always present in the mentoring received by graduate students from their primary advisors.

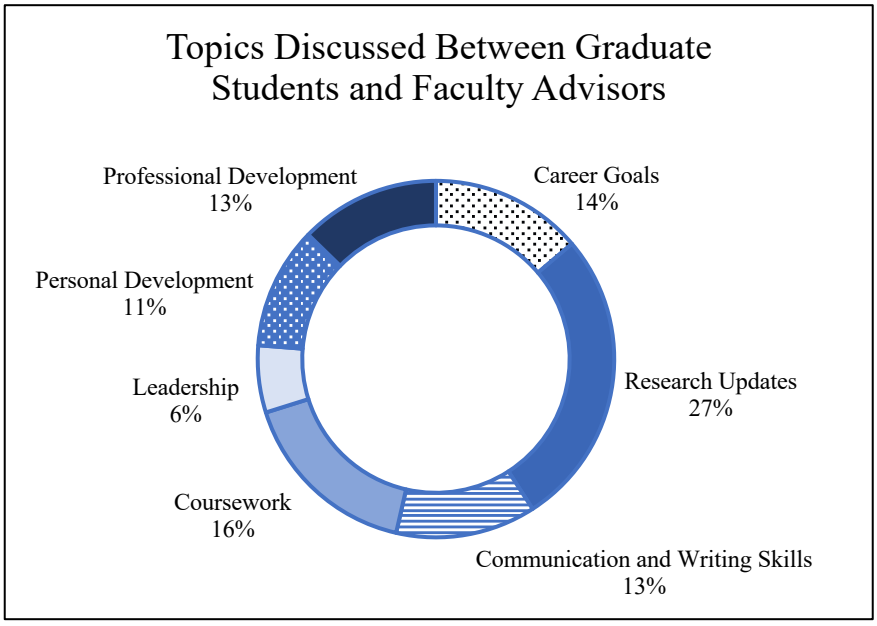

Figure 6. Distribution of topics discussed between primary advisors and students during their meetings

(5) Out of 62 responses:

- 45 (72.6%) students responded to be satisfied with their primary advisor relationship.
- 17 (27.4%) students responded to be unsatisfied with their primary advisor relationship.

(6) Out of 57 responses on a 5-Level Agreement Scale, the average level of agreement on the seminar's usefulness, learnability, valuable perspective provided, and recommendation to others is described by Figure 7. It is noticeable that the majority of the students found seminars to be helpful regarding mentorship, learned something new about mentorship, or found the seminar speakers to have provided a valuable perspective relative to mentorship. In addition, it can be inferred that the majority of the students found seminars to be satisfying enough to recommend the seminar to other graduate students.

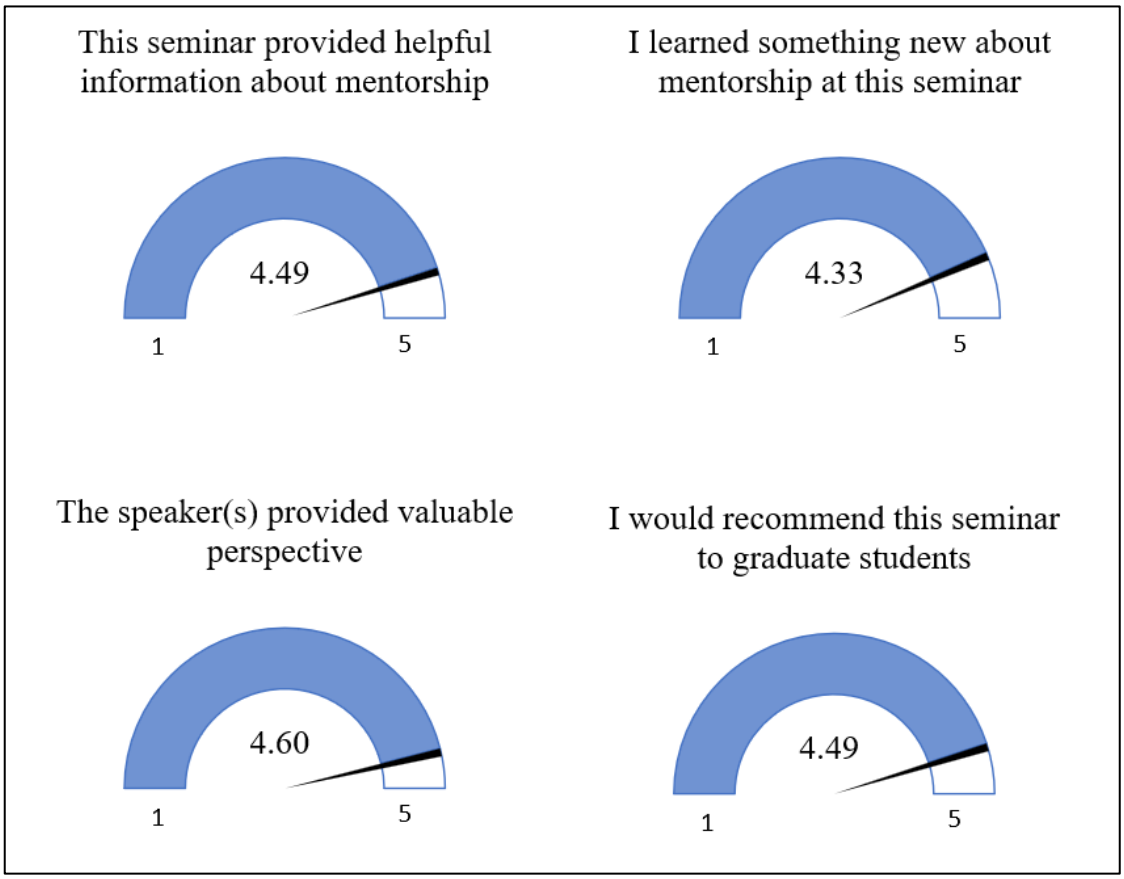

Figure 7. 5-level agreement scale average responses to the usefulness and satisfaction of the seminars

A closer inspection of disagreement responses revealed that:

- A 4th year ECE PhD student found the seminar on Navigating Toxic Environments to be strongly irrelevant and unhelpful (correlated to strongly disagreement answers).

- A 3rd Year Civil Engineering PhD student didn't find the seminar on Building Individual Development Plans to be helpful (correlated to somewhat disagree answers).
- A 1st Year ECE Master's student didn't find the seminar on Building Individual Development Plans to be helpful because they wanted the IDP to discuss post-docs' satisfaction in their mentorship relationships (correlated to somewhat disagree answers and indifferent answers).

This demonstrates that only three graduate students who filled out the feedback survey held negative feelings toward the usefulness and satisfaction received from the seminar series.

When inquiring further about unaddressed or unmet student needs, it was found that students wished their mentoring relationships could improve by:

- Having their primary advisors be willing to discuss other topics during their meetings besides updates on a research project.
- Initiatives to enable mentoring between faculty advisors and non-thesis master students.
- Having primary advisors better understand/guide students on their goals, be open to discussing an Individual Development Plan, or better clarify expectations.
- Having primary advisors be more:
    - Involved in their students' academic/research/program progress.
    - Available or be willing to make accommodations to meet more frequently or on 1:1.
    - Open to meeting students on a more appropriate personal level such that the student can discuss their personal goals, course progress, or personal conflicts rather than having only a technical conversation.
    - Understanding of students' diverse backgrounds and differences in knowledge gained in their undergraduate institutions.
    - Aware that the communication needs to be improved between them and the student.
    - Invested in their students' career, professional, and personal goals besides research.

Relative to the seminars, it was noted that students found the seminars hosted to have taught them about:

- What mentorship is in graduate school.
- Importance of diversity and inclusion in research groups.
- Genuinely caring about a mentee's growth in their personal and professional endeavors throughout grad school.
- How to improve communication in a mentoring relationship

- How to tailor to different mentee needs
- How Individual Development Plans can enhance graduate mentorship relationships and mentee goal tracking.
- The advantages of having different or multiple mentors in graduate school.
- Mentor/Mentee responsibilities in a graduate mentorship relationship.

These lessons learned by graduate students from attending the Mentoring Seminar Series demonstrate that the overall objective of the seminar series and the individual goals of each seminar were indeed met.

Aside from the survey, it was also identified that as of January 19, 2022, the current number of views on each seminar is as follows:

- Developing an Individual Development Plan = 112 views
- Navigating Toxic Environments = 130 views
- Building Healthy Mentorship Relationships = 29 views
- Mentoring, Managing and Diversifying Graduate Student Research Groups = 19 views

The distribution of views demonstrates that graduate students and faculty members have indeed accessed the recordings of the seminars, reinforcing the need to make the content of the seminar series available post-live. Nonetheless, the drop-in views for the last two seminars compared to the first two may be attributed to some extent to lack of communication and awareness of the seminar recordings being available.

Conclusions

Individual Development Plan

The IDP was sent to faculty in each engineering department prior to being published to provide an opportunity for feedback. Now that the IDP has been distributed, additional feedback would be helpful from students who have utilized this tool, in addition to faculty who have used the IDP with their advisees. While this document was designed for COE PhD students, it would be beneficial to create a similar document tailored for various types of master's students, including thesis, non-thesis and professional master's degrees.

Faculty Survey

The results of the survey show that faculty have an overall positive attitude towards graduate student mentoring and show interest in prioritizing their graduate students' development further. To continue improving faculty and graduate student relationships, there are several factors to be addressed. The existing resources (IDP template, workshops, handbooks, etc.) are appreciated by many faculty, and these should continue to be advertised to faculty with all levels of experience.

The content for these should also be reviewed to ensure that suggestions are realistic given the time constraints that the faculty are already dealing with.

One example, received via oral feedback, included complaints from faculty members expressing frustration that the IDP was "yet another expectation" when the faculty members were already overwhelmed by their time commitments. Promotion of the IDP must include a clear explanation that it is a student-led effort that can help faculty have more focused and productive conversations with their students and be a net positive for both faculty and students. Similar thoughtful messaging would likely be beneficial for other resources being offered by the COE.

The COE should also ensure that a sufficient number of faculty and staff are employed to address the course loads, class sizes, and administrative needs that may be preventing some faculty members from reaching their fullest mentoring potential. While increasing the amount of consideration given to graduate student mentoring during the tenure application process could help to communicate the COE's prioritization of mentoring, without addressing concerns about course loads, class size, and support staff, the faculty may not be able to provide mentoring more than they currently are.

While the survey question regarding incentives was focused on incentives as rewards for good mentorship, it's very likely the same incentives could be considered for increasing faculty participation in workshops and completing other activities related to mentoring and professional development. This includes workshops or training on cultural awareness and sensitivity to ensure students from all backgrounds can benefit fully from the student-faculty relationships.

Workshop Series

With the success of the Mentorship Seminar Series hosted in Fall 2022, the College of Engineering was highly interested in continuing the efforts of mentorship advocation into the Spring semester. Therefore, in the Spring 2023, an additional three seminars on the topics of graduate women mentoring, re-examining mentoring relationships, and the different mentoring philosophies will be presented, once a month from February to April for both graduate students and faculty members in the College of Engineering. Hosting a seminar once a month, allows organizers to better balance the work required to host each seminar while considering that January and May usually tend to be transitional or busier months for graduate students and faculty members.

Nonetheless, from the seminar series survey feedback insights, the graduate school has been highly encouraged to recognize the unmet needs of graduate students from their faculty advisor mentors and discuss opportunities on how to implement encouraging changes from a faculty advisor perspective that will help mentors be willing to adapt changes into their mentoring styles.

Furthermore, it has been recommended to the graduate school that they consider how to facilitate the conversation that faculty advisors need to spend more time with their graduate students as that is perhaps the biggest unmet need voiced.

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