

Engineering Deans' Perspectives on the Current State of Faculty Development Programs in Engineering Education*

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There is little literature exploring the needs of engineering faculty and the resources available at engineering colleges to support faculty development. Engineering deans are key stakeholders within institutions well-positioned to discuss trends and practices in faculty development within engineering colleges, however their perspective has not been captured in the literature. The purpose of this exploratory qualitative study was to learn about the state of faculty development within engineering colleges through the perspective of engineering deans. A particular focus was placed on identifying salient faculty needs and resources available to support faculty development within engineering colleges. Semi-structured interviews were completed with 23 engineering deans representing three types of institutions: R1 public ($n = 8$), R1/R2 private ($n = 6$), and primarily undergraduate-focused ($n = 9$). A rigorous thematic analysis process was completed until a final codebook emerged with strong interrater agreement. According to the deans the primary needs for incoming faculty involved teaching, research, understanding expectations, time management, and connectivity. There were variances in the approaches and resources available at each institution especially in relation to mentorship. This study indicates that further investigating effectiveness of faculty development programs especially mentorship across the various stages of a faculty's career would be fruitful contributions to the engineering education community.

Keywords: faculty development; mentoring; institutional culture; qualitative methods

1. Introduction

Engaging in efforts that contribute to transformative change has been a focus in engineering education for decades [1–5]. Oftentimes the focus of the calls for transformation is on student learning and curricular outcomes. However, there is less emphasis on changes that are happening with some of the key stakeholders leading this change – namely, faculty and administrators. We suggest that it is important to focus on these groups because they possess the capacity, authority, resources, and influence that are necessary for lasting change. Faculty development is a commonly accepted broad term in higher education used to describe activities designed to facilitate the professional and personal growth of faculty. Institutional investments in faculty development programs are essential to supporting the professional success and well-being of faculty [6]. Faculty development programs vary in structure and function but include onboarding programs, workshops, teaching observation programs, mentoring programs, and faculty learning communities (FLCs) to name a few.

There has been more of a focus on faculty development in recent years within engineering education as demonstrated by the recent establish-

ment of the Faculty Development Constituent Committee within the American Society of Engineering Education (ASEE) and the continued support of the National Effective Teaching Institute (NETI) workshops. Most engineering education literature related to faculty development however tends to focus on pedagogical practices and how to support faculty in adapting evidence-based instructional practices [e.g., 3, 7–9]. Although the scholarship on faculty development is growing, it is still unclear to what extent colleges of engineering are involved in disseminating and supporting a wide-range of faculty development opportunities such as mentorship that can support faculty in other areas in addition to teaching such as research productivity, work-life balance, and more. There is also little research examining the effectiveness of these different types of faculty development programs with respect to supporting engineering faculty.

This study begins to address this gap by investigating the current needs of engineering faculty as well as capturing the state of faculty development programs from the perspective of engineering deans. In doing so, the study aims to use this information as well as the latest research developments and trends in the faculty development literature to inform next steps and priorities that may

support faculty development across colleges of engineering. Given the purview and scope of influence engineering deans have within the academic structure, they are well-positioned to comment on trends and practices in faculty development. The perspective of engineering deans is one that is rarely included among engineering education literature; but one that is important given their crucial role in providing vision and leadership on engineering education, research, and engagement. This study advances the body of knowledge by highlighting their unique perspective on the state of faculty development.

2. Literature Review

2.1 *Need for Faculty Development*

It is well-documented that the transition from being a graduate student, lecturer, or postdoc to a tenure-track faculty member can be challenging [10]. Faculty must quickly master ‘early career survival skills’ and become productive researchers, effective teachers, and meet service responsibilities for the institution. Each of these roles contains a variety of responsibilities. For example, research responsibilities include planning novel research projects, writing effective proposals, obtaining funding, recruiting and supervising graduate students, and presenting research effectively. Teaching responsibilities include learning how to plan a course, develop curricula, integrate various pedagogies into a course, and motivate students.

Traditionally, new faculty are expected to learn on their own how to perform these responsibilities effectively, but evidence indicates many are likely to struggle early in their career with balancing these competing responsibilities [11]. Boice found that 95% of new faculty take four to five years to become fully productive in research and effective in teaching [12]. The learning curve of mastering these various responsibilities can lead to considerable stress. Sorcinelli found that untenured faculty report higher stress levels in their first three to four years than tenured faculty due to five main reasons: (1) not having enough time, (2) inadequate feedback and recognition, (3) unrealistic self-expectations, (4) lack of collegiality, and (5) difficulty balancing work and life outside of work [13]. Work-life balance and not having enough time appear to be challenges that remain for many faculty beyond their first few years. The Times Higher Education’s 2016 University Workplace Survey found that 68% of the 1,398 academics surveyed agree that they “spend too much time working” and less than a third believe that their “work responsibilities allow for a healthy work-life balance.” 64% of faculty found their job “reward-

ing”, but nonetheless 39% of faculty want to quit [14]. Many academics enjoy what they do but are also finding it very challenging to balance their many responsibilities with their personal life.

Institutions want their faculty to be successful and productive early-on in their careers especially considering hiring a new faculty member is a major investment for an institution. A 2007 National Research Council report indicates it may take ten years to recoup the start-up costs of hiring a new STEM faculty [15]. Replacing a faculty member is considerably more expensive than retaining one that is already hired. Institutions therefore have invested in faculty development programs designed to assist faculty in their roles and expedite their learning curve. Faculty development activities can enhance faculty members’ knowledge, skills, approaches, and dispositions to improve their effectiveness in their academic roles including teaching, research, administration, writing, and career management [16]. Effective faculty development can result in increased productivity and performance in research and teaching, and reductions in stress [17]. The following sections provide an overview of faculty development programs and elaborates specifically on orientations, workshops, FLCs, and mentoring.

2.2 *Overview of Faculty Development Structure and Focus Areas*

Faculty development programs have now been around for many years and have increasingly become more formalized and centralized within institutions in recent years. In a survey distributed through the Professional and Organizational Development (POD) Network – the largest professional association of faculty development scholars and practitioners in higher education – Beach and colleagues found that 59% of institutions have an identifiable, centralized unit with professional staff, while 29% are run by individuals [6]. Of the 385 survey respondents, 56% reported that their existing faculty development structure is ten or fewer years old [6].

Sorcinelli and colleagues also distributed a similar survey to the POD Network ten years prior and received 494 responses [18]. Both the 2006 and 2016 survey results found that the three primary goals that influenced faculty development programs were (1) to create or sustain a culture of teaching excellence, (2) advance new initiatives in teaching and learning, and (3) respond to and support individual faculty members’ goals for professional development. Interestingly, while the first two goals remained relatively entrenched, the number of respondents that selected, “respond to and support individual faculty members’ goals for professional

development” dropped from 56% to 29% between 2006 and 2016. These results indicate the design of faculty development programs may be becoming less tailored to the individual goals of faculty members. Meanwhile, at just 8% of respondents, providing recognition and reward for excellence in teaching emerged as the least influential goal driving faculty development programs.

In general, faculty development programs tend to focus on improving teaching and learning outcomes. As seen in Table 1, Beach and colleagues (2016) found that other than the new faculty orientation, the other top issues faculty development centers provide service for are all directly related to improving teaching and learning outcomes through the integration and use of technology, active teaching pedagogies, assessment tools, and curriculum reform [6]. With the exception of the integration of technology, all of these issues actually increased in priority from 2006 to 2016. Faculty development programs however may provide support for scholarly writing, mentoring, career advancement, leadership, and work-life balance. Mentoring programs in particular notably experienced a significant spike from 1.90 to 2.71 from 2006 to 2016, signifying this is emerging as a primary issue for faculty development centers [6, 18].

Faculty development centers primarily offer their programs via workshops (59%) and individual consultations (53%), however a number of other approaches are commonly used including FLCs (26%), department/discipline-specific workshops (20%), informal discussions with colleagues about teaching problems and solutions over coffee or lunch (20%), institutes/retreats (20%), web-based resources (16%), seminars (16%), structured discussions (13%), and small group instructional diagnosis (SGID; 12%) [6].

2.3 Onboarding/Orientation Programs

Creating a welcoming environment through new faculty orientations has remained a critical component of faculty development offerings [19, 20]. New faculty go through standard institutional and/or departmental onboarding procedures, which typically involves submitting human resources paperwork, setting up office space, participating in

mandatory trainings, setting up one's teaching management platform, and more. Faculty are typically required to attend an orientation program also that typically involves relaying information on key campus resources (e.g., teaching and learning center), introducing faculty to teaching and research topics, and offering opportunities for faculty to network and begin to make collegial connections [21–23]. This is also an opportunity for the institution and/or department to present the values of the institution, establish expectations, and address questions or concerns faculty may have [22].

2.4 Workshops & Faculty Learning Communities (FLCs)

The orientation is typically just a starting point for faculty development as additional programs are necessary to sustain holistic faculty development [24]. Although workshops are the most common approach among faculty development programs, evidence suggests that the standard, one-time workshop approach may be among the least effective approaches [25–27]. Research recommends that the most effective faculty development programs require sustained faculty engagement over a significant period [25, 28]. Otherwise, a significant proportion of faculty will initially adopt new student-centered approaches will revert to their original approach [29]. This perhaps explains why faculty learning communities (FLCs) are becoming increasingly more common and have been cited as a faculty development program to expand [6, 30]. An FLC is a more intensive, long-term program that engages faculty in collaborative work on topics related to their various responsibilities. FLCs have been found to provide environments that promote reflection on how students learn and the long-term adoption of evidence-based instructional approaches [3, 31–33].

There are however challenges in incentivizing faculty to attend professional development programs, especially long-term programs. Instructional development programs can be found at many universities; however, the participation of engineering faculty members is usually low except when it is made mandatory [34]. Time constraints

Table 1. Top 5 issues of faculty development centers

Issue	2016 Score	2006 Score
New faculty orientation/development	3.48	3.03
Integrating technology into traditional teaching and learning settings	3.28	3.28
Active, inquiry-based, or problem-based learning	3.25	3.00
Assessment of student learning outcomes	3.21	2.57
Course and curriculum reform	3.08	2.40

Scale: 4 – to a great extent, 3 – moderate extent, 2 – slight extent, 1 – not at all.

have been commonly cited as a top barrier for STEM education change [9, 29, 35]. Felder, Brent, and Prince (2011) have suggested that faculty development programs may be more attractive to engineering faculty if facilitated by teaching experts with engineering backgrounds instead of social scientists [28]. They also suggest that providing incentives for faculty to attend may be necessary such as having attendance count toward tenure and promotion, making it a certification program, and/or releasing faculty from teaching or service responsibilities. Indeed, research has suggested that providing faculty with external motivation to attend teaching workshops through university reward structures can eventually lead to more internal motivation upon experiencing benefits from attending [36].

2.5 Mentoring Programs

Another important approach to faculty development is mentorship. Mentoring has been defined as:

“A process where an experienced faculty member serves as a guide to an individual with lesser experience for the purposes of socializing them into disciplinary norms, fostering their acquisition of institutional and scholarly knowledge, providing professional opportunities, and person and/or professional support” [37, p. 911].

A number of studies have highlighted how individuals who receive adequate mentoring become more productive scholars, more effective teachers, self-report more satisfaction in the workplace, and have more collegial relationships with other faculty [12, 38–40]. The main functions of mentoring have been divided into three main domains – career development, psychosocial support, and role modeling – which can be accomplished through both formal and informal interactions [41–42]. Mentors often serve to support goal setting in research [43], be an advocate in the workplace and support networking [44] and provide emotional support [45]. Effective mentoring relationships are “characterized by trust, honesty, and a willingness to learn about self and others, and the ability to share power and privilege” [46, p. 46]

2.5.1 Formal Mentoring

Formal mentoring programs involve the assignment of at least one mentor to a mentee with the intention of ensuring each new faculty member has at least one mentor [47]. These programs are institutionally supported and may be structured with specific discussion topics, require regular meetings, and/or involve the assessment of outcomes [48, 49]. The assignments can be made by a department chair, dean, or someone in a leadership role. Only about a quarter of U.S. universities have formal

mentorship programs [43]. Formal mentoring programs require time, money, and programmatic support. Senior faculty need to be involved and perhaps incentivized to participate. Assigned formal relationships also show less success than relationships developed organically and may feel forced [50]. Jackson and colleagues discuss how expectations made at the beginning of the program should make it clear that there are no hard feelings if an assigned mentor-mentee relationship does not work out [47]. In a qualitative study, Lechuga found formal mentoring programs may also infringe on the autonomy of younger engineering faculty [37]. In another qualitative study involving engineering faculty, Long and colleagues (2018) found participants expressed dissatisfactions with their departmental formal mentoring structures, which involved periodically scheduled meetings [51]. Overall, the literature suggests the implementation of formal mentorship programs can be challenging to implement successfully.

2.5.2 Informal Mentoring

Informal mentoring relationships meanwhile develop spontaneously when two individuals are drawn together by mutual interests, and therefore almost always work [52]. Studies of formal mentoring programs generally conclude by recommending expanding networking opportunities for faculty so that they can more naturally develop informal relationships [38, 47, 53, 54]. Jackson and colleagues advise that new faculty should be provided with opportunities to briefly meet all other faculty members in their department early on to help identify someone that might be a natural fit as a mentor [47]. This can lead to a more organic way of developing a connection. However, a drawback is some faculty may not feel comfortable with developing an informal mentoring relationship. There is evidence suggesting same race and same gender mentoring relationships provide more psychosocial support than cross-race and cross-gender relationships [55]. Female mentees may not feel like they can address certain issues to male mentors due to a lack of experience and/or understanding [56]. As of 2018, women constitute just 16.9% of tenure-track faculty in U.S. colleges of engineering [57]. Consequently, women and other underrepresented minorities (URMs) in engineering usually find it more difficult to identify mentors. Women and URMs academics perceive and self-report that they have less access to higher-ranking mentors, experience more isolation, and seldom receive emotional and psychosocial support from mentoring [58–60].

2.5.3 Mentoring Constellations

Whether a mentoring relationship develops for-

mally or informally, the goal for faculty should be to develop a network of multiple mentors, known as “mentoring constellations” [61]. Individuals with mentoring constellations experience greater objective career success than those with just one mentor [62]. Mentoring constellations can also consist of peer mentors and external mentors. Although external mentors may lack knowledge on the culture and internal politics of the institution of the mentee, they may be able to provide more objective and unbiased advice as a result because they are less conflicted by organizational relationships. This can help create a “safe” environment for the mentee to be more open and honest since what they say will not affect a future tenure decision. Women often times need to be more strategic in identifying mentors and go outside of their institution and find external mentors [51].

2.6 Future Directions

Although most faculty development programs are tailored to new faculty, professional development and mentoring should be considered a career-long commitment. Faculty have different needs at different stages of their career [10, 28]. While early career faculty must learn teaching, research, advising, and time management skills – mid to senior faculty are more interested in developing leadership, administrative, and communication skills to effectively run meetings, lead committees, and foster collaborations. Faculty development programs therefore should address faculty’s professional needs at different stages of their career. Indeed, expanding faculty development programs tailored to mid to senior level faculty has been found to be an emerging priority [6]. Austin and colleagues (2011) suggest that leadership development opportunities should be made available for deans, committee chairs, and department chairs since they play such a major role in decision-making and communicating expectations [63].

Having leadership continuously review and revise tenure and promotion policies has also been identified as an influential factor in faculty development. The reward structure of an institution has a major influence on what responsibilities a faculty member should prioritize. In a qualitative study with 44 tenure-track engineering faculty, a transparent and flexible reward system emerged as an important systematic need to support faculty development [10]. Faculty expressed concerns over whether tenure and promotion guidelines may stifle interdisciplinary and collaborative research projects, because of the difficult nature of evaluating the impact of the work and the contribution of each faculty member. This can lead to a culture of prioritizing workload over productivity or quantity

over quality of work. Finally, additional reward structures that should also be continuously reviewed are career and life stage-oriented grants or funding. New faculty are provided with startup packages, but Austin and colleagues highlight that other stage-oriented grants should be considered to further support mid-career faculty [63].

2.7 Purpose

Within an engineering education context, there is sparse literature on how engineering colleges support faculty development. It is also unclear to what degree engineering colleges are aware of the recommendations and challenges cited in the faculty development literature. This exploratory study was conducted to learn more about the state of faculty development programs within engineering colleges and identify potential opportunities to improve these programs. Engineering deans were selected as participants in this study because of their high-level perspective over what happens within their college of engineering and because of the influence they have on the values and decision-making of their institution. Additionally, their perspective on faculty development and mentorship has not been captured in the literature. The research questions for this study are:

According to engineering deans:

1. What are engineering faculty’s most salient professional development needs?
2. What approaches and/or resources exist within institutions to onboard, mentor, and generally support engineering faculty?

3. Methods

This study was the first phase of a larger research initiative aimed at enhancing faculty development offerings across colleges of engineering including the home institution of the researchers. This paper focuses on the findings from the initial phase of this research initiative, which was focused on investigating the state of faculty development offerings within colleges of engineering and particularly identifying areas of need. The second main phase of the overarching project involved applying the information learned from this study to design and assess faculty development offerings that address these needs.

The initial investigation involved conducting a literature review on faculty development with a focus on efforts within engineering education. As highlighted in the literature review, there is considerable research on faculty development, however there was insufficient evidence to determine the extent these faculty development efforts have been applied within colleges of engineering and what

Table 2. Demographic Information of Deans

Characteristic	Quantity
Types of Institution	
R1 Public	8
R1/R2 Private	6
Undergraduate-focused	9
Gender of Deans	
Female	6
Male	17

needs or problems still may exist. This study was therefore designed as a “needs assessment” to clarify the needs and gaps within current faculty development efforts. Needs assessment are commonly used by organizations to clearly identify problems and utilize this information to refine and improve existing interventions or solutions. This was the intended purpose of this study as the findings informed next steps of the overarching research initiative. A particular emphasis was made on investigating mentorship approaches since this emerged as an area with no clear optimal solution in the literature review.

Since this study was exploratory in nature, it was determined semi-interviews would be most appropriate to elicit the desired rich contextual information from the deans. A qualitative research design was therefore employed. Since the researchers were exploring and interpreting the subjective perspective of deans, a constructivist worldview was adopted to guide the overall study. Those who hold a constructivist worldview believe each individual forms their own subjective reality and the role of the researcher(s) is to uncover these views through an inductive process.

3.1 Data Collection

Forty-eight engineering deans representing three types of institutions [R1 public ($n = 17$), R1/R2 private ($n = 14$), and primarily undergraduate-focused ($n = 17$)] were contacted in the fall of 2017 via email. The schools were sampled in this manner to ensure a wide-diversity of perspectives.

Twenty-three engineering deans participated in the interviews resulting in a 48% response rate. The demographic breakdown on type of institution was eight R1 public, six R1/R2 private, and nine primarily undergraduate-focused. There was an intentional effort to sample schools that had the largest student populations for the R1 public and R1/R2 private institutions. The R1 public schools ranged from having 283 to 773 total faculty while the other schools ranged from 13 to 356 total faculty [64].

The interviews lasted on average 33 minutes and ranged from 26 to 49 minutes. The interviews were delegated among the authors and were completed over the phone one-on-one. The interviews were semi-structured; all of the authors followed the same interview protocol but had flexibility to ask follow-up questions based on the participants' response to various questions. The interview protocol inquired each dean about faculty needs and existing resources available to support faculty professional development. The interview protocol questions relevant to this study are mapped to the research questions in Table 3. Specific questions were asked to uncover the different institutional processes for hiring and onboarding new faculty, mentorship structures and programs, and other types of programs in place to support faculty development. Other supplemental questions in the protocol investigated retention strategies, the top priorities and values of the institution, and about the role of entrepreneurial thinking in engineering colleges. These questions were not the focus of this study, however the entire interview protocol is provided in Appendix A.

3.2 Data Analysis

All of the interviews were audio recorded and later transcribed using Rev's transcription services. These transcriptions were then uploaded to a qualitative analysis software called Dedoose (Version 7.0.23). A thematic analysis was used to identify major patterns within the interviews. Efforts were made to minimize researcher biases by adhering closely to the best practices shared by Braun and

Table 3. Interview Protocol Mapped to Research Questions

Research Question Focus	Question
Faculty Development Needs (RQ1)	1. As faculty get started, have you noticed any areas where they tend to need more guidance, or alternatively, areas where they seem to do well? 2. Have you noticed any requests or trends from faculty in terms of what they need to be successful? 3. What would you suggest as critical components of a faculty mentorship model/program? 4. What opportunities (or needs) are you aware of that relate to mentorship of faculty after promotion/tenure?
Existing Resources (RQ2)	1. Do you have a process for onboarding new faculty and if so, can you describe it? 2. Do you provide any resources to your faculty in terms of mentorship/faculty development? Please describe. 3. Are there programs (such as faculty development workshops) that you are aware of, and that you recommend to your faculty? (could be internal, external) And why those (if any mentioned)?

Clarke (2006) and Creswell (2016) [66, 67]. First, one of the authors listened to all of the audio recordings. Second, the same author read through all of the transcripts and inductively generated a list of open-codes. A second read-through was then made to begin to identify relationships between different codes. The initial list codes were shared with the other authors and was discussed. An initial codebook was then generated consisting of 36 codes and was then used to organize the transcripts into excerpts.

To gauge the agreeability of the codebook, an inter-rater reliability test consisting of 160 excerpts was completed at this stage on Dedoose with another author. Dedoose uses a Pooled Cohen's (1960) kappa score to summarize rater agreement across many codes as compared to the rate of agreement expected by chance. Fleiss (1971) suggested that kappa values of < 0.40 = poor agreement, $0.40\text{--}0.59$ = fair agreement, $0.60\text{--}0.74$ = good agreement, and $0.75\text{--}1.0$ = excellent agreement [68]. The initial inter-rater reliability test produced a kappa score of 0.51 indicating fair agreement.

Changes to further refine the codebook were then discussed between the authors. A second round of axial coding was completed between the authors to reduce the redundancies and overlap of the codes. Several strategies from Saldaña's (2005) *The Coding Manual for Qualitative Researchers* were applied including identifying the top 10 quotes that are most representation of the study and applying the touch-test [69]. The touch-test involves carefully considering to what extent the different codes can be transformed or combined into a more abstract term or meaning. These methods helped collapse the codebook further from 36 codes to 16 codes. This codebook was then used to organize all of the transcripts into excerpts. A second inter-reliability test produced a kappa score of 0.72 indicating good agreement. Once again, the authors discussed discrepancies and one last iteration of the codebook was made. This final codebook was organized into two primary themes (faculty needs and faculty development resources) and several underlying codes that provide granularity on the main themes.

Overall, the thematic analysis was iterative and involved multiple perspectives. Since this study was intended to inform future work, the authors were genuinely interested in uncovering potential needs as well as the best practices already being applied within colleges of engineering. As will be seen in the following section, the excerpts from this study were generally straight-forward and required little interpretation. The data analysis process was therefore more focused on documenting and organizing the excerpts in a report-like manner and ensuring all of the unique perspectives and ideas were captured.

4. Results

The thematic analysis for the interviews with the deans produced two overarching themes in alignment with the research questions: (1) faculty needs and (2) the resources available to support faculty development. Fig. 1 provides an overview of the primary faculty needs and primary institutional resources dedicated to faculty professional development that were discussed from the interviews with the deans. The figure also highlights the symbiotic relationship of the faculty needs and existing faculty development resources. For example, the needs influence the design of faculty development resources and vice-versa – the existing resources can help address faculty needs. The primary faculty needs theme was further divided into two main codes: new faculty needs and needs specific to mid-senior faculty. Tables 4 and 5 provide more detail on each the faculty needs and faculty professional development resources offered. Each table contains a description for each need and resource as well as an example quote from a dean. The themes and underlying codes are discussed in detail in the rest of this section.

4.1 New Faculty Development Needs

The areas of need for incoming faculty most frequently identified by deans were within teaching and research. Other needs for new faculty discussed by the deans include understanding expectations & time management, and connectivity. The

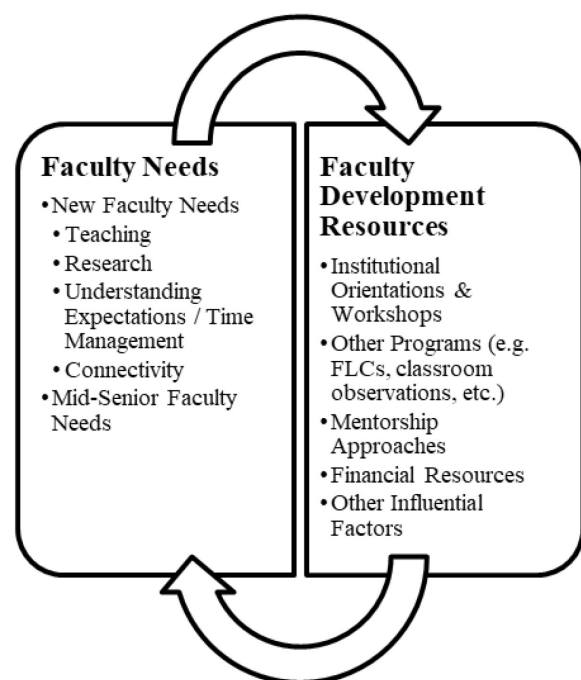


Fig. 1. Overview of Primary Faculty Needs & Faculty Development Resources.

areas of need for mid-career faculty members also were included as an additional primary code. A description and example for each code is provided in Table 4.

4.1.1 Teaching

Fourteen deans (60%) representing all three types of institutions discussed teaching as an essential skill for all faculty that typically needs development. The deans highlight how most incoming new faculty lack experience and training in teaching. A quote from a dean representing an R1/R2 institution summarizes this sentiment well, “I would say my experience in general of my 26 years in academia has been that many of our faculty, well, very few of our faculty members are actually trained educators.” Several deans infer that the transition to becoming a teacher is often times challenging and that many new engineering faculty have not been exposed to different pedagogies (e.g., flipped classrooms) or know how to manage large classes. Several deans expressed that they believe faculty often times have to devote more upfront time to teaching than they anticipate.

The deans converge on the idea that faculty come in with varying levels of competency with respect to teaching based off previous experiences as well as innate ability. For example, one dean highlights that previous experience as a teaching assistant or

having a teaching certificate can expedite the learning curve significantly. Another dean remarked, “Some are natural teachers and others are not and need a lot of help.” Regardless the deans expect new faculty’s teaching to improve over time with experience and training. One dean from an R1/R2 institution commented, “teaching tends to be more readily identifiable and addressable.”

4.1.2 Research

The importance of developing as a researcher was acknowledged as an essential need for tenure-track faculty. Within the domain of research, the most common needs identified by the deans for new faculty were writing grant proposals and effectively supervising students. Building a research identity and vision was also mentioned by a few deans. Deans representing all three types of institutions discussed how being able to bring funding to support research initiatives is an essential component of a tenure-track faculty member’s job and that these faculty need to be able to “sell” their ideas and develop effective strategies to secure funding. Many deans discussed that new tenure-track faculty need to quickly learn how to write effective grant proposals, which often times involves getting feedback on their proposals from more experienced faculty early in their career. Newer faculty receiving feedback on their propo-

Table 4. Overview of Primary Faculty Needs

Theme	Code	Description	Example Quote
New Faculty Needs	Teaching	New faculty often start their position with little to no teaching experience and/or formal training, and therefore need support in teaching.	“I think everybody always underestimates how much time they will devote to teaching or how much developing materials for teaching will take”
	Research	New faculty typically require support in becoming strong researchers including learning how to craft grant proposals, manage PhD students, and develop a research vision.	“Then I have found the most important element in getting faculty off to a quick start is helping them transition from the research programs of either their PhD or their post-doc or both into their own scholarship.”
	Understanding Expectations & Time Management	New faculty need to have a clear grasp of the expectations for their different responsibilities (research, teaching, service) and manage their time effectively between these different responsibilities in alignment with tenure and promotion guidelines.	“Managing [teaching] with all of the other demands tenure-track have in terms of scholarship are big themes that tend to emerge among new faculty”
	Connectivity	New faculty would like to be immersed in the community of practice and feel connected to other faculty members	“The thing that I would say is, there’s been a request to build more of a community. We’ve been doing more social activities with the group, so that they can begin to feel like they’re a cohort.”
Mid-Senior Faculty Needs		Mid-career/senior faculty need support systems in place to support leadership development while continuing to support evolving research, teaching, and service responsibilities	“I think we need more leadership mentoring at the mid-career, at the senior associate professor level or the associate professor level, that we want more to be able to help those people develop their leadership skills, particularly in research”

sals is not something that is consistently done according to a dean from an undergraduate institution.

A key need cited by the deans is the importance for tenure-track faculty to develop a research agenda and program. This involves establishing a research identity, and successfully building off of or transitioning from previous research from their PhD (or postdoc experience). According to some deans, some faculty have little to no issue in generating research ideas, but others may struggle in this area.

Several deans also discuss how new faculty must be able to effectively recruit and supervise graduate students. A dean from an R1/R2 institution commented, "For the first time, you're the boss of students. That has a whole set of challenges that you've not encountered in the past." A dean from an R1 institution noted this involves "learning to be productive through others." Another dean from an R1 institution argues that new faculty need the most guidance in learning how to effectively mentor graduate students. This dean highlights that new faculty are not typically formally trained on how to mentor graduate students and that this can emerge as a hidden element early on in the tenure and promotion process.

4.1.3 Understanding Expectations & Time Management

A key challenge for new faculty that the deans discussed is the importance of faculty understanding expectations and managing their time appropriately according to the values of their institution. Several deans brought up that new faculty are often unsure of whether they are meeting expectations from research, teaching, and service perspectives. Several deans discuss that it can be challenging for new faculty to balance making progress on long-term research projects (e.g., writing journal papers or proposals) with completing everyday tasks (e.g., preparing for class or answering emails). These responsibilities must be balanced in a manner according to the values and expectations of the institution.

In general, comments from the deans indicate all institutions value: (1) quality teaching that engages students, (2) impactful research initiatives including proposal development and publications, and (3) having inclusive, collaborative communities. However, deans from undergraduate institutions especially stressed their expectations that high-quality teaching is extremely important even in the hiring process. Meanwhile, a dean from an R1 institution discussed how it is not an expectation that incoming faculty will be great teachers right away, but that they must be invested in improving their teaching

skills over time. Several deans from R1 institutions especially stressed the importance of supporting and graduating PhD students.

One dean from an R1 institution expressed their belief that the expectations for faculty are higher than they used to be because of "the acquisition cost of a new faculty member is much higher" now. On the other end of the spectrum, a dean from an R1/R2 institution discusses the importance of managing research expectations with clear course load expectations. In other words, if a faculty member has a high course load, it is unreasonable to expect them to have a high research output.

4.1.4 Connectivity

Several deans highlighted the importance for faculty to be immersed in the community of practice within one's own institution. A dean from an R1 institution discussed how easy it is for faculty to become isolated and how difficult it can be to reintegrate them into the community of practice at one's own institution. A dean from an R1/R2 institution mentioned that new faculty "have requested to build more of a community . . . so that they can begin to feel like they are part of a cohort" indicating new faculty recognize this as a need. Another dean from an undergraduate-focused institution elaborates on the importance of conversations to help alleviate some of everyday identity challenges and unreasonable expectations new faculty sometimes impose on themselves:

"Personal connectivity is really, I think is really important, to a certain extent, a little bit beyond the professional. And a second aspect to not underestimate the importance of nitty gritty conversations. I'd said at our institution we do have some faculty that suffer from Imposter Syndrome when they walk in and considering that, at least in the teaching area that we have, that they perceive us to have unreasonable . . . or them impose on themselves sort of unreasonable expectations. We have a tendency sometimes to just make assumptions or talk about sort of big picture, philosophical issues when the newer faculty are really being challenged by the what do I do today or next week."

4.1.5 Mid-Senior Faculty Needs

There was a strong consensus among the deans from all types of institutions that not enough is being done to support recently mid-senior level faculty. Several deans discussed the need to expand their efforts to identify and cultivate leaders among associate-level faculty. This could involve mentoring faculty to become principal investigators in grants or to take academic leadership positions like department chairs. In addition to cultivating leaders, other ideas emerged in terms of how

institutions can support newly tenured faculty. Several deans discussed how newly tenured faculty might be assigned bridge funding or a new startup package to support them in transitioning research topics. A dean from an undergraduate institution suggests encouraging collaborative research projects with other faculty as a potential option to help facilitate a transition to investigating new research topics.

A different perspective was shared by a dean from an undergraduate institution as they expressed doubt on whether an institution can and should push recently tenured faculty to engage in research if this is not their primary interest. Instead this dean proposes that it may be more valuable to focus on improving teaching for these types of faculty. A final thought related to supporting mid/senior faculty was expressed by a dean from an undergraduate institution who proposes that additional resources should be dedicated to support faculty in licensing and commercializing technology.

Overall, there was some consensus among the deans in that mid-senior career faculty development should focus on supporting the leadership capabilities of certain mid-senior faculty who demonstrate

aptitude. There was however little consensus on the extent to which these faculty should be supported in research, teaching, and other responsibilities, which could perhaps be attributed to differences in type of institution and faculty goals and interest. Most deans expressed that more attention and resources likely need to be allocated to understanding and support the needs of these faculty members.

4.2 Institutional Resources to Support Faculty Advancement

The deans shared and discussed a number of programs and approaches to support faculty advancement. The resources shared by the deans were categorized into five main codes: (1) institutional orientations & workshops, (2) other types of programs, (3) mentorship approaches, (4) financial resources, and (5) other influential factors. A description and example are provided for each code in Table 5.

4.2.1 Institutional Orientations & Workshops

Many of the deans discussed their onboarding process, which usually includes an orientation. The orientations ranged from half a day to a week

Table 5. Overview of Resources to Support Faculty Development

Theme	Code	Description	Example
Faculty Development Resources	Institutional Orientations & Workshops	Discussion of institutional orientation programs and/or workshops that the institution encourages or requires faculty to attend to support their effectiveness in both teaching and research	“We have a teaching and learning center that offers faculty professional development in a setting where they can interact with other disciplines.” “We have a very proactive proposal development office at the university, which offers classes in proposal-writing.”
	Other Programs	Includes other sparsely mentioned programs such as faculty learning communities (FLCs), classroom observations, online faculty development programs, sending faculty to meet with funding agencies, or institutional grants to support educational initiatives	“We have a program that provides the faculty with professional and peer training on how to become effective teachers, effective researchers, and effective communicators to the public and to the stakeholders who will benefit from their work. The program is for a full year—once every week the cohort comes together over lunch to discuss topics related to teaching and research in a Research I university.”
	Mentorship Approaches	Includes discussions of how mentoring happens within the institution both through formal programs and through informal mechanisms. Also includes general discussions on best practices and ideas to improve mentoring	“I will say that one thing this conversation has made me think about is whether my interactions or the school’s interactions with the mentors should be more structured and formal, because I think that would lead to a more effective program, whether there is a way to acknowledge or reward mentor service in a way that would make that more meaningful”
	Financial Resources	Includes financial resources dedicated toward supporting faculty professional development including discretionary funding and competitive startup packages that provide benefits such as teaching breaks	“If I am offering a faculty member a chance very specifically to go to a leadership development workshop or a grant writing workshop or a teaching development workshop, or even an advanced teaching workshop, that is something that the school will support that will not require them to tap into those discretionary funds that we have provided them.”
	Other Influential Factors	Includes discussions on changing institutional values and policies that influence the design of faculty professional development initiatives	“And one change we made to the promotion and tenure guidelines, is to say that multi-author proposals, multi-author grants, multi-author papers, conference proceedings, journal papers, multi-author book chapters, all of the forms of publishing your work, are equally valuable”

and are typically offered in the fall, although some larger institutions offer them in the spring as well. Depending on the institution, the workshops can be organized at the university, college, and/or department levels. The orientation offers an opportunity to introduce faculty to the institution including institutional policies, and the mission, culture, values, and expectations for research and teaching. Many of the institutions also introduce faculty to the relevant resources from teaching and learning centers to proposal development offices to the library database. These orientations may also cover research and/or teaching topics such as reflecting on research goals, how to set up a research lab, how to transition from being a graduate student or postdoc to now recruiting and managing students, how to manage large-classes, how to integrate teaching pedagogies, and other related topics. Several deans mentioned that administrative tasks are covered in the orientation including how to set up a website, learning where to print and make copies, how to make purchases, and how to handle emergencies. Other topics that were mentioned for the orientation include discussions on how to build inclusive, collaborative communities, diversity, leadership, and entrepreneurial mindset. One dean mentioned they like to put together a panel consisting of some of their top faculty to discuss relevant topics to getting started.

After the orientation, the most frequently covered topic covered was ongoing workshops – all of the different types of institutions mention offering workshops to support faculty. Many of the deans mentioned having a center for teaching & learning that facilitate workshops and even working groups. Several deans also mentioned their institution has an office of research or proposal development that also facilitate workshops. In relation to teaching, the topics covered in workshops can include building a syllabus, best practices for teaching a large class or lab, how to integrate technology in the classroom, research-supported pedagogies, student learning theories, assessment, how to handle difficult situations, and academic integrity issues. For research, the topics mentioned include grant writing strategies, developing a research agenda, and managing students. Another frequently covered topic is tenure and promotion guidelines and expectations. Deans mention that these types of workshops, especially if they are formalized into a program, help build the community by allowing new faculty to network with each other and more senior faculty.

4.2.2 Other Programs

There were several other types of faculty development programs or opportunities the deans shared other than workshops. For supporting research

development, one of the programs discussed by several deans involves sending new faculty to connect with funding agencies in Washington D.C. Several deans also discuss that their office of research or proposal development helps review and provide feedback for faculty grant proposals. One dean even revealed that their institution will hire external groups to review proposals.

To support teaching, a few deans mentioned they have more targeted one-on-one programs. This includes one-on-one consultation and classroom observation programs in which another faculty member will observe a class being taught by a new faculty member and provide them with feedback. Another example is that faculty can have consultations with a member of a teaching and learning center if they would like feedback on a teaching-related initiative. Several deans also discussed encouraging educational and pedagogical innovations through institutional seed grants ranging from \$500 to up to \$100,000 that can be used to pilot course improvements in core engineering courses, develop new courses, integrate new teaching pedagogies, and so forth.

Two deans explicitly discussed that their institution offers a faculty learning community (FLC). One from an R1 institution discussed key elements of the FLC their institution in detail and is summarized in the following quote:

“We have a program that provides the faculty with professional and peer training on how to become effective teachers, effective researchers, and effective communicators to the public and to the stakeholders who will benefit from their work. The program is for a full year – once every week the cohort comes together over lunch to discuss topics related to teaching and research in a Research I university. . . , I will tell you, is one of the most useful things, because this cohort, I have seen it now over the years, stays connected as years go by. And their experiences with the program make them very willing to come back and contribute to the program as they become seasoned professors and expert teachers and expert researchers.”

More generally, numerous deans also discussed how their institutions offer formal review processes to provide feedback to faculty through annual letters and more intensive mid-term reviews. A few deans shared that they offer free scheduled luncheons in which faculty can discuss any relevant issues and network. Interestingly, one dean from an undergraduate institution mentioned that they have all of their new faculty introduce themselves to an industry board consisting of high-level executives of companies. Another unique idea shared came from one dean from an R1 institution who discussed having a council in place consisting of assistant professors who share the needs of new faculty and

provide ideas for resources with one of the deans within the college of engineering.

Finally, one dean explicitly mentioned that their institution has a membership to an online faculty development program called the National Center for Faculty Development & Diversity (NCFDD), which offers faculty members (at any level) free access to webinars, professional development trainings, and mentoring programs. At least two institutions have formal ways to identify potential leaders among associate faculty and provide leadership training. One dean described how they have their department chairs identify and invite leaders among mid-senior level faculty within their department to participate in a cohort that is exposed to academic leadership training. Overall, most of the programs in place discussed by the deans were more tailored to newer faculty members.

4.2.3 Mentorship Approaches

Mentorship was unanimously viewed as a valued activity among deans, however there were differences across the institutions in how these types of offerings are structured. Many of the institutions have a formal process in place in which a mentor is assigned (typically by a department chair or hiring committee). One dean from an R1/R2 institution described how they assign a mentor in the offer letter so that each new faculty has an official contact they can reach out to with questions while they transition to their new institution and role. These questions could be related to their role, but also more general questions like tips on where to live. Another institution assigns both an internal and external mentor to each new faculty member. According to the dean, the internal mentor understands the values and expectations of their department very well and provides specific feedback related to the tenure and promotion process. The external mentor can also be a good resource because the new faculty member may feel like they can be more open and honest since there is no conflict of interest with regards to the tenure and promotion process.

Generally, the institutions try to match mentors with mentees based on similar research interests, teaching interests, and other general characteristics. Several deans acknowledged that the pairings do not always work out for a variety of reasons. One dean expressed that perhaps the initial assigned mentor should be viewed as an onboarding mentor and the relationship should not be expected to extend over a long-period of time. This provides the incoming faculty member with the autonomy to identify other mentors as they become more connected within the institution. Within these formalized mentoring programs, the degree of organization can also vary. One R1 institution for

example has a college-wide mentoring program with a faculty fellow responsible for managing it. Other R1 institutions leave it up to each department to decide how they want to run their mentoring program. A dean from an R1/R2 institution expressed that mentoring is completely optional at their institution, but they do have a formal process where a faculty member can request and be matched with a mentor.

At other institutions without formal mentoring programs, there are still other mediums in which mentorship may occur. One dean from an R1 institution expressed that they look for opportunities for new faculty to collaborate with senior faculty on existing research initiatives to help ease the transition into their new research role. This may even involve co-advising their first student. One undergraduate focused institution has all of their new faculty co-teach their first course with a senior faculty member to gain experience. A few deans described how they feel it is important for them self or an associate dean to allocate time to try and meet with every single incoming faculty member with the purpose of understanding their goals and providing pertinent advice and/or recommendations on who the new faculty member should connect with. At larger institutions, the hiring committee and department chairs are usually primarily responsible for having these types of conversations and connecting incoming faculty to other faculty with similar interests. One dean expressed that their institution closely monitors teaching evaluations and will look to meet with new faculty who are struggling in order to discuss strategies to improve their teaching.

The goals of mentoring can vary across different institutions. One dean from an R1 institution described the mentors at their institution as primarily supporting research, while a dean from an undergraduate institution said their mentors are more focused on teaching. Several deans mentioned that mentors should review research proposals and/or teaching evaluations and provide feedback to the mentee.

A number of considerations for effective mentoring were also discussed by the deans. A few deans discussed the importance of not forcing assigned mentoring relationships and empowering the new faculty to feel like they can approach more senior faculty and ask the questions they need to ask. The importance of having multiple mentors was highlighted by multiple deans. A frequently identified problem by the deans involves the time commitment for mentoring. One dean believes that new faculty may feel like they should not “waste” the time of more senior faculty and may not want to take the initiative in setting up regular meeting

times. This dean believes it may be necessary for the senior faculty member to consider taking the initiative in scheduling meetings. Another dean described the importance for new faculty to feel empowered to approach more senior faculty and seek honest feedback from them. In doing so, they must be able to handle constructive criticism and learn from it. In return, more senior faculty need to not just provide positive affirmation, but actually provide constructive criticism when it is necessary.

Several deans expressed interest in further developing their mentoring program. One dean even openly questioned whether moving to more of a formal mentorship structure could lead to a more effective program. This is demonstrated in the following quote:

"I will say that one thing this conversation has made me think about is whether my interactions or the school's interactions with the mentors should be more structured and formal, because I think that would lead to a more effective program. . . . You know, maybe there should be more regular and formal check-in from the mentor. Maybe once a year we should ask the mentor as well to go through a checklist that has some very specific questions to ask about teaching progress and research progress and plans, because it would be less threatening than it is coming from the dean or the department chair."

4.2.4 Financial Support

The deans also frequently discussed financial support mechanisms in place to support faculty professional development including competitive startup packages with annual discretionary funding. The startup package is negotiated and can be tailored in a way to assist each faculty member in establishing their research program quickly (e.g., funding to purchase necessary lab equipment, graduate student funding to support research, course relief and summer salary for the first year or so, travel funding to meet with funding agencies). Additionally, there is typically funding for conferences and professional development. There was not enough data to determine whether there are differences within these categories of financial support across the institutions. Separate from startup packages, discretionary funding provided to faculty was frequently mentioned and discussed. According to the deans, these funds are typically used for external professional development opportunities, or to fund students supporting research. Several deans also mentioned that they are willing to offer additional funds for faculty to attend professional development opportunities as long as they provide an appropriate rationale. One dean even shared having an open-door request policy for new faculty to come in and request additional resources that they feel they need to be successful.

4.2.5 Other Influences

Tenure and promotion guidelines and the evolving responsibilities of the faculty role were highlighted by deans as a mechanism to provide clear expectations for faculty. Therefore, these topics may influence the design of faculty development programs. For tenure and promotion guidelines, a dean from an R1 institution discussed how their institution values multi-author proposals and papers as just as much as single-author work:

"And one change we made to the promotion and tenure guidelines, is to say that multi-author proposals, multi-author grants, multi-author papers, conference proceedings, journal papers, multi-author book chapters, all of the forms of publishing your work, are equally valuable . . . it's time to change that emphasis . . . because the problems today require multiple researchers from multiple disciplines to address the serious problems that we face in engineering."

The same dean also discussed how they have actually altered the tenure and promotion guidelines to include commercializing technologies and starting companies and have seen "an extraordinary increase in invention disclosures and companies that have been spun out of college." Commercializing technologies was highlighted by other deans as well as a pathway to create meaningful impact through research. The following quote from a dean at an R1/R2 private institution highlights this notion:

"I will argue that we fell in love with this notion of engineering science, where engineers published papers in *Science* and *Nature* in a university environment, the same as scientists did, and that was the mark of prestige. That's great, and we want our faculty to publish in those places, but what we really value is putting it to use. We talk about lives touched, and the way to touch the greatest number of lives, which is what society asks of us as engineers, is to have your development, your creation, your invention, be commercialized and put to broad use."

Several deans note that faculty participation in entrepreneurial endeavors may come more naturally to younger faculty. A few deans described younger faculty as being more collaborative, data-driven, and entrepreneurial than older faculty. Several deans also noted valuing more untraditional faculty responsibilities – some of the examples shared include helping a graduate student start a company, creating a makerspace, disseminating their research in creative ways (e.g., giving a Ted Talk), and creating educational innovations.

5. Discussion

5.1 Evolving Faculty Needs

As expected, deans discussed the need for new

faculty to become productive in teaching and research early in their careers. The deans recognized that different incoming faculty have varying needs for learning how to become effective teachers and researchers. The results indicated that deans believed poor teaching could be addressed with training and support. The most frequently mentioned research needs for incoming faculty were developing grant proposals and supervising students. Several deans discussed the importance of providing early-stage faculty with opportunities to receive feedback on their proposals. Additionally, deans discussed the importance of equipping faculty with awareness of the best practices for recruiting and mentoring students early in their career.

Several deans also mentioned the importance for faculty to understand the expectations of their role so that they are managing their time appropriately according to the values of the institution. For example, while teaching is valued at all institutions, the results indicated high-quality teaching to be more of an immediate priority for faculty at undergraduate-focused institutions. This is not surprising as research expectations are typically higher at R1 institutions. There was little discussion from deans on supporting faculty with stress and work-life balance, despite the literature indicating that faculty maybe struggling in these areas. Instead, several deans discussed some of the evolving expectations they have of the faculty role. For example, the deans described the importance of having faculty critically evaluate the impact of their work and to extend their roles and responsibilities beyond traditional research, teaching, and service activities. Examples of non-traditional activities that deans discussed include commercializing research and creating educational innovations. Although a few deans mention that these types of non-traditional activities are valued and expected among their faculty, it is unclear whether this is widespread among all engineering colleges or just an emerging trend at a few institutions. One dean did share that their institution had revised their tenure and promotion policies to commercialization is included and to ensure multi-author work is just as valued as single-author work. However, it is not clear overall whether tenure and promotion guidelines are shifting at most institutions to accommodate these types of non-traditional activities.

Traditionally, peer-reviewed journal publications are considered a main output of a faculty member's research. However, researchers now have many creative ways to disseminate their work to the public and make an impact. For example, having a Ted Talk go viral and have thousands of views can

lead to a significant impact. Commercializing a technology and having it be applied can lead to a significant impact as well. How should these types of output be compared to a publication in a peer-reviewed journal, especially a high-tier journal? These are questions that tenure and promotion committees will need to consider. Laursen & Rocque cited the importance of creating transparent and flexible reward structures so incoming faculty clearly understand the values and expectations of the institution [10]. They also discuss how tenure and promotion policies can stifle interdisciplinary and collaborative research. Ensuring tenure and promotion policies are continuously updated to ensure faculty have autonomy in creating different types of impact is especially important moving forward as the roles and responsibilities of faculty evolve.

Deans also recognized connectivity as an important need for faculty. Deans acknowledge the importance of everyday conversations in helping early-stage faculty navigate their immediate problems. This theme aligns well the idea of faculty forming mentoring constellations, which was discussed in the literature review as instrumental to the success of faculty. The deans did not mention potential additional challenges women may undergo in making connections with their colleagues as a faculty need. As discussed in the literature review, women constitute just 16.9% of tenure-track faculty in U.S. colleges of engineering [57], and typically have greater challenges in identifying relatable mentors, networking, and collaborating on research projects, resulting in feelings of isolation in their departments [70]. Asking about the specific needs of women faculty was not part of the interview protocol, however it still was surprising this was not brought up as a need or consideration in the design of faculty development programs. Engineering departments would greatly benefit from developing formal mechanisms to ensure early-stage women faculty (as well as faculty of underrepresented groups) are provided with ample opportunities to connect with other faculty (especially those of the same-gender and/or same-race) to build their social network.

5.2 Faculty Development Resources

The primary resources deans shared are internal programs including the initial orientation and then ongoing professional development workshops. Across the different institutions, there appears to an abundance of resources dedicated to supporting teaching, and also some for supporting research. All of the deans discuss an onboarding orientation, and these programs appear to be quite comprehensive and cover a number of teaching, research, and

administrative topics. These programs can range from half a day to the week, which is a major difference in terms of the depth at which these topics can be covered. There appears to be ongoing faculty development workshops run by different groups such as a teaching and learning center, or office of research. A few deans mention creative approaches to supporting faculty in research including sending them to Washington D.C. to connect with NSF funding agencies and offering proposal reviews through an office of research or external reviewers. It is unclear from the interview how effective these programs are and to what extent incoming engineering faculty attend. Most of the programs described took on a workshop format though, which the literature suggests may not be as effective as engaging faculty over an extended period. FLCs, were mentioned by just two deans. Perhaps more of the institutions offer these types of programs, but they were not explicitly mentioned as a primary program by the vast majority of the deans. As discussed in the literature review, FLCs are very effective because they require longer term faculty engagement, which leads to greater adoption of evidence-based teaching pedagogies. Sustained involvement is imperative to the success of faculty development programs. It is unclear to what extent institutions are incentivizing participation in these programs and what the level of participation is the ongoing workshops and programs offered by the institutions in this study.

There was considerable variation in terms of how institutions promote mentorship. A number of deans described formal mentorship programs that exist at their institution in which a mentor is assigned to a new faculty member. One institution even mentioned they assign an external mentor in addition to an internal mentor. One dean mentioned the use of an online faculty development program through the National Center for Faculty Development & Diversity (NCFDD). This provides an alternative way to access mentorship and faculty development resources. The majority of the institutions however do not have formal mentorship programs. At smaller institutions, the dean or an associate dean can meet one-on-one with each faculty and provide recommendations on who to connect with. The pros and cons of formal models were highlighted by several deans. One dean mentioned that perhaps the assigned mentor should be viewed more as an "onboarding mentor". If implemented correctly, this model seems to mitigate the risk of the mentor and mentee feeling like they are being forced into a long-term relationship while ensuring that every incoming faculty has at least one mentor in the early stages to ask questions and get feedback. This can be especially important for

URMs and women in which it may be more difficult or take additional time to identify long-term mentors. Overall, the deans do discuss connectivity as an important need, yet most institutions offer do not offer formal mentorship programs. The literature does indicate that informal mentoring relationships are more likely to be successful, however there was little to no mention of how institutions are designing orientations and ongoing workshops and programs to promote faculty networking and the natural formation of peer relationships. Whether the mentoring program is structured or unstructured, formal or informal, engineering departments should be cognizant in how they are addressing gender and racial inequities that disproportionately impact certain faculty's social capital and ability to identify mentors.

While the study was focused on identifying incoming faculty needs and general faculty development resources, one question in the protocol focused on understanding the needs of recently tenured faculty and what resources exist at institutions to support them. There was consensus among the deans that more could be done to support mid to senior level faculty. Providing leadership training opportunities and mentorship so that these faculty are equipped to take academic leadership positions and/or be principal investigators in large-scale collaborative research studies was discussed by a few deans. Another idea that was discussed was providing bridge funding to these faculty or have them participate in collaborative research with other faculty, to help make the transition to new research topics. There appear to be few specific resources and programs dedicated to supporting recently tenured faculty.

5.3 Limitations & Future Work

The primary limitation of this study stems from how it was framed as an exploratory study to obtain engineering deans' perspectives on the overall state of faculty development programs within engineering education. The results therefore only provide a high-level evaluation of the different areas within faculty development. Additionally, the deans were not explicitly asked about certain areas of faculty development such as tenure and promotion requirements, FLCs, and work-life balance issues. Asking the deans about these topics would have likely elicited more information that would have provided value to this study.

Despite these limitations, this exploratory study did reveal interesting insights into how engineering deans approach faculty development and it also highlighted several areas for future work. One key area to further investigate involves how faculty development programs may be able to support

faculty in achieving work-life balance early in their career. Work-life balance and stress-levels for faculty appear to be a major issue according to the literature. Faculty have limited time and must manage many different responsibilities. This study indicates that expectations for faculty may actually be evolving to include untraditional activities such as commercializing technologies, which only puts more pressure on faculty. As it currently stands, time is already the main barrier to faculty participating in professional development programs [9]. The engineering education community could benefit from investigating how faculty responsibilities may be evolving and how this may influence faculty work-life balance issues and the design of faculty development programs.

While this study indicates that the engineering faculty have many opportunities to get involved in faculty development programs, it did not indicate to what extent engineering faculty get involved in these programs and how effective they are. In general, the assessment of faculty development programs has been minimal and primarily focused on the number of participants and their satisfaction [6]. Properly assessing faculty development programs requires extensive knowledge and skills, time, and resources that most faculty development centers do not have [71]. The engineering education community could benefit from supporting more planned research projects that assess the type of impact different types of faculty development programs have on teaching, student learning, research productivity, connectivity, and more. The primary form of faculty development programs that engineering deans elaborated on were in the format of workshops. The literature suggests that expanding upon these programs and further providing opportunities for engineering faculty to engage in longer-term programs such as FLCs may be an important next step to enhance faculty development offerings. Providing the proper incentives for faculty to engage in longer-term programs will likely be important to ensure the compliance of faculty until they experience the value of these programs.

This study also confirms that further investigating the effectiveness of different mentorship approaches across the various stages of a faculty's career would be fruitful contributions to the engineering education community. There were significant variations to the extent in which colleges of engineering support mentorship ranging from promoting informal mentorship to formal mentoring. Although, the literature indicates that informal mentoring relationships are generally more successful, ensuring all faculty, including women and other underrepresented minorities, have opportunities to connect and find relatable mentors is of critical

importance to their future success. Investing in formal mechanisms that encourage mentorship and connectivity could support faculty in developing mentoring constellations.

Some research questions within the topic of faculty development that we would suggest the engineering education community should consider include:

- What are non-traditional activities that engineering faculty are increasingly becoming engaged in? Are these activities valued by senior administrators? Are these activities supported in tenure and promotion guidelines?
- How often are tenure and promotion guidelines revised by engineering college administrators? How well do tenure and promotion guidelines support the different non-traditional activities?
- To what extent do engineering faculty participate in different types of faculty development programs and what is the impact of these programs?
- What are best practices for engineering colleges to support the development of mentoring relationships especially for early-stage women and underrepresented groups?
- Are mid to senior level faculty supported enough? What types of faculty support programs exist for these faculty and to what extent are they implemented?

6. Conclusion

This paper presents the findings of an exploratory study to capture engineering deans' perspectives on faculty development needs and existing programs. The deans who participated in this study affirmed the importance of faculty development programs to support the professional development needs of engineering faculty, which include the areas of teaching, research, connectivity, and understanding and managing expectations. A variety of approaches and strategies to support these needs were shared, however there is a lack of coordinated data on which approaches are most effective and the extent to which they are utilized. The results of this study suggest there are opportunities to further investigate the best practices for designing faculty development programs that foster long-term faculty engagement and cultivate mentoring relationships. There also appears to be an opportunity to further investigate the needs of recently tenured faculty and design appropriate programs and resources to support them. Finally, our findings suggest there may be a growing recognition of the value of untraditional activities for faculty such as commercializing technology or developing educational innovations. The results have implications

for both faculty and administrators interested in learning more about the variety of faculty development programs that exist, and engineering educa-

tion researchers interested in learning about specific research topics in faculty development to further investigate.

References

1. National Research Council, *Transforming undergraduate education in science, mathematics, engineering, and technology*, National Academy Press, Washington DC, 1999.
2. S. Elrod and A. Kezar, Increasing student success in STEM: Summary of a guide to systemic institutional change, *Change: The Magazine of Higher Learning*, **49**(4), pp. 26–34, 2017.
3. C. Henderson, A. Beach and N. Finkelstein, Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature, *Journal of Research in Science Teaching*, **48**(8), pp. 952–984, 2011.
4. D. L. Reinholz, J. C. Corbo, M. H. Dancy, N. Finkelstein and S. Deetz, Towards a model of systemic change in university STEM education, *Unpublished manuscript*, 2015.
5. A. F. McKenna, J. Froyd and T. Litzinger, The complexities of transforming engineering higher education: Preparing for next steps, *Journal of Engineering Education*, **103**(2), pp. 188–192, 2014.
6. A. L. Beach, M. D. Sorcinelli, A. E. Austin and J. K. Rivard, *Faculty development in the age of evidence: Current practices, future imperatives*, Stylus Publishing, 2016.
7. C. Finelli, A. Klinger and D. D. Budny, Strategies for Improving the Classroom Environment, *Journal of Engineering Education*, **90**(4), pp. 491–497, 2013.
8. C. Finelli, M. Ott, A. C. Gottfried, C. Hershock, C. O'Neal and M. Kaplan, Utilizing Instructional Consultations to Enhance the Teaching Performance of Engineering Faculty, *Journal of Engineering Education*, **97**(4), pp. 397–411, 2008.
9. S. E. Shadle, A. Marker and B. Earl, Faculty drivers and barriers: laying the groundwork for undergraduate STEM education reform in academic departments, *International Journal of STEM Education*, **4**(1), p. 8, 2017.
10. S. Laursen and B. Rocque, Faculty development for institutional change: Lessons from an ADVANCE project, *Change: The Magazine of Higher Learning*, **41**(2), pp. 18–26, 2009.
11. R. Brent and R. Felder, Helping New Faculty Get Off To A Good Start Paper, 2000 *American Society of Engineering Education Annual Conference*, St. Louis, Missouri, June 18, 2000.
12. R. Boice, *The new faculty member: Supporting and fostering professional development*, Jossey-Bass, 1992.
13. M. D. Sorcinelli and A. E. Austin, *Developing new and junior faculty*, Jossey-Bass, 1992.
14. THE University Workplace Survey 2016: results and analysis. Times Higher Education (THE). <https://www.timeshighereducation.com/features/university-workplace-survey-2016-results-and-analysis>, accessed 14 November 2021.
15. National Research Council, *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, National Academy Press, Washington, DC, 2007.
16. D. Switzer, S. M. Holzer, R. M. Felder and D. E. Hirt, A Model Program for Promoting Effective Teaching In Colleges Of Engineering 1999 *American Society of Engineering Education Annual Conference*, Charlotte, North Carolina, June 20, 2000.
17. R. Brent and R. M. Felder, A model for engineering faculty development, *International Journal of Engineering Education*, **19**(2), pp. 234–240, 2003.
18. M. D. Sorcinelli, A. E. Austin, P. L. Eddy and A. L. Beach, *Creating the Future of Faculty Development: Learning from the Past, Understanding the Present*, Anker, Bolton, MA, 2006.
19. A. E. Austin, M. D. Sorcinelli and M. McDaniels, Understanding new faculty background, aspirations, challenges, and growth, The scholarship of teaching and learning in higher education: An evidence-based perspective, pp. 39–89, Springer, Dordrecht, 2007.
20. C. A. Trower, *Success on the tenure track: Five keys to faculty job satisfaction*, JHU Press, 2012.
21. J. M. Gappa, A. E. Austin and A. G. Trice, *Rethinking faculty work: Higher education's strategic imperative*, Jossey-Bass, 2007.
22. C. Cook and M. Kaplan, *Advancing the Culture of Teaching on Campus: How a Teaching Center Can Make a Difference*, Stylus Publishing, Herndon, VA, 2011.
23. L. Dee Fink, Orientation programs for new faculty, *New directions for teaching and learning*, **50**, pp. 39–49, 1992.
24. C. Henderson, M. Dancy and M. Niewiadomska-Bugaj, Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation process?, *Physics Education Research*, **8**(2), pp. 1–14, 2012.
25. A. Stes, M. Min-Leliveld, D. Gijbels and P. Van Petegem, The impact of instructional development in higher education: The state-of-the-art of the research, *Educational Research Review*, **5**(1), pp. 25–49, 2010.
26. D. Ebert-May, T. L. Derting, J. Hodder, J. L. Momsen, T. M. Long and S. E. Jardeleza, What we say is not what we do: Effective evaluation of faculty professional development programs, *BioScience*, **61**(7), pp. 550–558, 2011.
27. N. Davidovitch and D. Soen, Using students' assessments to improve instructors' quality of teaching, *Journal of Further and Higher Education*, **30**(4), pp. 351–376, 2006.
28. R. M. Felder, R. Brent and M. J. Prince, Engineering instructional development: Programs, best practices, and recommendations, *Journal of Engineering Education*, **100**(1), pp. 89–122, 2011.
29. C. Henderson and M. H. Dancy, Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics, *Physical Review Special Topics-Physics Education Research*, **3**(2), 020102, 2007.
30. L. D. Fink, The current status of faculty development internationally, *International journal for the scholarship of teaching and learning*, **7**(2), pp. 1–9, 2013.
31. A. E. Austin, Promoting evidence-based change in undergraduate science education, Fourth committee meeting on status, contributions, and future directions of discipline-based education research, 1 March 2011.
32. A. L. Beach and M. D. Cox, The impact of faculty learning communities on teaching and learning, *Learning Communities Journal*, **1**(1), pp. 7–27, 2009.
33. K. Mårtensson, T. Roxå and T. Olsson, Developing a quality culture through the scholarship of teaching and learning, *Higher Education Research & Development*, **30**(1), pp. 51–62, 2011.

34. J. Groccia, *Building Teaching Capacities in Higher Education. A Comprehensive International Model*, Stylus Publishing, Sterling, VA, 2010.
35. S. E. Brownell and K. D. Tanner, Barriers to faculty pedagogical change: Lack of training, time, incentives, and . . . tensions with professional identity?, *CBE – Life Sciences Education*, **11**(4), pp. 339–346, 2012.
36. J. Bouwma-Gearhart, Research university STEM faculty members' motivation to engage in teaching professional development: Building the choir through an appeal to extrinsic motivation and ego, *Journal of Science Education and Technology*, **21**(5), pp. 558–570, 2012.
37. V. M. Lechuga, A motivation perspective on faculty mentoring: the notion of “non-intrusive” mentoring practices in science and engineering, *Higher Education*, **68**(6), pp. 909–926, 2014.
38. P. Schrodt, C. S. Cawyer and R. Sanders, An examination of academic mentoring behaviors and new faculty members' satisfaction with socialization and tenure and promotion processes, *Communication Education*, **52**(1), pp. 17–29, 2003.
39. S. C. de Janasz and S. E. Sullivan, Multiple mentoring in academe: Developing the professional network, *Journal of Vocational Behavior*, **64**(2), pp. 263–283, 2004.
40. L. Sheridan, N. H. Murdoch and E. Harder, Assessing Mentoring Culture: Faculty and Staff Perceptions, Gaps, and Strengths, *Canadian Journal of Higher Education*, **45**(4), pp. 423–439, 2015.
41. D. L. Haggard, T. W. Dougherty, D. B. Turban and J. E. Wilbanks, Who is a mentor? A review of evolving definitions and implications for research, *Journal of Management*, **37**(1), pp. 280–304, 2011.
42. B. R. Ragins and K. E. Kram, *The handbook of mentoring at work: Theory, research, and practice*, Sage Publications, Thousand Oaks, CA, 2007.
43. K. Kjeldsen, A proficient mentor is a must when starting up with research, *Experimental & Clinical Cardiology*, **11**(3), pp. 243–245, 2006.
44. K. F. Schrubbe, Mentorship: a critical component for professional growth and academic success, *Journal of Dental Education*, **68**(3), pp. 324–328, 2004.
45. A. M. Padilla, Ethnic minority scholars, research, and mentoring, *Educational Researcher*, **23**(4), pp. 24–27, 1994.
46. C. A. Stanley and Y. S. Lincoln, Cross-race faculty mentoring, *Change: The Magazine of Higher Learning*, **37**(2), pp. 44–50, 2005.
47. V. A. Jackson, A. Palepu, L. Szalacha, C. Caswell, P. L. Carr and T. Inui, T, “Having the right chemistry”: a qualitative study of mentoring in academic medicine, *Academic Medicine*, **78**(3), pp. 328–334, 2003.
48. R. K. Haynes and J. M. Petrosko, An investigation of mentoring and socialization among law faculty, *Mentoring & Tutoring: Partnership in Learning*, **17**(1), pp. 41–52, 2009.
49. A. S. Detsky and M. O. Baerlocher, Academic mentoring – how to give it and how to get it, *JAMA*, **297**(19), pp. 2134–2136, 2007.
50. B. R. Ragins and J. L. Cotton, Mentor functions and outcomes: A comparison of men and women in formal and informal mentoring relationships, *Journal of Applied Psychology*, **84**(4), p. 529, 1999.
51. Z. Long, P. M. Buzzanell, K. Kokini, R. F. Wilson, J. C. Batra and L. B. Anderson, Mentoring Women and Minority Faculty in Engineering: A Multidimensional Mentoring Network Approach, *Journal of Women and Minorities in Science and Engineering*, **24**(2), 2018.
52. L. Pololi and S. Knight, Mentoring faculty in academic medicine, *Journal of General Internal Medicine*, **20**(9), pp. 866–870, 2005.
53. P. P. Wilson, A. Pereira and D. Valentine, Perceptions of new social work faculty about mentoring experiences, *Journal of Social Work Education*, **38**(2), pp. 317–332, 2002.
54. M. H. Wasburn and J. M. LaLopa, Mentoring faculty for success: Recommendations based on evaluations of a program, *Planning and Changing*, **34**(3/4), pp. 250–264, 2003.
55. J. W. Smith, W. J. Smith and S. E. Markham, Diversity issues in mentoring academic faculty, *Journal of Career Development*, **26**(4), pp. 251–262, 2000.
56. S. K. Gibson, Mentoring of women faculty: The role of organizational politics and culture, *Innovative Higher Education*, **3**(1), pp. 63–79, 2006.
57. American Society for Engineering Education, *Engineering by the numbers*, Washington, DC, 2018.
58. C. C. Dunham, L. H. Weathers, K. Hoo and C. Heintz, I just need someone who knows the ropes: Mentoring and female faculty in science and engineering, *Journal of Women and Minorities in Science and Engineering*, **18**(1), pp. 79–96, 2012.
59. K. E. O'Brien, A. Biga, S. R. Kessler and T. D. Allen, A meta-analytic investigation of gender differences in mentoring, *Journal of Management*, **36**(2), pp. 537–554, 2010.
60. C. McKeen and M. Bujaki, Gender and mentoring: Issues, effects, and opportunities, in B. R. Ragins & K. E. Kram, *The handbook of mentoring at work: Theory, research, and practice*, Sage Publications, Thousands Oaks, CA, 2007.
61. M. D. Sorcinelli and J. Yun, From mentor to mentoring networks: Mentoring in the new academy, *Change: The Magazine of Higher Learning*, **39**(6), pp. 58–61, 2007.
62. I. J. H. van Emmerik, The more you can get the better: Mentoring constellations and intrinsic career success, *Career Development International*, **9**(6/7), pp. 578–594, 2004.
63. A. E. Austin, S. Laursen, A. B. Hunter, M. Soto and D. Martinez, Organizational change strategies to support the success of women scholars in STEM Fields: Categories, variations, and issues, *Proc. Annual Conference of the American Educational Research Association*, New Orleans, LA, 2011.
64. American Society for Engineering Education College Profiles, <http://profiles.asee.org>, Accessed 14 November 2021.
65. V. Braun, and V. Clarke, Using thematic analysis in psychology, *Qualitative Research in Psychology*, **3**(2), pp. 77–101, 2006.
66. Dedoose Version 7.0.23, web application for managing, analyzing, and presenting qualitative and mixed method research data, www.dedoose.com, accessed November 14, 2021.
67. J. Creswell and J. Creswell, *Research Design: Qualitative, Quantitative, Mixed Methods Approaches*, Sage Publication, Thousand Oaks, CA, 2016.
68. J. L. Fleiss, Measuring nominal scale agreement among many raters, *Psychological Bulletin*, **76**(5), p. 378, 1971.
69. J. Saldaña, *The coding manual for qualitative researchers*, Sage Publications, Thousand Oaks, CA, 2015.
70. C. A. Smith, Assessing academic STEM women's sense of isolation in the workplace, in P. J. Gilmer, B. Sanel & M. H. Miller (Eds.), *Alliances for advancing academic women, Bold Visions in Educational Research*, (pp. 97–117). Rotterdam, Netherlands: Sense Publishers.
71. S. R. Hines, Investigating faculty development program assessment practices: What's being done and how can it be improved?, *The Journal of Faculty Development*, **23**(3), pp. 5–19, 2009.

Appendix A: Interview Protocol

1. On average, how many faculty does your college hire per year? (ask about TT and contract)
2. Do you have a process for onboarding new faculty and if so, can you describe it?
3. As faculty get started, have you noticed any areas where they tend to need more guidance, or alternatively, areas where they seem to do well?
4. Have you noticed any requests or trends from faculty in terms of what they need to be successful?
5. What would you suggest as critical components of a faculty mentorship model/program?
6. Are there programs (such as faculty development workshops) that you are aware of, and that you recommend to your faculty? (could be internal, external) And why those, if any mentioned?
7. Do you provide any resources to your faculty in terms of mentorship/faculty development? Please describe. Probe for where funding for resources come from and how much.
8. Does your college have specific targets for recruitment and retention? If so, probe for any strategies that college is implementing to achieve targets.
9. What are some of the top priorities for your college? (e.g., the overall strategic direction, mission, etc.)
10. In recent years entrepreneurship (or entrepreneurial thinking/education) has become more present in engineering colleges. What is your perspective on the role of entrepreneurial thinking in engineering?
11. What opportunities (or needs) are you aware of that relate to mentorship of faculty after promotion/tenure?
12. Are there any questions I should have asked or anything else I should know?

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