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Faculty Development for Chemical Engineering Professors: Opportunities Across Career Stages

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Abstract

This research paper centers on documenting the professional development opportunities available for chemical engineering faculty across their entire career from graduate school to late career. In brief, the professional growth of chemical engineering professors is supported by a wide range of faculty development opportunities, from one-on-one mentorship to large-scale workshops engaging hundreds of participants. In this work, we analyzed current faculty development opportunities. The goal was to identify and develop new, targeted faculty development activities. We categorized faculty development activities based on career stages—future faculty, early career, mid-career, and late career—and mapped them to the four major job roles, namely teaching, research, service, and leadership/administration. By first providing a detailed compilation of faculty development opportunities from the multiple lenses of our authors, several opportunities for new professional development were identified. While abundant resources exist for future and early-career faculty, a pronounced gap exists in development programs for mid-career faculty. Additionally, we highlight the evolving role of faculty in mid- and late-career stages, where leadership and administrative responsibilities become increasingly prominent. The need for mid- and late-career development initiatives focusing on these expanded roles is evident. This contribution aims to serve as a valuable resource for chemical engineering faculty as well as a template for other engineering faculty to do a similar analysis of faculty development opportunities in their specialty across career stages. Finally, we hope to leverage this contribution to assist our professional organization, AIChE, with creating new opportunities that can address the gaps identified while also being tailored to unique career trajectories.

Introduction

The importance of faculty development in higher education cannot be overstated, as it directly impacts the quality of teaching, research, service, and leadership within academic institutions [1-4]. In engineering, where rapid technological advancements and interdisciplinary integration continually occur, professional growth is essential [3]. The need for faculty professional development has been increasing in importance, particularly with changes in accreditation standards, continual evolution in student demographics, advancements in learning technologies, and the progression that has been made within the scholarship of teaching and learning field [3]. In support of this recognized need, engineering professional associations have created networks that focus on faculty development, such as the ASEE Faculty Development Division and the POD Science, Technology, Engineering, and Mathematics (STEM) Special Interest Group [2].

Faculty professional development can take a wide array of forms. These can include workshops, seminars, mentoring programs, and collaborative research projects [3, 5, 6]. For instance, the National Effective Teaching Institute (NETI) is a three-day workshop that has been in place since 1991 to help faculty members understand how to design instruction, integrate active learning into their classes, and effectively assess learning [7]. Another example, Mentorship 360, is an effort undertaken between Arizona State University and other national universities, with the support of the Kern Entrepreneurial Engineering Network (KEEN), to allow all faculty members

the chance to benefit from faculty mentorship [8]. Some faculty development models apply a combination of workshops, seminars, mentoring programs, and collaborative research projects to ensure their effectiveness. One such example is the Just-in-Time Teaching with Two Way Formative Feedback (JTFD) faculty development. As part of this model, faculty attended workshops throughout the first semester and then transitioned into communities of practice throughout their second semester of participation [9]. Another example is the Engineering Unleashed faculty development program, sponsored by the Kern Family Foundation, which offers a wide variety of faculty professional development training opportunities that combine 3-5 day virtual or in-person workshops with a yearlong coaching model [10].

Effective faculty development programs not only improve individual faculty performance but also lead to impacts on students and the broader educational system [2, 7, 9]. Some of the more well-recognized work on faculty development outcomes relates to programs focused on active learning. Felder and Brent [7] performed a NETI workshop alumni survey in 2008, where they obtained responses from past participants (representing 44% of all NETI participants). Faculty shared that the quality of their instruction improved, they were more confident in their approaches, and they had learned and improved in their use of teaching methods. They also shared how their student ratings showed increases since their participation in the workshop (true of 67% of participants) [7]. Similarly, results from the JTFD year-long professional development program found that faculty members had improved attitudes and practices related to active learning, which has even carried forward into improvements in student achievement [9].

Faculty development can be categorized into different stages based on the experience of faculty members: future faculty, early career, mid-career, and late career. Each stage has unique needs and challenges that require tailored development opportunities.

1. **Future Faculty**: This stage includes graduate students and postdoctoral researchers who aspire to become faculty members. Development opportunities at this stage focus on preparing individuals for the academic job market and equipping them with the necessary skills for teaching, research, and the nuances of academic culture.
2. **Early Career**: Early-career faculty members are typically in their first few years of a tenure-track or professional-track position. Development programs for this group often emphasize teaching effectiveness, research productivity and independence, and work-life balance. Mentorship from senior faculty plays a critical role in guiding early-career faculty through the tenure and early-career processes.
3. **Mid-Career**: Mid-career faculty members have typically achieved tenure and/or promotion and then are looking to expand their roles both inside and outside their institution. Mid-career faculty often seek opportunities to enhance their leadership skills, engage in larger-scale interdisciplinary research, start providing mentorship to more junior faculty, and take on administrative roles.
4. **Late Career**: Late-career faculty members often have valuable experience in leadership and administrative positions. Opportunities at this stage include preparing faculty for retirement, legacy planning, and mentoring the next generation of both students and faculty colleagues.

This research aims to document and analyze the faculty development opportunities available to a single engineering discipline, chemical engineering, across the entire career span. By identifying gaps and proposing targeted development activities, this work seeks to identify opportunities that

can enhance the professional growth of faculty members at all stages. Furthermore, this study serves as a template for other engineering disciplines to conduct similar analyses, fostering a holistic approach to faculty development across engineering. Ultimately, this contribution aims to assist professional organizations, like AIChE, in creating tailored professional development opportunities that support the unique career trajectories of their faculty members, foster academic excellence, promote effective leadership, and ensure the continued advancement of the chemical engineering discipline.

Research Questions

The authors began this project with an overarching goal to identify gaps in chemical engineering faculty development opportunities with the prospect of proposing new and innovative programs that could be developed to assist these faculty members throughout their careers. Although there were a variety of areas of analysis related to faculty development program opportunities that could be investigated, the authors focused upon career stages for the purpose of this particular study as addressed by the following research questions:

1. What types of faculty development opportunities exist for chemical engineering faculty across their career stages?
2. What gaps exist in faculty development opportunities, and what types of faculty professional development opportunities may address these gaps?

Methods

Four engineering faculty members at varying career stages with diverse experiences in the chemical engineering field were brought together to work on this project. The faculty members represented a mixture of genders (two female and two male) as well as distributed academic and leadership experience (chair, associate chair, full professor, and associate professor). During the authoring of this paper, each author was at a different university, and collectively, the authors had been faculty members at 7 unique institutions. The project team had monthly meetings to help guide the work that was being conducted.

Initially, the project team met to discuss their backgrounds and experiences with faculty development in the chemical engineering field. This led to the development of a plan for the identification of chemical engineering faculty development opportunities. Each faculty member was tasked with developing a list of all the professional development opportunities they had participated in as well as those that they had recommended to others, and finally, any that they were aware of but may not have had personal experience with. The first author, lead of the project team, then collated the assembled lists of faculty professional development opportunities into one spreadsheet that could be used for the categorization process, removing any duplicate entries that may have been brought forward due to the individual faculty experiences shared.

In the second project team meeting, the faculty members reviewed the collated list of faculty professional development opportunities and categorized them based on the primary career stage focus (future faculty, early career, mid-career, late-career), primary job role (teaching, research, service, or leadership/administration), and through what type of organization the professional development opportunity was offered (university or organization) while noting examples of

specific groups that had these professional development opportunities. Through this exercise, it was possible to gain a deeper understanding of the distribution of chemical engineering faculty professional development opportunities.

Other project team meetings focused on reviewing the curated chemical engineering faculty professional development opportunities list and identifying areas where gaps existed and what types of professional development opportunities might be able to address these shortcomings.

Limitations

This project did not follow a systematic approach to identify chemical engineering faculty professional development opportunities. For example, no search engine, digital tool, or archive specific to cataloging faculty development opportunities exists to our knowledge. Although the broad base of experience of the project team was meant to attempt to cover the extent of chemical engineering faculty professional development experiences, it is possible that some programs were missed as they were outside the scope of the project team's experiences. We also acknowledge that due to our focus on categorizing professional development opportunities based upon career stages, other elements of faculty professional development that may be of interest to faculty, such as availability and accessibility to these opportunities by diverse audiences, was not included as part of the analysis.

Results and Discussion

This section centers on the two research questions that guided this project work. Each section provides a summary of the project team's results and how they relate to relevant literature in the faculty development field. However, a general discussion of faculty's various job roles and some habits related to faculty development and personal growth begins this section to provide greater context.

The fallacy of the superstar professor who excels at research, teaching, service, mentoring, and all other job roles has been discussed [11]. Similarly, many faculty work hard to excel in multiple roles, and this grit is commonly correlated with successes in life [12-14]. Here, our group's focus was not on the primary activities of a chemical engineering professor but rather on the actions and activities that help develop transferable skills used throughout a chemical engineering faculty member's professional activities and careers. The habits compiled here (Table 1) capture some faculty activities that look beyond prepping for the next class or submitting the abstract/proposal/paper by tomorrow's deadline. More comprehensive views of successful faculty life are available elsewhere [15, 16].

Table 1. List of general habits for engineering faculty development

Attending department retreats
Attending short courses and workshops.
Reading non-technical books/journals papers. Ex: Leadership, Writing, Communication, Goal setting, etc.
Reading technical books/journals - both teaching and research

Responding to reviews/criticism for grants, papers, etc.
Serving as a session chair or co-chair
Serving on committee(s) (internal or external)
Setting annual goals. Ex: Submitting proposals, obtaining funding, winning awards, strengthening CV, etc.
Taking breaks. Ex: Regular sleep, weekly downtime, annual vacation
Talking to friends/mentors

Therefore, various habits help faculty succeed in their multi-faceted job. How faculty learn about or form these habits relates to the responses to our research questions, which are detailed next.

Research Question 1 (RQ1)

In response to RQ1, *What types of faculty development opportunities exist for chemical engineering faculty across their career stages*? The project team assembled all the faculty professional development opportunities they could identify based on their personal experiences, many of which related to activities outlined in Table 2. Additional information about where to learn more about each of these professional development opportunities is included as a reference in the Appendix.

Table 2. Curated List of Chemical Engineering Faculty Professional Development Opportunities.

Event name and brief description	**Primary career stage**	**Primary job role(s)**	**Organization or University**	**Specific group (if applicable)**
ACS Webinars	Multiple	Multiple	Organization	ACS
AIChE Academy Webinars	Multiple	Multiple	Organization	AIChE
Future Faculty Mentorship Program AIChE Education Division	Future	Multiple	Organization	AIChE
AIChE Career Discovery workshops	Multiple	Multiple	Organization	AIChE
ASEE Webinars and Short Courses	Multiple	Multiple	Organization	ASEE
ASEE Conference workshops - topics vary annually	Multiple	Teaching	Organization	ASEE
ASEE Safe Zone Workshops	Multiple	Multiple	Organization	ASEE
ASEE DELTA workshops	Early	Multiple	Organization	ASEE
Summer School for Chemical Engineering Faculty	Early	Teaching	Organization	ASEE/AIChE
Virtual communities of practice - lab, teaching faculty, teaching online during 2020 and 2021, others by NSF grant	Multiple	Teaching	Organization	ASEE/AIChE

Engineering Unleashed faculty development workshops - 3.5 days in person plus 1 year of coaching (~10 different per year)	Multiple	Teaching	Organization	Kern Family Foundation
Kern Entrepreneurial Engineering Network (KEEN) National Conference	Multiple	Multiple	Organization	Kern Family Foundation
Engineering Unleashed Webinars and Short Courses (~10 different)	Multiple	Multiple	Organization	Kern Family Foundation
NAE Frontiers of Engineering Education conference (2010-2016)	Early	Teaching	Organization	NAE
NAE Frontiers of Engineering conference	Early	Teaching	Organization	NAE
National Effective Teaching Institute workshops (~4 different)	Multiple	Teaching	Organization	NETI
NSF Grants Conference (in-person and virtual)	Early	Research	Organization	NSF
Webinars/web conferences from vendors	Multiple	Teaching	Organization	Ex: Perusall, zyBooks, Knovel
External mentor(s)	Early	Multiple	Organization	Various
Student Chapter advising	Multiple	Multiple	Organization	Various
Technical workshops (e.g., hosted/supported by NSF, NIST, NAE, other organizations)	Multiple	Research	Organization	Various
Preparing Future Faculty Workshop	Future	Multiple	University	Auburn University
Executive Leadership in Academic Technology, Engineering and Science (ELATES)	Multiple	Multiple	University	Drexel University
Advocates and Allies Program	Multiple	Multiple	University	Iowa State University
ProQual Institute for Research Methods	Early	Research	University	University of Georgia
COACh Workshops (~10 different topics)	Multiple	Multiple	University	University of Oregon
Internal mentor(s)	Multiple	Teaching	University	Various
University Teaching and Learning Centers (seminars, communities, fellows, etc.)	Multiple	Teaching	University	Various
Emerging Leaders Programs	Mid	Multiple	University	Various
Professionalism & Integrity in Research Programs	Multiple	Research	University	Washington University in St Louis

Analysis of the chemical engineering faculty professional development opportunities revealed that the majority of opportunities tried to address multiple career stages (20; 67%) with more focused professional development opportunities primarily targeted towards the early career stages (7; 23%). Mid- and late-career stage targeted faculty professional development opportunities were almost non-existent with only one mid-career stage opportunity identified.

Similar to the distribution of chemical engineering faculty professional development opportunities across career stages, the primary job function associated with the opportunity often focused on multiple elements (16, 53%). With regards to individual job functions, teaching professional development opportunities were most prevalent (10; 33%), followed by research (4; 13%). It is not surprising that teaching has many professional development opportunities, particularly with an emphasis on encouraging the use of active learning in the classroom [7, 9]. However, as echoed in other faculty development reviews [2], there is a much lower quantity of research professional development opportunities.

The majority of chemical engineering faculty professional development opportunities (21; 70%) were offered by organizations (professional organizations, private foundations, governmental entities), whereas a smaller component was found to be provided through universities (9; 30%).

Research Question 2 (RQ2)

To address RQ2, *What gaps exist in faculty development opportunities and what types of faculty professional development opportunities may address these gaps?,* we have provided a brief overview of the importance of job roles as a function of career stage before sharing the outcomes of our analysis from Table 2 that allowed us to identify gaps and propose potential opportunities.

The traditional faculty roles of teaching, research, and service propagate across all career stages. With many types of professional track faculty positions now available in addition to traditional tenure track positions, alignment of this analysis with promotions may or may not apply. Starting in mid-career, historically after earning promotion and tenure, new opportunities generally become available related to administration, creating new avenues for additional professional development opportunities. Thus, summarizing the roles of faculty in relationship to career stages was completed and shown in Table 3. Next, brief summaries across these career stages are presented.

Table 3. Importance of job roles as a function of career stage for chemical engineering faculty (nominally in a tenure-track position).

Role → **Career Stage ↓**	**Teaching**	**Research**	**Service**	**Administration**
Future	Minor	Major	Minor	Not applicable
Early	Major	Major	Minor	Not applicable
Mid	Minor to Major	Minor to Major	Minor to Major	Minor to Major
Late	Minor to Major	Minor to Major	Minor to Major	Minor to Major

Future and prospective faculty have many funded programs, from Research Experiences for Undergraduates (e.g., NSF REUs) to special graduate fellowships and training (e.g., NIH and NSF) to postdoctoral programs helping transition to an independent career (e.g., ASEE and NIH K99R01). The AIChE Education Division's Future Faculty Mentoring program is an exemplar in this space. While some of these programs may not provide opportunities to all prospective faculty, support for future and prospective faculty is available.

Similarly, many opportunities exist for faculty development for engineering professors in the early stages of their independent academic careers. In addition to numerous early career funding opportunities (e.g., government agencies including NSF, DOE, DOD, and NIH), most universities have mentoring programs with colleagues inside their home department, across the home institution, and sometimes externally. These institutional programs can range from semi-formal to highly formal. Long-running, high-impact workshops in this space include NETI and many other national, regional, and institutional programs in operation. One of the largest opportunities for chemical engineering faculty is the Chemical Engineering Summer School co-hosted by ASEE's Chemical Engineering Division and AIChE's Education Division. This weeklong event has only been offered every 5 years. The impact of this event is measurable through the authors' personal experiences as well as documented over recent years [17-19]. For the size of Chemical Engineering faculty in the United States at this point, an opportunity was seen to host this type of event more often to reach almost all faculty during their first ~3 years of faculty life. For these reasons, additional faculty development targeted at this early career stage is not essential at this time.

We found that opportunities for intentional and focused faculty development in the mid-career stage are sparse. As faculty members progress through their careers, their roles and responsibilities evolve. Mid-career faculty often take on more significant leadership and administrative responsibilities, which require specialized training and support. This expansion of responsibilities related to administration and leadership is distinct and important, and these roles require a different set of skills compared to those needed for teaching and research. Administration can begin at the home institution as undergraduate or graduate program chair or department chair. Other administrative positions include associate dean, journal editor, or temporary program manager at another organization such as NSF (often through a leave of absence or sabbatical). External leadership roles in the service area are commonly taken up during this period also, such as hosting meetings/conferences or serving as an elected leader in a society/division/forum. Although our review allowed for identification of the Emerging Leaders Programs as a university-based initiative that could assist mid-career faculty, the number of faculty professional programs targeted specifically for this career stage were found to be lacking and could serve as an opportunity for further development. Specifically, programs that can uniquely target the transition in job responsibilities that occurs at this career stage would be invaluable.

Finally, an analogy between successful late-career faculty and successful founders of growing, profitable companies is apt. While founders in the private sector initiate succession plans, the transition from founder to second-generation leadership has been found to be the most difficult [20]. Faculty who, during mid-career, stood up new programs (e.g., major or minor) and oversaw those for years must now pass on these responsibilities to others. We see some limited

opportunities for faculty development at this career stage, specifically related to the transition of leadership.

Next Steps for Chemical Engineering Faculty Development

Some additional ideas to add structure and sustainability related to chemical engineering faculty development were discussed and shared here to capture ongoing work in this space. First, the AIChE Education Division recently formed a committee on Faculty Development. The group was initiated in 2024 to consist of about a half dozen members, including faculty volunteers at different career stages, a representative from the elective volunteers of the Education Division, an AIChE staff member, and plans to add an outside-of-chemical-engineering member to broaden the perspectives. One of the committee's initial goals is to create and maintain a website related to chemical engineering faculty development, which would have made the authors' work discussed here much easier. In addition, the group hopes to evaluate new opportunities as well as financial models for faculty development events.

Other opportunities that have been created by the chemical engineering community have shown variable sustainability. Examples include virtual meet-ups and virtual communities [21-24]. AIChE's Institute of Learning and Innovation has run versions of a workshop titled Career Discovery. While focused on working with chemical engineers and students in the past, a faculty-centric workshop was hosted at the 2024 AIChE Annual Meeting. We also see opportunities at interfaces, such as infusing research and best practices from the engineering education community into the faculty development space. The integration of non-AIChE activities and funding opportunities (e.g., NSF) to measure the impact of faculty development programs may attract researchers and other groups (e.g., NAE). For example, research examining belonging and development for engineering students could be expanded to faculty as part of new faculty development programs [25, 26].

Conclusion

This study highlights the extensive range of faculty development opportunities available to chemical engineering professors across various career stages. From mentorship programs for future faculty to workshops for early career faculty, these initiatives play a crucial role in enhancing teaching, research, service, and administrative skills. However, the analysis also reveals a gap in development programs for mid-career faculty, particularly in areas related to growing into new leadership and administrative responsibilities. Addressing this gap is essential to ensure faculty members are well-prepared to take on evolving roles and continue contributing effectively to their institutions and the broader academic community.

Moving forward, we believe professional organizations like AIChE should develop targeted faculty development initiatives that cater to the unique needs of mid-career faculty. By fostering a culture of continuous professional growth and providing tailored support, these initiatives can help faculty members navigate the complexities of their careers and achieve excellence in their multifaceted roles. This study serves as a valuable resource for chemical engineering faculty and a template for other engineering disciplines to conduct similar analyses, ultimately promoting a holistic approach to faculty development across the engineering field.

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Appendix

Table 4. Links or references to provide additional details related to faculty development activities for chemical engineering professors presented in Table 2.

Event name	Details available at: (web link or DOI or other reference)
ACS Webinars	https://www.acs.org/acs-webinars.html
AIChE Academy Webinars	https://www.aiche.org/ili/academy
Future Faculty Mentorship Program AIChE Education Division	https://www.aiche.org/community/sites/divisions-forums/education-division/future-faculty-programs
AIChE Career Discovery workshops	https://www.aiche.org/ili/career-discovery
ASEE Webinars and Short Courses	https://www.asee.org/publications/Multimedia/Select-Webinars
ASEE Conference workshops - topics vary annually	https://www.asee.org/events/Conferences-and-Meetings/2025-Annual-Conference/Session-Management/For-Workshop-Organizers
ASEE Safe Zone Workshops	https://lgbtq.asee.org/safe-zone-workshops/
ASEE DELTA workshops	https://learning.asee.org/about-us/
Summer School for Chemical Engineering Faculty	http://ched.asee.org/events/summer-school/
Virtual communities of practice - lab, teaching faculty, teaching online during 2020 and 2021, others by NSF grant	Ex: https://doi.org/10.18260/1-2--29820; https://doi.org/10.1103/PhysRevPhysEducRes.15.020147; https://doi.org/10.18260/2-1-370.660-125282; https://www.ingentaconnect.com/content/magna/jfd/2016/00000030/00000001/art00005
Engineering Unleashed faculty development workshops - 3.5 days plus 1 year of coaching (~10 per year)	https://learningevents.engineeringunleashed.com/pages/2024-eufd-homepage
Kern Entrepreneurial Engineering Network (KEEN) National Conference	https://engineeringunleashed.com/keen-national-conference
Engineering Unleashed Webinars and Short Courses (~10 different)	https://learningevents.engineeringunleashed.com/collections/on-demand
NAE Frontiers of Engineering Education conference (2010-2016)	https://www.nae.edu/

NAE Frontiers of Engineering conference	https://www.naefrontiers.org/
National Effective Teaching Institute workshops (~4 different)	https://www.neti-workshop.org/
NSF Grants Conference (in-person and virtual)	https://nsfpolicyoutreach.com/
Webinars/web conferences from vendors, e.g. Perusall, zyBooks, Knovel	Ex: https://www.zybooks.com/webinars/; https://www.perusall.com/events; https://www.elsevier.com/products/knovel/resources
External mentor(s)	Varies greatly by mentor and mentee
Student Chapter advising	Ex: AIChE Advisors Guide Book https://www.aiche.org/students/student-leader-resources
Technical workshops (e.g., hosted/ supported by NSF, NIST, NAE, etc.)	Specific audience may be limitation.
Preparing Future Faculty Workshop	https://www.eng.auburn.edu/faculty-workshop/index.html
Executive Leadership in Academic Technology, Engineering and Science (ELATES)	https://drexel.edu/provost/priorities/elates
Advocates and Allies Program	https://www.advancepartnership.iastate.edu/project/advocates-allies
ProQual Institute for Research Methods	https://proqual.uga.edu/
COACh Workshops (~10 different topics)	https://coach.uoregon.edu/
Internal mentor(s)	Varies greatly by mentor and mentee
University Teaching and Learning Centers (seminars, communities, fellows, etc.)	Ex: https://ctl.gatech.edu/faculty/groups/PTLF
Emerging Leaders Programs	Ex: https://provost.gatech.edu/emerging-leaders
Professionalism & Integrity in Research Programs	https://integrityprogram.org/
HERS Network Various Programs	https://hersnetwork.org/programs/

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