Enhancing Engineering Early-career Faculty Awareness of Research Grant Writing Using an On-demand, Online Intervention

By

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ABSTRACT

During the last 25 years, the academic research environment has become increasingly competitive, with those seeking grants contending for over $83.7 billion, available from primarily six federal agencies. Notably, this increased competition occurred at the same time states have cut support for public universities. To deal with decreases in state support, university leaders and administrators have adopted "new managerialist" approaches that capitalized on three elements obliging early-career engineering faculty members to 'win' more federal funding. These three components include (a) leveraging the probationary period during promotion and tenure to stimulate grant production, (b) seeking revenue beyond tuition and operations to support the institution, and (c) augmenting faculty resources by including professional grant writers/support personnel who collaborate with early-career faculty members to mitigate challenges of increased competition for grants by providing domain and implicit knowledge to aid the engineers in grant development. The promotion and tenure process has become particularly challenging for early-career engineers because of the highly competitive federal research landscape.

This mixed-methods action research (MMAR) study was conducted to examine the effects of an intervention designed to provide on-demand, online grant writing professional development using a set of five modules. The modules focused on providing information about five constructs related to grant development or grant writing, including requirements, processes, skills, attitudes, and self-efficacy. For three of the five modules, participants demonstrated modest or moderate increases in quantitative scores for the constructs based on survey data. During semi-structured interviews, early-career

engineering faculty members revealed candid thoughts about the modules, grant writing, and the “need” to obtain grants as part of their professional lives. Four themes emerged from the qualitative data, including *Knowledge*, *Online Learning*, *Grant Writing Process*, and *Winning the Next Grant*. The discussion focused on connections between the quantitative and qualitative data, explaining the findings based on the theoretical frameworks, limitations, implications for practice and research, and included a summary.

DEDICATION

I dedicate this educational journey with loving gratitude to my family near and far,

those with us and those who have gone ahead of us, and

those who are blood and those who are family through life's pathways.

Espero que Dios les bendiga con salud, paz, y amor.

My Truth Tellers,

Thank you for your love, joy, and levity during this dark time. Dante had Virgil, and I had you. New babies, Pinterest-fails, and untold home repairs. Thank you for making space when I could not find space. Your families, the avocado, Tessa, and crazy data you do. Coffee. Compassion. Snacks. The Pitt. Life marches on even in a pandemic. Making cloth masks. Audible, Scribd and Insight should be paying us. Luna. Zoom dinners. FL Harriet. Salsa. *Mi casa es su casa*. Olaf & Comet. Phone calls. Crypto. Baking Bread. Tiny frogs. Flowers. New hopes. Forgiveness. Love. Retail Poetry. Miracle. Blessings. New houses. TX babies. The girls. Pictures of you. Music. Waiting. NEOWISE. Writing.

Vanessa and Julian,

Tag you're it. It is your turn to find your thing.

Love,

Mom

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CHAPTER 1

LEADERSHIP CONTEXT AND PURPOSE OF THE STUDY

Luck is where preparation meets opportunity.

– Seneca

To understand better the context surrounding my problem of practice, I have situated it within the broader Higher Education Research and Development (R & D) ecosystem. During the last 25 years, the Higher Education R & D ecosystem has advanced extensively in the United States, influencing academic, federal research funding (National Science Board [NSB] & National Science Foundation [NSF], 2020). Fiscally, in the United States, R & D has been a $656 billion enterprise (Boroush M; NSF NCSES, 2021). Within academia, federal R&D funding was an $83.7 billion source of revenue to support innovation, research, and teaching (NSB & NSF, 2020; Boroush M; NSF NCSES, 2021). Federal academic R &D funding for engineering has been distributed primarily through six federal agencies, including the Department of Health & Human Services (HHS), Department of Energy (DOE), Department of Defense (DoD), National Aeronautics Space Administration (NASA), National Science Foundation (NSF), and Department of Agriculture (USDA/NIFA) (Boroush M; NSF NCSES, 2021).

Three interlinked ecosystem adaptations have influenced and shaped the overall system's complexity, growth, and especially new engineering faculty members' work. These three interlinked adaptations included (a) using the probationary period during promotion and tenure to facilitate and stimulate grant production, (b) generating revenue

beyond tuition and operations, and (c) augmenting faculty resources by including professional grantwriters who collaborate with early-career faculty members to mitigate challenges of the increased competition. These critical changes promoted high research environment adaptive behaviors, particularly in healthcare and engineering research.

Promotion and Tenure

Universities capitalized on the pursuit of this federal research funding by encouraging and requiring grant acquisition as part of the promotion and tenure (P & T) process. Although the tenure process has been a part of academia for nearly four centuries. Since the founding of Harvard in the United States, modern P & T practices were not enacted until the 1940s, with the Statement of Tenure signed by over 250 professional academic organizations (AAUP, 1940; Christensen & Eyring, 2011). More recently, universities leveraged the P & T process as an optimization tool for strategic talent development of faculty members, particularly those in highly funded, competitive research fields. Thus, there has been an increasing expectation that faculty members in areas such as engineering would seek and obtain grant funding to support their research work. When asked whether there was a connection between grant writing and the promotion and tenure process, one participant responded by saying,

> Oh, that's very important, especially for … research universities like Utah State University. And if a faculty member wants to be promoted, and they are in a research track, and research is their primary emphasis in their role statement, and then, you know, the ability to win federal grants is one of the major metrics to evaluate their performance toward tenure … So, I would say for research universities, grant writing and tenure promotion and academic performance are

very well connected. (Faculty Administrator, Cycle 3)

Engineering faculty members have similar P & T requirements as those of most other faculty members, with differing expectations for the level of performance within each component. Nevertheless, the P & T process can be particularly challenging for engineers because of the highly competitive federal research landscape. Early-career engineering faculty members have regarded P & T as an essential achievement that fosters academic freedom, supports intellectual innovation, and affords an opportunity to share their passion and expertise (Austin & Rice, 1998; Carter et al., 2021; Jaschik, 2020, September 23).

The tenure process has served as a critical proving ground through which universities have assessed individuals' potential for contributing human and intellectual capital to the institutions. In particular, early-career faculty members have been provided opportunities to showcase their contributions to the university through their tenure portfolio and external recommendations. The tenure process has afforded a "performance-based, voluntary, probationary period that allows the organization the opportunity to acquire a valuable asset through a communal policy-based process" that was used to evaluate early-career faculty engineering members based on contributions in three primary domains: (a) research, (b) teaching, and (c) service (Utah State University [USU], 2021, para. 17; USU, 1997, para. 1). These three core components have been standard for faculty members' promotion and tenure at higher education institutions in the United States (Carter et al., 2021; Jaschik, 2020, September 23; Moore & Ward, 2010). The USU policy indicated a performance-based component of the early-career faculty member's candidacy was based upon the role statement with

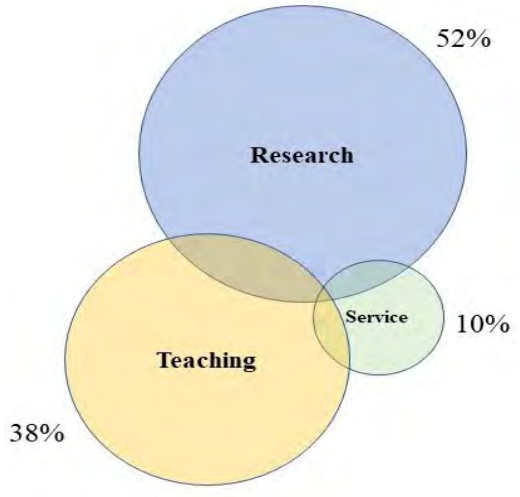
respect to research, teaching, and service and the relative assignments therein (USU, 2021, para.17).

Within the College of Engineering at Utah State University, typically, research has been the largest component of tenure-track faculty members' role statements (50%-80%), followed by teaching (15%-35%), and finally, service (5%-20%) (USU COE, 2021; M. Larson, personal communication, September 20, 2021). For early-career faculty members these role statements varied by department, but the components remained parallel with some variability because some role statements included administration.

Figure 1 illustrated the difference between what has been depicted in academic literature as compared to what occurred in the USU engineering context for a typical early-career engineering faculty member (M. Larson personal communication, September 20, 2021, USU COE, 2021).

Figure 1

Role statement average composition for USU early-career engineering faculty



Note: Average USU early-career engineering faculty member's data fall 2021

These three components have served as ubiquitous drivers for early-career tenure/tenure-track (T/TT) engineering faculty members, permeating all their work activities.

Diversifying Funding Streams

The second area of adaptation within the academic R & D ecosystem had to do with how universities sought to diversify their funding streams beyond tuition and traditional operations revenues. Deem (2001) described the search for new sources of finances to replace declining funding of higher education as one of the motivating factors for increased grant development and submission. The drive to seek alternative resources by adopting business approaches within public institutions like universities was called the "new managerialism" (Deem, 2001, p. 10). Those who promoted the new managerialism claimed their ideas and actions sought "continuous improvement, efficiency, effectiveness, and excellence" (Deem, 2001, p. 10). This 'new managerialist' dialogue provided essential context for other research work examining how academic systems and their changes influenced employees.

In a similar approach, Slaughter and Leslie (1997) maintained the new "academic capitalism" began as early as the 1970s but gained a foothold in academia in the mid-1990s (p. 6). Academic capitalism has been described as "efforts to acquire external monies by institutional, professorial, or market-like efforts and captures the profit motive's encroachment into the public research environment of academia" (Slaughter & Leslie, 1997, p. 17). This led state employees, staff and faculty members, and administrators to act with an entrepreneurial mindset to mitigate the declining state revenues. Moreover, Deem (2001) provided an example to illustrate this approach when

he suggested that a high research university would conduct applied research for industry as opposed to fundamental research to maintain support (cash flow) for its staff and faculty members and infrastructure as it continued to apply for federal funding. Federal funding had much longer cycles and was less predictable in terms of individual awards. Additionally, from a slightly different perspective, public universities also sought to serve their constituents' interests and acquire federal funding, which would afford support for regional needs. These constituencies formed the base of their student recruitment, alumni, advancement donors, and community and regional partners.

Taken together, declining state funding of higher education pushed university administrators and leaders to seek alternative funding to support the universities' efforts. As a result, many more universities sought to apply for grant funding when they had not previously done so. Notably, grant funding was sought from federal, industry, and foreign sources. There has been a substantial increase in federal grant applications, which federal agencies reported between 2009 and 2019 (NASEM, 2016; usaspending.gov, 2021).

Augmenting Faculty Resources with Grant Writers in the Competitive Landscape

Finally, one of the most critical ecosystem adaptations arose from the increasingly competitive federal landscape for research grant funding. At Carnegie Very High Research (VHR or R1) and High Research (HR or R2) universities (The Carnegie Classification Institution of Higher Education, 2021), universities, faculty members, and their departments have been increasingly supported in various ways to become more competitive in their federal grant research. In federal engineering research, this change became quite evident in the amount of federal funding allocated and the competition to acquire it from academic and industry participants. The next-generation of early-career

engineering faculty members has continued to face highly competitive federal funding research landscapes (Brutkiewicz, 2012; NSB & NSF, 2021; usaspending.gov, 2021).

As a means to engage in the increased competition more effectively, the ever-emerging Higher Education R & D ecosystem became more interdisciplinary, collaborative and was enhanced by a new breed of technical writer, the research development professional, a.k.a. professional grant writer (Levin, 2011). Recently, the National Organization for Research Development Professionals (NORDP) has claimed research development "encompass[es] a set of strategic, proactive, catalytic, and capacity-building activities designed to facilitate individual faculty members, teams of researchers, and central research administrations in attracting extramural research funding …" (NORDP, 2021, para. 1). Further, critical facilitators in this process were research development professionals who helped researchers become more successful communicators, grant writers, and advocates for their research. NORDP also asserted research development professionals had four primary realms of expertise, including (a) strategic research advancement, (b) communication of research and research opportunities, (c) enhancement of collaboration/team science, and (d) proposal support functions (NORDP, 2021, para. 5-8).

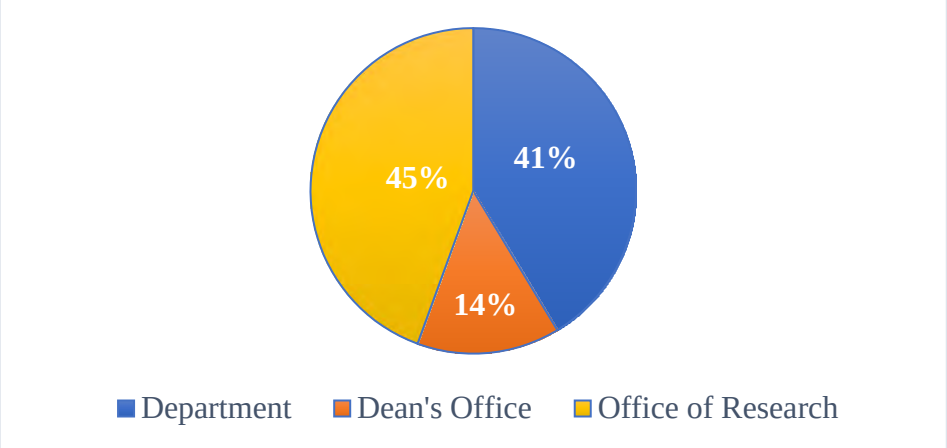
The highly competitive research environment has necessitated the support of early-career engineering faculty members by these grant professionals to clarify factors stemming from the complex linguistic and legal requirements of grant applications. Moreover, they supported faculty members to make the best use of time given the limitations imposed by their promotion and tenure clocks. Finally, these grant writing professionals acted on behalf of the institution that desired to provide support in grant

writing processes. Results from Dundar and Lewis' (1998) study indicated within highly productive colleges of engineering (n = 24), the percentage of faculty members who received research support was over 50%. Serrano Velarde (2018) concluded early-career researchers who were "embedded in a group/organization with highly successful and productive grant writers have a better chance at learning the skill than their isolated counterparts" (p. 104).

To catalyze the grant research activities, USU, like many other universities, has invested in start-up packages for early-career faculty members. The start-up packages have been negotiated individually between the department head and each early-career faculty member, but the costs have been shared across the departments, colleges, the Office of Research, and occasionally a center for research. In Figure 2, I have presented the distribution of start-up costs across the academic R & D ecosystem that was related to acquiring new talent.

Figure 2

Average distribution of engineering start-up costs within the university ecosystem



Note: Deidentified sample of USU early-career engineering faculty members' data 2013-2019 provided by USU GRAMA

Start-up packages have been key negotiating points for organizations that were recruiting talent. The sizes and compositions of the start-up packages have varied. Factors influencing the packages were dependent on variables such as expertise, fundability of the research area, teaching experience, prior support, training, and education, among other components. Moreover, start-up funding was also dependent on what the early-career faculty member advocated for as a part of their package. Nevertheless, these monies also came with expectations from department heads, the dean, and the Office of Research, who provided the funds. One participant indicated the following when asked if there was a connection between grant writing and the promotion and tenure process when they said,

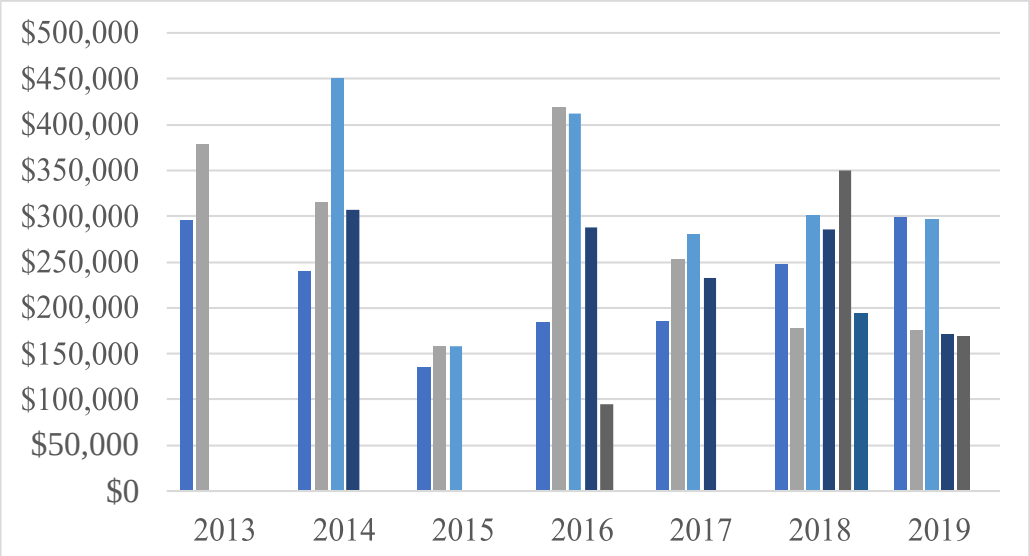
> I went into my one-year review with the dean, and he was basically like, [name deleted], you're doing a great job with things. You just need to get some money. He said it jokingly, but I know he was totally serious at the same time, so to me, it just [is]. Also, for me, teaching, I think I have 5X percent research, 4X percent teaching, and 1X percent service, and the research also helps me make connections for those service endeavors, and then the research also helps inform how I teach. So, to me, the grant writing kind of supports everything in my career. (Participant 2, Cycle 3)

Early-career engineering faculty members sensed and occasionally encountered the urgency of the performance-based university ecosystem because the behavior is systemic. They were expected to perform. Further, the sizes of the packages may have been a factor in the organizational urgency, with larger packages fostering greater urgency. In Figure 3, I have presented information about the variation in sizes of USU

engineering start-up packages from 2013 to 2019. Some data points (n = ~9) were missing per the USU GRAMA disclosure limitations.

Figure 3

Distribution in sizes of USU engineering start-up packages between 2013-2019



Note: Deidentified sample of USU early-career engineering faculty members' data 2013-2019 provided by USU GRAMA

Organizationally, start-up funds have been regarded as investments in future grant funding for which the researcher will apply, receive, and function as research capacity-building mechanisms. In other words, faculty members who received a high level of start-up funding were expected to acquire grants. These faculty members often felt tremendous pressure to be successful grant writers. The built-in *quid pro quo* was manifested from the start and activated by the start-up packages and the formative promotion and tenure feedback during the probationary employment period prior to tenure. Start-up funding was one form of financial support the institution provided initially, but it was often

expended within the first few years. Thus, there was a need to seek new grant funding for the faculty member to continue their research efforts.

Taken together, the three adaptations that have occurred in the grant funding ecosystem have substantially influenced the work of assistant professors, especially with respect to their interest in and need to obtain grant funding to support their research work. In particular, the adaptations have influenced (a) P & T, (b) external revenue generation, and (c) augmentation of faculty resources by including professional grant writers who collaborate with early-career faculty members to manage the increased competition in the federal grant landscape and to help the ecosystem recover start-up costs quickly, which have altered the academic R & D ecosystem. The adaptations have affected the lives of early-career, tenure-track engineering faculty members in substantial ways.

Role of Faculty Members in Grant Writing

Early-career engineering faculty members must develop clear research visions and plans for research development to be successful, but there are challenges. Within the College of Engineering (COE), there has been an expectation that research will be funded through grants, which required submissions and awards. This expectation often has fostered mixed emotions among faculty members evaluating colleagues for promotion and tenure (Hearn & Anderson, 2002). Faculty members' emotional responses have depended on their knowledge about the resources accessible to individual faculty members at their institution or within their region, among other factors.

Nevertheless, among early-career faculty members, there has been an implicit understanding that federal grant awards were advantageous for tenure and promotion, research, and, ultimately, faculty success (Brutkiewicz, 2012; Hearn & Anderson, 2002;

Quadlin, 2018). Knowing the receipt of grants contributed positively to the faculty members' careers did not mean the faculty members necessarily understood the nuances of federal grant requests for proposal, budget preparation, or the various explicit protocols of each particular agency. Navigating the grant writing process had the potential to become overwhelming for faculty members because they were developing their innovative ideas, *and* they must have decoded the grant requirements and expectations. The cognitive load requirements and updated repertoire of required information and processes have been two reasons why successful researchers have collaborated with research development professionals, grant writers. In Chapter 2, I have discussed this matter in more detail.

At its essence, federal grant writing has been and continues to be a written request for money in exchange for an agreed-upon scope of work or plan of action within a specific period of performance. Thus, grant writing was best viewed as a genre with multiple requirements, processes, and in most cases, deadlines that the applicant must strictly adhere to in order to succeed at competing for federal funding. As defined in the Uniform Administrative Requirements, Principles, and Audit Requirements for Federal Awards (OMB, 2021), the grant genre's linguistic boundaries and legal and fiscal requirements have been critical in shaping the components required by various federal agencies. Further, the National Council on Research published a study that called for more continuity and recommended that components be made more uniform across federal agencies to minimize applicants' burden of decoding the requirements (National Academies of Sciences, Engineering, and Medicine [NASEM], 2016).

Context

At the national level in 2020, AAUP reported that 928 doctoral universities employed 41,194 early-career, tenure-track (TT) assistant faculty members (AAUP, 2019-2020). To provide perspective, ASEE reported that the number of engineering faculty members in all positions was 36,776, with 7,668 tenure-track faculty members comprising 20.8% of all positions nationally (Roy, 2019). Most early-career engineering faculty members were employed at doctoral universities, particularly Very High Research/High Research universities (Roy, 2019).

USU is the only public land- and space-grant university in Utah. It was established in 1888 by employing the Morrill Land-Grant Colleges Act, created during the Civil War by President Abraham Lincoln (U.S. Congress, 1862). Originally named the Agricultural College of Utah, it became Utah State University in 1957 (USU, 2020a). The university has maintained a statewide presence through regional campuses and centers to provide higher education access and course programming (USU, 2020c). In 2020, the fall headcount was 24,647 students (Utah State University Office of Analysis Assessment and Accreditation, 2020). According to the USU Office of Analysis Assessment and Accreditation (2020), fall full-time equivalent enrollment in the USU COE was 1,981 graduate and undergraduate students, ten more than in 2019.

The Carnegie Classification of Higher Education Institutions classified USU as a High Research University (HR/R2; Center for Postsecondary Research Indiana University School of Education, 2020). Overall, USU's research awards for FY19 were $290.7 million; $175.5 million was from the classified research in engineering and computer science (USU Office of Research Sponsored Programs Offices, 2020).

College of Engineering

The COE has been comprised of five departments and 21 academic programs (Utah State University College of Engineering, 2021). There were seven Ph.D. programs, eight Masters-level programs, and six undergraduate programs. These included biological engineering, civil engineering, environmental engineering, computer engineering, electrical engineering, engineering education, irrigation engineering, and mechanical and aerospace engineering.

USU was ranked 11th by the NSF Higher Education Research Development (HERD) Survey in engineering research expenditures in FY 19 (NSF, NCSES, 2021). However, on-campus, the COE (non-classified) received $15,353,802 in new funding, a 14.5% increase over the previous year (USU Office of Sponsored Research Programs, 2020). USU was awarded 1,129 non-classified grant awards and 432 classified awards from federal, state, local, and private entities (USU Office of Sponsored Research Programs, 2020). Within the COE, the overall contract and grant funding is 47% federal, 23% state, and 31% private. However, this varies by department. In addition, in 2019, the research expenditure per faculty in the COE averaged $331,000 across the COE (USU COE, 2020). These numbers were much higher in larger departments such as mechanical and aerospace engineering and electrical and computer engineering.

The number of early-career engineering faculty members who apply for grants annually was noteworthy because there were 94 faculty members in the college (Larson, personal communication, September 29, 2021). Typically, faculty members were tenure-track/tenured, but USU also has hired three other types of faculty members for full-time positions. Research engineers were not tenure-track and were based

on grant/research contracts availability; they have been exclusively research-focused. Others were hired for teaching positions (e.g., professors of practice and lecturers) and were typically engineers whose contracts were limited to teaching; the exception was two lecturers in engineering education. In all, the COE faculty members consisted of 76 T/TT, eight research professors, eight professors of practice, and two lecturers (USU, COE, 2021). Approximately 31.91%, 30 were tenure-track, assistant professors who were actively writing grants they submitted to various federal agencies. Another 15.95%, 15 were tenured, associate and 30.67%, 31 were full professors (USU, COE, 2021). Notably, their grant participation levels between 2013-2020 varied widely (Utah State University Office of AAA, 2019). By far, TT, assistant professors submitted the most proposals within the COE, which was likely due to the tenure process's performance clause (USU Office of Research Sponsored Programs Offices, 2020; Utah State University Kuali & Perry, 2020; Utah State University Sponsored Programs Office, 2013).

Notably, Van Miegroet (2018) found USU female faculty members in engineering obtained fewer research awards than men, but their "scientific achievement was significantly less likely to be recognized…. especially at the university level" (pp. 85, 105). Despite the increased hiring rate, the number of women in associate and full professor ranks remained the same. The USU NSF ADVANCE (Proposal ID #0820273) grant study showed women were absent in mid-level leadership positions. Further, results indicated retention of associate professors and promotion to the highest rank (full professor) "remains a considerable concern," particularly in engineering (Van Miegroet, 2018, p. 27; Park, 1996; Quadlin, 2018). In particular, Van Miegroet (2018) found that no

females in engineering were full professors during the period from 2010-2014, even though the number of female associate professors slightly increased following the NSF ADVANCE grant. These two factors were discouraging in the COE context for early-career engineering faculty members who sought promotion and tenure in the college.

Problem of Practice

Within the COE, there has been and continues to be an expectation that research will be funded through grants, which required submissions and awards by early-career engineering faculty members. In 2020, nine new tenure-track, assistant professors members were added to the five departments, and in 2021, three more were added in two departments. Combined, these two cohorts of new engineering assistant tenure-track faculty members comprised about 15.78% of total engineering tenure-track faculty members and more than 36.67% of the tenure-track faculty members who were also competing for federal funding.

Additionally, there are other challenges to obtaining federal grant funding. Early-career engineering faculty members must have developed substantial research grant writing expertise because the six federal agencies that routinely fund engineering research often support less than 20% to 28% of the applications they receive. This is often contingent upon research area and agency portfolio composition. The next-generation of early-career engineering faculty members have faced and will continue to face highly competitive federal funding research landscapes (Brutkiewicz, 2012; Hearn & Anderson, 2002; Quadlin, 2018).

Although early-career engineering faculty members have acquired experience in writing and working on grants during their graduate and postdoctoral experiences, they

are expected to receive substantial funding early on in their careers. The experiences vary from no exposure or experience to grant writing to some grant writing training and experience. Thus, many faculty members have needed considerable support as they navigated the grant writing process at a competitive level. The Grant Development Manager has played a key role in that process and has provided an integrated support system to help early-career faculty members and experienced faculty members navigate the challenging grant writing process. As a research development professional, the Grant Development Manager, actively aided engineering faculty members in discerning the various grant writing requirements, processes, and skills.

Work Role

From the beginning of my employment in the COE, my role as Grant Development Manager has been defined by my dean and associate dean of research to prioritize the grant writing support of early-career, tenure-track engineering faculty members *and* to support large proposals. From their perspective, these two areas constituted an institutional gap; thus, I was asked to focus on proposals from early-career faculty members and large proposals, typically led by senior faculty members. Previously, early-career and large proposals had only been won with external consultant support within the college; this was costly to sustain in the long-term and lacked ongoing continuity for faculty members. They hired me to provide a more permanent solution.

I have worked in proposal development in academia and industry for over 15 years, which allowed me to share various agency and reviewer perspectives. I also enjoyed the challenge of seeking funding and working with new faculty members to develop their research visions and plans.

> The COE has a unique combination of aspiring, innovative new faculty members as well as mature and collaborative senior faculty members who challenge the current state-of-the-art. Together, we serve as a team working toward innovation and attaining research funding. Our ability to leverage our individual strengths and match them in highly focused requests for applications or solicitations has allowed us to partner, position, and succeed. (Kessel, 2018)

My interest in the problem of practice emerged as I responded to early-career engineering faculty members' grant writing needs in the COE. I drew upon Wenger's research, which defined community of practice (CoP) as affording the members opportunities to (a) develop forms of collaborative engagement, (b) understand and tune their collective research enterprise, and (c) build their grant writing repertoire, styles, and discourses (Wenger, 1998). Combining peer technical knowledge and mentoring, grant writing knowledge, and faculty members' feedback was a logical and natural starting point in the university context.

Cycle 0 Action Research Study

The Cycle 0 study was designed to examine staff members' perceptions regarding early-career, engineering faculty members' turnover. The purpose of Cycle 0 work was three-fold. First, the study was designed to investigate professional/classified staff perspectives on faculty members' turnover. Currently, the perspective of professional/classified staff has been absent from the literature. Second, the study was designed to help identify potential differences in perspectives based on the department as compared to college perspectives about faculty members' turnover. Third, the study was designed to aid the identification of potential commonalities across the participants**.**

The study took place in a mid-sized College of Engineering located in a Carnegie HR university with five female participants. Purposive sampling was used to capture staff members' perspectives on faculty members'' turnover in high and low research departments and demonstrate differences of perspectives from the department level compared to the college level (Patton, 2002; Creswell and Plano-Clark, 2011). Data were collected using semi-structured, in-person interviews; however, one interview was conducted over the phone. The interview protocol included questions about factors influencing turnover and factors that might mitigate turnover.

Five of six individuals who were asked agreed to participate in the interviews did. Participants responded to four questions about (a) departmental-level and (b) college-level factors contributing to faculty member turnover, (c) support for assistant professors, and (d) potential solutions to mitigate turnover at the department level. The interviews ranged in length from 9 minutes to 14 minutes. The interviews were transcribed. Then, for each anonymized interview, descriptive codes, categories, and analytic codes were developed based on the data. This process yielded seven key concepts (Brinkmann & Kvale, 2015; Charmaz, 2014).

The coding procedure was consistent for each transcribed interview. I used descriptive codes to capture key concepts and actions, which were later refined into focused-code categories. The goal of developing these focused-codes was to identify comparable codes with analytic power (Charmaz, 2014). It also provided direction in the analysis and allowed me to identify central ideas that were theoretically relevant. Next, I developed analytic codes by asking myself the standard question, "What is this data a study of?" (Glaser, 1978, p. 57). This question helped me to narrow the data into analytic

codes by refining the focus-code categories further and staying close to the main question.

The interviews revealed none of the participants thought faculty member turnoverwas positive for the COE. Many participants stated it was possible to influence the problem through various mechanisms, including monetary and interdepartmental support. Figure 4 has been used to illustrate the outcomes of Cycle 0 in which staff members indicated there were seven key ideas that influenced faculty members' turnover in engineering departments, college, and university level (i.e., micro-, mesosystem).

Figure 4

Key Themes Cycle 0

Note. The key ideas and the number of times they were mentioned were Salary (*n* = 4), Spousal Influence (*n* = 2), Religious Influence (*n* = 2), Active Mentoring (*n* = 2), Institutional Ranking (*n* = 3), Collaboration (*n* = 2), and Community Integration (*n* = 2).

A Brief Introduction to the Intervention

I developed an intervention to apply the action research approach to my unique role within the COE. The intervention's design and scope were consistent with my role in the organization and sphere of influence as a Grant Development Manager, a.k.a. Grant Writer III.

To serve a large number of early-career, tenure-track faculty members effectively in a highly competitive environment, I developed an intervention comprised of five on-demand, online modules that focused on developing faculty members' federal grant writing knowledge of requirements, skills, processes, attitudes, and self-efficacy. These modules were designed to help early-career faculty members navigate federal grant requirements and expectations with the desired outcome of improving the number of federally funded grants for early-career engineering faculty members.

Notably, the intervention supported early-career, assistant professor, tenure-track faculty members in the USU COE. Moreover, it supported the Vice President of the Office of Research's ongoing strategic plan to enhance researcher capacity and productivity (Utah State University Office of Research, 2019). It consisted of five federally grant-focused elements, which were available in online modules accessible at any hour of the day. On an individual level, it was intended to support the early-career engineering faculty member who immediately needed to begin developing grant proposals by providing on-demand, online modules to support grant skill development and efficacy. The intervention's information allowed early-career engineering faculty members to access on-demand, topic-specific information about research grant development. In this way, I attempted to directly influence the research funding for

early-career faculty members and anticipated that it would influence research productivity and research expenditures.

Purpose Statement and Research Questions

The purpose of this study was to influence early-career engineering faculty members' awareness of research (a) requirements, (b) skills, (c) processes, as well as (d) attitudes, and (e) self-efficacy in grant writing. In doing so, I adopted an approach using an on-demand, online intervention with an emphasis on changing skills, processes, attitudes, and self-efficacy. This study was designed to provide early-career engineering faculty members with professional development in research grant development. It also contributed to an understanding of individuals' early-career formation. In the dissertation study, I assessed the intervention's effect on early-career, engineering faculty members at the same time I sought to create positive outcomes for participants (Brutkiewicz, 2012; Hearn & Anderson, 2002; Tseng & Seidman, 2007).

Two research questions guided the conduct of this research study.

Research Question 1—How and to what extent did the implementation of five on-demand, online modules affect early-career, engineering faculty members' understanding of grant writing (a) requirements, (b) processes, and (c) skills?

Research Question 2—How and to what extent did the implementation of five on-demand, online modules affect early-career engineering faculty members' (a) attitudes toward and (b) self-efficacy for writing grant proposals?

CHAPTER 2

THEORETICAL PERSPECTIVES AND RESEARCH GUIDING THE STUDY

> *I believe it is difficult to kill an idea because ideas are invisible and contagious, and they move fast. I believe that you can set your own ideas against ideas you dislike. That you should be free to argue, explain, clarify, debate, offend, insult, rage, mock, sing, dramatize, and deny.*
>
> —Neil Gaiman, 2016

The complexities and nuances of early-career engineering faculty members' grant development, attitudes, and self-efficacy within the Academic Research Development Ecological System (ARDES) are challenging to measure. Nowhere in higher education has an ecological system been so critically valuable to the U.S. economy or the research enterprise and yet so uncertain in terms of defining the most essential inputs and supports for understanding its processes. Likewise, academia's innovation processes have not been well understood (NRC, 2014; 2019; Sullivan et al., 2013). Importantly, it was critical to conduct this mixed methods action research (MMAR) in engineering and education to add to the body of knowledge in these fields. In addition, it contributed and continued to build our understanding of grant development and support the research enterprise as knowledge-generating activities (Tashakkori &Teddlie, 1998).

As new research has been conducted in engineering and education with the emergence of new technologies such as deep learning, virtual reality, and bioinspired transportation, researchers have relied upon theoretical frameworks to guide research about relations among constructs and factors. Theories have provided foundational

models for exploring the unknown and, in the case of mixed-methods action research, acting as a framework for informing the design (Creswell & Creswell, 2018; Mertler, 2017). Theoretical frameworks have allowed us to explore, through research, unknown places such as the Marianas Trench, the moon, and Mars, as well as the human body by allowing us to test anticipated or hypothesized outcomes with theoretical frameworks to understand better the phenomena's underlying the processes leading to outcomes. Theories have allowed us to create processes for educating others, train the next-generation workforce, and catalyze innovation. In this way, engineering and education always have been connected and will continue to be so.

Engineering faculty members have been critical educators, researchers, and visionaries who shared their ideas with students in their classrooms and labs. They have mentored undergraduate and graduate students working on a wide range of fundamental and applied research matters. Future engineers, both applied and research engineers, have often been supported through federal grant funding awarded to engineering faculty members. Nevertheless, the processes for acquiring and supporting grant writing skills have not been well understood in engineering. Drawing upon theoretical perspectives from multiple fields, including business, education, engineering, healthcare, and psychology, this study was conducted to implement an intervention to support federal grant development for early-career engineering faculty members (NASEM, 2016; Thurner et al., 2018). As the overarching goal, the study's intervention supported early-career engineering faculty members applying to federal agency requests for proposals (RFPs) and solicitations in a highly competitive national landscape. The theoretical

perspectives and research in Chapter 2 have been organized into four main sections to illuminate elements guiding the research and the intervention.

In the first section, I have focused on organizational factors affecting ARDES. Then, I have described how Bronfenbrenner's (1979) Ecological Systems Theory (EST) inspired the study's academic ecological system framework within the USU context. EST anchored the other theoretical operational perspectives by providing critical scaffolding and operational reference points in an academic setting (Bluteau et al., 2017). The EST levels of macrosystem, mesosystem, microsystem, exosystem, as well as the chronosystem served as critical scaffolds for articulating the study's processes that affect the developing individual (Bronfenbrenner, 1979, 1986).

Within the EST exosystem level, the U.S. academic research and development (R&D) enterprise's magnitude and scope were described along with four key components relevant to the system's context for grant development and early-career engineering faculty members. The first component described the U.S. R & D enterprise's valuation in the global and academic contexts. The second component offered a discussion of the Bayh-Dole Act and its influences on patenting changes from work funded by grants. This resulted in a marked change in (a) the number of applications submitted, (b) the requirements with respect to federal accountability for sharing intellectual property acquired from grant and contract funding, and (c) the extension of this provision through other legislation. Then, I have described the macrosystem, mesosystem, and microsystem from the early-career engineering faculty members' perspective. Tseng and Seidman (2007) identified the social processes for resources, setting outcomes, and distribution of organizational resources. The Ecological Process Model Systems Change (EPMSC)

framework, which was based on EST (Tseng & Seidman, 2007; Kelly et al., 2000), was contextualized in a social context. I utilized this framework in the USU engineering Community of Practice (ECoP) and drew parallels to the research development enterprise (Lin, 2008; Wenger, 1998). Pierson et al. (2011) clarified that two or more ecological levels could be involved. This was particularly helpful when attempting to understand the inherent interconnectedness of the ARDES.

In the next section, I have described the human factors within the mesosystem, microsystem, and faculty member levels. Notably, Self-Efficacy Theory (Bandura 1977, 1986, 1997) was used to identify constructs relevant to early-career engineering faculty interactions with different connected systems and structures of power (i.e., macrosystem, mesosystem, and microsystem) as they become aware of federal agency (i.e., exosystem) requirements, processes, skills, and their attitudes and self-efficacy (i.e., faculty member level) toward grant development following participation in the intervention. The intersections of different contexts, power relations, and grant experiences may have affected the outcomes for early-career engineering faculty seeking federal grant funding.

In the final section, I have discussed Microlearning Theory from business (Emerson & Berge, 2018) and education (Baumgartner, 2013; Hug, 2006) as critical inputs for designing the on-demand, online learning modules intervention for grant development. Adapted microlearning theories and techniques were drawn upon to develop the on-demand, online modules (De Gagne et al., 2019a; Hug, 2006; Halbach & Solheim, 2018).

ARDES and Its Influence

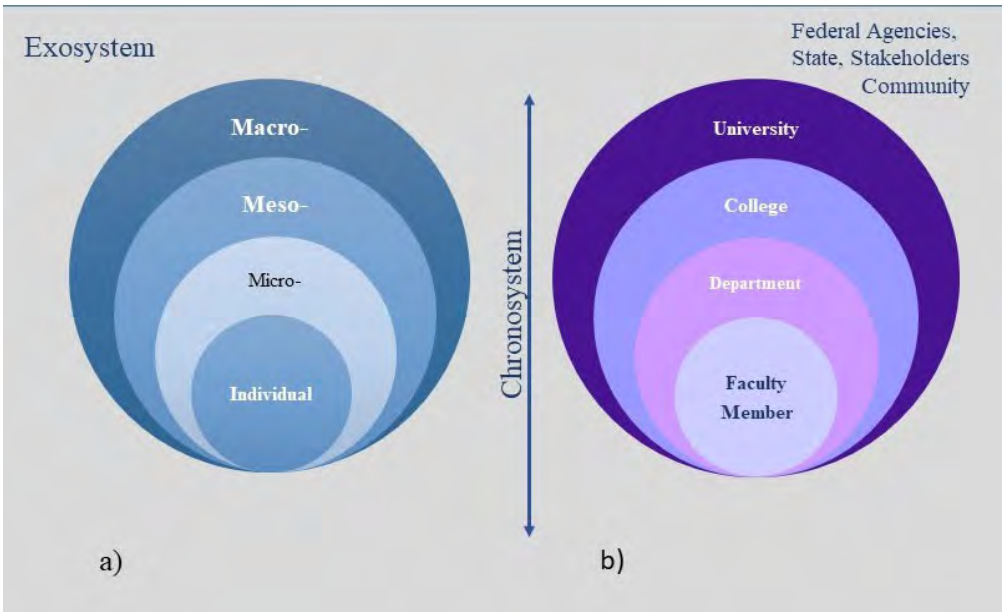
ARDES has served as a complex system comprised of many diverse academic elements that influence grants, grant funding, and ratings of institutions in the United States. Notably, the federal grant byproducts have been measured by the U.S. National Center for Science and Engineering Statistics and the National Science Foundation, which have been reported in a clear, specific, and measurable fashion that have been reported annually in terms of research expenditures by institutions, agencies, and field. This has resulted in high stakes positioning efforts for universities and colleges competing for students, faculty, and limited federal research dollars. This federal data has provided the fundamental underpinnings for many of the national rankings for university engineering programs among various organizations. Although these data were not specific for individual departments, they have contributed to department ratings.

Ecological System Theory

Bronfenbrenner's (1979) Ecological System Theory (EST) has shaped multiple areas of research in many fields, including education. He articulated nested levels within the systems, which have been added to and expanded upon by researchers in various fields asthey adapted his work to their efforts. Conceptually, the original EST contained the depicted in Figure 5 (a). Later, Bronfenbrenner (1986) added the chronosystem to the theory to account for the influence of time over a person's development.

Figure 5

Comparison of (a) Brofenbrenner's 1986 EST with chronosystem (b) ARDES conceptual framework based on EST



The addition of the chronosystem was a critical change because it acknowledged the influence of time upon individuals' system-level functioning. For example, within the ARDES, the chronosystem was important; faculty members were operationalized in academic temporal constructs created by the ARDES. There were many examples of how the chronosystem was manifested. For example, the notions of office hours, final exam week, semesters, tenure-track increments of review such as three-, five-, and sixth-year or the waiting periods between grant solicitation announcement, submission, review, and award all are elements of the chronosystem.

Each nested level has changed and evolved with respect to its definition and implementation, but all are context-focused, making them particularly suitable for action research (Gustavsen, 2014; Mertler, 2017). Brofenbrenner (1979) described the

macrosystem as the form and substance of culture or subcultures combined as a belief system to communicate consistencies in ideologies. He described the mesosystem as the interactions of the developing individual and the levels of relationship(s) to others in more than one setting where the developing individual participated (Brofenbrenner, 1979). The microsystem was "a pattern of activities, roles, and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics" (Bronfenbrenner, 1979, p. 22; Lin, 2008). Finally, the exosystem included the settings that did not involve the developing individual directly but affected the individual (Bronfenbrenner, 1979). The EST theoretical frame was adapted to develop ARDES because of the ecological parallels that were useful in describing the effects on faculty members.

As noted above, EST comprised the nested-system levels, which were used in the design of the Academic Research Development Ecological System (ARDES). The central figure became not just any individual but, specifically, a faculty member. The conceptual and linguistic shift was that the macrosystem was defined as "university" to capture the notion of university-level culture, form, content, and belief systems, which may have affected developing faculty members. At the mesosystem level, the college interactions and the relationships within outside departments affected the faculty member. Within the microsystem, the faculty member was situated in a setting where they could identify routine patterns and social processes within their department on whichthey depended for physical or material resources. The exosystem included many external factors, such as the U.S. Congress, which appropriated funding for the federal agencies

annually. In this way, EST helped to explain the Academic Research Development Ecological System.

Exosystem

U.S. Academic Research Development Enterprise. To successfully understand the ecological exosystem context, one must understand the global and national environment that has shaped the U.S. academic research & development (R&D) environment and enterprise. The National Science Board, in conjunction with the National Science Foundation through the National Center for Science and Engineering Statistics (NCSES), directly reported the *Science and Engineering Indicators 2020: The State of U.S. Science and Engineering*, which included a detailed analysis of the composition of research and development as well as workforce projections in the United States. NCSES (2020) reported that globally $2.2 trillion was spent on R&D; the U.S. (25%) was the highest performer, followed closely by China (23%). This was more than France, Germany, Spain, Japan, India, Russia, and many other nations, including the European Union (NSB and NSF NCSES, 2020, pp. 8-9).

In the U.S., industry R&D comprised 73% ($400.1 billion) of the overall portfolio, but Academic R&D comprised the second-highest portion at 13% ($71.3 billion); other U.S. R&D segments included federal national labs 10% ($52.6 billion) and nonfederal government and non-profits 4% ($24.0 billion) (NSB and NSF NCSES, 2020, p. 10). As part of these R&D expenditures, academic institutions applied for grants and contracts, which generated "revenue" for their institutions annually as a mechanism to bolster their operations, support their constituents, and engage their communities. The research expenditures of academic institutions in healthcare and engineering have a

higher value than many large blue-chip initial public offerings (IPOs) on Wall Street. Thus, academic research was a part of a complex ARDES system, and it was a thriving enterprise in the U.S. worth, at minimum, $83.7 billion in FY19 (Boroush M; NSF NCSES, 2021).

Bayh-Dole Act, Technology Transfer & Patenting. Academic institutions have long touted the ability to develop patents from research dollars (Tahmooresnejad & Beaudry, 2018; Varadarajan, 2016). Before the 1980 Bayh-Dole Act, academic researchers were not as motivated to disclose their patent findings or processes even when federal money was involved (COGR, 1999). The lack of commercialization was primarily due to low-level motivators as well as a lack of continuity in the processes across the federal agencies. Once the Bayh-Dole Act was authorized, many universities created a Technology Transfer Office or Commercialization Office to meet with faculty and/or staff members and manage the process of disclosing, submitting patents, and commercializing. Patents and patent disclosures have been highly prized in STEM faculty members' portfolios, particularly in engineering, where they have been seen as evidence of intellectual property and capacity at an institution to generate potential economic prosperity (Sullivan et al., 2013; Tahmooresnejad & Beaudry, 2018).

It has been four decades since the U.S. Congress enacted the 1980 Bayh-Dole Act to prevent the valuable intellectual property generated by its many sponsored research projects acquired through grants and contracts from " 'languishing due to lack of commercialization'" (Eisenburg & Cook-Deegan, 2013, pp. 78-79). The legislation was a Congressional reaction to the perceived lack of economic and political competitiveness of

the United States in the world in the decades post-WWII and the financial crisis, which resulted in the 1970s because America had lost its economic and political prowess to other countries internationally, including those in Europe and Japan (COGR, 1999; Stevens, 2004; Thomas, 2016).

According to the Council on Government Relations (COGR, 1999), between the 1960s and 1970s, multiple federal agencies studied the problem of technology transfer resulting from research dollars, patent disclosures, and eventual commercialization. Inconsistencies in federal agency policies and regulations had resulted in low adoption and implementation rates by industry. For example, of the 28,000 patents owned by the U.S. government in 1980, fewer than 5% (< 1,400) were commercialized (COGR, 1999). The purpose of the Bayh-Dole Act was to reconcile the effect government patent policy had on commercial utilization of federally sponsored inventions, industry participation in federally sponsored R&D, and industry competition (Thomas, 2016). Varadarajan (2016) indicated that the patenting system's goal was to promote industry and economic growth through innovation. The patent system served the overall "public good," and the system sought to overcome traditional barriers to disclosing new products and processes and encouraging appropriate use of federal grants and contracts funding.

Tahmooresnejad and Beaudry (2018) found federally funded research in universities was especially important when examining academic patents. Further, they showed academic inventors' federal funding exhibited a positive effect on renewing their patents and exploring commercialization. Further, "by matching renewal information data with bibliometric analysis of patent statistics, we are able to evaluate the policy impacts on the quality and value of patents" (Tahmooresnejad & Beaudry, 2018, p. 8).

Ecological Process Model of Systems Change (EPMSC) Framework

Notably, these constructs were connected to another EST-based framework called the Ecological Process Model of Systems Change (EPMSC) framework. Kelly et al. (2000) and Tseng and Seidman (2007) described the EPMSC framework as a means to contextually (i.e., within a setting) represent social processes in dynamic systems. EPMSC framework mainly focused on areas often targeted for interventions, including (a) social processes, (b) resources, and (c) organization of resources. The researchers also included (d) setting outcomes because they resulted from the interplay of work dynamics (Tseng & Seidman, 2007; Kelly et al., 2000). Importantly, this framework, like the EST, was contextually centered. Notably, in this model, there was a concern and a desire to understand the relations between the contexts and how those relations changed the dynamics of transactions in Figure 6.

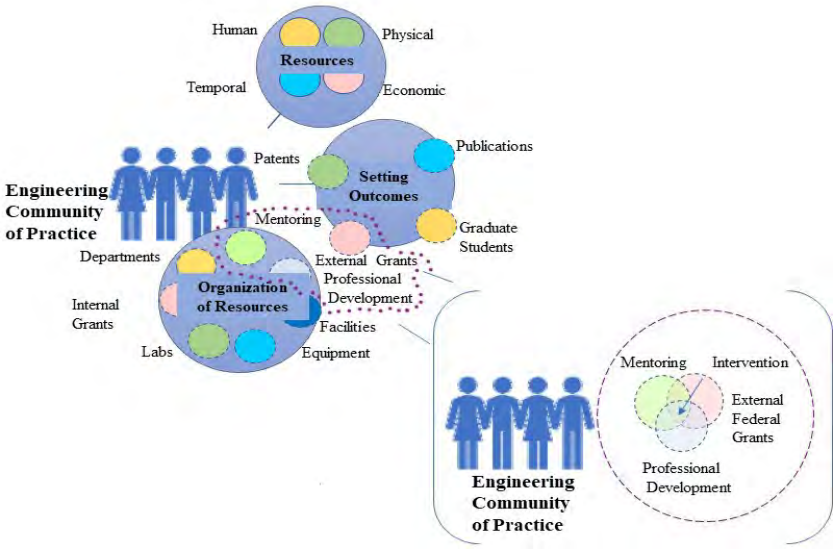
Figure 6

Tseng and Seidman's EPMSC Framework Depicted

In terms of the Academic EPMSC framework components, examining "grant writing" requirements, processes, and skills among early-career engineering faculty members and how those skills were acquired and communicated to attain valuable "grant dollars" was vital in a highly competitive environment. Because grant funding can manifest and spread across any of the three system levels of the Academic EPMSC, careful examination of the early-career engineering faculty members' attitudes and self-efficacy toward grant writing was considered. For example, grant funding has been used to purchase and provide access and entre to students, labs, equipment, and so on, and indirect costs were used to pay other internal operational costs for the university to support the research enterprise. As Brutkiewicz (2012), Stankovic, and Apray (2003) indicated, grant funding laid a critical foundation for tenure. Notably, the portion of the study, which was the area of focus, has been depicted in the blowout in Figure 7.

Figure 7

ECoP EPMSC Framework in Context



Tseng and Seidman (2007) and other scholars provided a framework for the importance of the setting and the social processes within the nested levels macro-, meso-, and micro-systems affecting the developing individual. Faculty members were affected by the Academic EPMSC framework in a similar manner. The faculty members' interpretations of social processes can be filtered by culture, gender, race/ethnicity, sexual orientation, citizenship status, department status, rank, and 'fundability of the researcher's area,' among other variables and other factors. Department heads, deans, staff members, and others have similar filters and perceptions, but not all have the same ability, i.e., power, to assign resources, influence setting outcomes, or allocate organizational resources. This fact reiterated that in ecological systems, there was a natural hierarchy.

Acknowledgment of the ARDES system as hierarchical was crucial, and therefore, the subsystem within ARDES of the Academic EPMSC framework was also. These systemic hierarchies influenced the levels of power within the system. It also influenced how those within the hierarchies allocated resources, established setting outcomes and provided organizational resources. The ecological system may have influenced faculty members' abilities to be successful based on macro-, meso-, microsystem levels among developing faculty members. These human factors were influential in this study and the development of the action research questions about grant writing and early-career engineering faculty members.

Faculty members have found themselves seeking the Academic EPMSC resources to support their personal research enterprise and probationary bid toward promotion and tenure. Although there has been no consensus for defining social capital, it has been used in many fields, including education, political science, and sociology, to serve as a

construct associated with 'resources' available to individuals to attain goals. Notably, in education, it has been defined by Coleman (1988) as "a variety of entities with two (or more) elements in common; they all consist of some aspect of social structure, and they facilitate certain actions of actors…. within the structure" (p. S98). Therefore, social capital was considered to be anything that facilitated individual or collective action (positive or negative) generated by networks of relationships, reciprocity, trust, and social norms (Portes, 1998). Critically, an essential premise behind "the notion of social capital is rather simple and straightforward: *investment in social relations with expected return*s" (Lin, 2001). Lin (2008) indicated social capital networks afforded four main components that engaged individuals or collectives (i.e., engineering community of practice):

1. **Information** flow is facilitated in the group and can provide individual user information and opportunities otherwise not available (pp. 6-7).
2. **Influence** can be exerted on members or agents within the institution who have access to resources, decision-making power involving the actor, and strategic locations (p. 7).
3. **Personal credentials** via relationship acknowledgment within the social group (p. 7); and
4. **Reinforcement** of identity and recognition within the social group is essential to mental health and access to resources (p. 7).

Macrosystem, Mesosystem, & Microsystem Influences on Human Factors

As noted above, the U.S. Academic Research Development Enterprise has been a significant motivator for many universities to apply for federal research funding. The $83.7 billion and the potential to license patented research have resulted in implementing

subsystems within the university and college levels to support the research development enterprise (NSF NCSES, 2021). In these subsystem levels where the Academic EPMSC framework has begun to operate, power relations, social interactions, and department and college social locations have been related through intersectional human factors.

Related Studies Based on Intersectional Themes with Engineering Faculty.

Although the following studies were not labeled as intersectional or under intersectional theory nevertheless, they were intersectional in their nature and scope based on their subject matter and discussion. The meta-inferences from these studies were that individuals cannot be reduced to their independent variables (i.e., race/ethnicity, gender, citizenship status, etc.) within dynamic systems. Faculty members within unique social locations have their own experiences and power relations due to faculty member rank and interpersonal relationships within their communities of practice. In this way, these articles contributed to the body of knowledge about faculty members at the macro-, meso-, and micro-system levels.

Connections among Setting, Individual Characteristics, and Research Productivity.

In terms of the ARDES, describing the potential for Academic EPMSC framework impact, many examples in the literature also presented potential areas for intersectional examination. Smart (1990) utilized organizational research turnover models and applied them to higher education settings. His causal model classified variables into three groups (a) individual characteristics, which included demographic information (gender, marital status, career age), (b) work factors (research time, teaching time, research productivity, influence, etc.), and (c) organizational characteristics (organizational decline, campus governance, etc.). He found three types of job satisfaction

(salary, organizational, and career) resulted in faculty members' perceptions of external conditions and served as a mediating layer between objective factors and personal turnover intentions. This study uniquely described ARDES as well as the potential influences on faculty members through causal factors such as (a) faculty member demographics, (b) the grant development/research productivity (e.g., experiences) and influence (e.g., power relations), and (c) perceptions of organizational decline and campus decline (e.g., experiences and power relations).

Lin (2008) indicated much of the analysis in their work had focused on two elements: (a) the location of individuals in a social network and (b) access to embedded resources. For network locations, the influential factors were identification of a bridge or structural constraint/hole, the strength of the ties to the network, in terms of intimacy, intensity, interaction, and reciprocity are key. In terms of resources, these were measured in various ways, including nature and scope of resources, best resources, variety of resources, composition (average resources), and contact resources. Access to contact's status and contact's occupation, authority, sector was also important (Lin, 2008). Further, Lin noted,

> two types of causation forces are of special interest to scholars in the analysis of inequality of social capital: structural and positional variations. A structure may be characterized by many variations, such as the economy, technology, and participation in the social, cultural, and political arenas. Individuals may be described as occupying different social, cultural, political, and economic strata within a structure. These variations may be hypothesized to affect the richness or poorness of various social ingredients (p. 14).

Relationships Among Setting, Gender, and Engineering Research.

Van Miegroet (2018) demonstrated that female STEM faculty members, particularly in engineering, were at a disadvantage with respect to recognition across multiple organizational categories of recognition at Utah State University. These categories included rank at hire, length of time for promotion from associate to full professor, nomination for internal awards, and selection for the awards. The awards represented the organizations' recognition of excellence within various categories and were a form of peer prestige bestowed by organizations to recognize their faculty members. The study data were collected for the period from 2008 through 2014 across four colleges, includingthe College of Agriculture and Applied Sciences, COE, Quinney College of Natural Resources, and the College of Science. Van Miegroet's data collection occurred during the same time USU had received an NSF ADVANCE (Proposal# 0244922) grant to promote an increase in the number of STEM faculty members on the campus.

According to Van Miegroet's (2018) results, she found only ten tenure-track (T/TT) females across the four STEM colleges were promoted during the six years. Overall, female T/TT faculty comprised only 18% of the faculty members in those colleges. Women were substantially underrepresented as full professors, with only 6% overall. During the period 2008-2014, COE did not promote any women to full professor. Notably, female faculty attrition occurred primarily at the assistant professor level, particularly in engineering. Perhaps, this was because, as Van Miegroet (2018) claimed, women were absent as department heads and, lacking the attainment of full professor were unable to achieve this mid-level step of leadership. Multiple climate surveys

revealed the difference between STEM faculty members, gender, and their college experiences regarding promotion and tenure, work environment, and position expectations.

Within the Academic EPMSC framework, the attainment of internal or external awards has served as an indicator of status and prestige among peers and colleagues. According to DiPrete and Eirich (2006), there was a connection between recognition, future productivity, and resource access. Thus, there were important implications and consequences for those who attained or were nominated for awards and those who were not. In the case of the internal awards, the selectivity of the awards impeded or supported access to resources to support their research productivity, according to Van Miegroet (2018). Further, it may be something as simple as acknowledgment. The only female dean of engineering was not featured on the wall of deans in the dean's suite. Her picture was taken but not hung. She was one of six female mechanical engineering deans of engineering at the time. Many new faculty members did not know the College of Engineering had a female dean (e.g., mesosystem signaling the microsystem and faculty member).

Relationships among Setting, Citizenship Status, and Engineering Research.

Nationally, the prevalence of foreign-born students in graduate programs in science and engineering has led to a parallel increase in their prevalence in academia and industry (National Foundation for American Policy [NFAP], 2017). "Between 1995-2015the number of foreign-born electrical engineers increased 27 percent from 8,855 to 32, 736" across all degree levels in the U.S. (p.1). The tremendous growth in graduate students and subsequent faculty increases were not limited to electrical engineering, also

included dramatic increases in mechanical, civil, and chemical engineering among others (NFAP, 2017). However, in 2016, Rovito et al. noted (2021) there was an observable shift in where international graduate students decided to complete their course work which may impact future talent trends.

Rovito et al. (2021) noted that foreign scientists and engineers had instrumental contributions in innovation and played significant roles in the development of many modern technologies that impact our lives such as the COVID-19 vaccines, Pfizer-BioNTech and Moderna, as well as recent innovations in electric vehicle design such as Rivian and Tesla. Furthermore, Rovito et al. (2021) studied the composition and contributions of the highly ranked Massachusetts Institute of Technology (MIT) faculty and found that “43%, nearly half, hailed from 90 countries” (p. 17). Their productivity was equivalent in all categories except publishing where they published half of all new journal articles, conference papers, patents and clinical research which was slightly less (Rovito et al., 2021). MIT is not anomalous in science and engineering; foreign-born engineers are prevalent in every ARDES including USU.

The contributions and engagement of foreign-born faculty has been a perennial conversation in academia. For example, in Corley and Sarbarwal's (2007) study, foreign-born academic scientists and engineers became the intersectional focus as they examined citizenship status, discipline, career trajectories, work satisfaction, productivity levels, and salaries. Their findings indicated patterns of differences in foreign-born scientists and engineers' career pathways that may impact their engagement in the ARDES. In related work, several researchers have shown that work satisfaction was an essential component of faculty members' retention (Johnsrud & Heck, 1994; Rausch, 1989).

Methodologically, Corley and Sabharwal (2007) used the *2001 Survey of Doctorate Recipients* (SDR) conducted by the National Science Foundation to collect data on all individuals under the age of 76 who had received a doctoral degree in the science or engineering from a U.S. institution and were residing in U.S. as of April 15, 2001. In the second phase, they used a telephone follow-up to non-respondents usinga computer-assisted telephone interviewing system. In total, they had an 82.6 percent response rate of 31,366 (Corley & Sabharwal, 2007). They then reduced the dataset to include only full-time academic science and engineers at (a) four-year colleges or universities, (b) medical schools, or (c) university research institutes. Two-year colleges, government agencies, and other entities were excluded. The original data included 30.1 percent women, and the filtered data had 28.7 percent. Foreign-born scientists and engineers were defined as those with permanent or temporary visas and naturalized citizens.

Corley and Sabharwal (2007) concluded that foreign-born academic scientists and engineers were more likely to have taken a postdoctoral position because of a perceived lack of full-time academic or industry positions. In addition, they were more likely to report research and development as their primary work activity. They did not report less grant or patent activity because of citizenship. Foreign-born male scientists had higher salaries than foreign-born female scientists. Faculty members at Carnegie Research I or II institutions earned more than those employed at less research-intensive universities. Foreign-born scientists and engineers earned nearly $7,000 less than their U.S.-born academic peers (Corley & Sabharwal, 2007). Overall, foreign-born faculty members reported less satisfaction than U.S. born scientists on all dimensions of the work

environment, including opportunities for advancement, job benefits, the intellectual challenge of the job, degree of independence, location, levels of responsibility, salary, job security, and contribution to society.

Implications of the Academic EPMSC for Faculty Members

The notions of structural and positional variations are prevalent in the full cycle of new faculty recruitment, the iterative nature of the promotion and tenure process, and the variability between departments about what is promotion "worthy." The first begins with the interactions between faculty candidates, faculty members, departments, and the university during the interview process to establish relationships. Faculty members are initially hired based on a series of phone and on-site interviews over a period of weeks following the review of applications. Once candidates are selected, the department head initiates an 'offer letter,' which included salary and benefit package negotiations and initial start-up costs for one to three years, depending on the faculty members' identified requests. As indicated in Chapter 1, these are co-funded across the ecosystem and vary radically in size.

Carnegie R1 and R2 research universities engaged with the assistant professor, faculty member with a substantial capital outlay and future commitment from the beginning. Thus, during this time of 'wooing,' it was crucial that the institution and its representatives be clear about performance expectations. The amount and number of resources leveraged and negotiated varies by department. This places the new cohort of faculty members hired by the USU College of Engineering in vastly different circumstances depending on how much their group negotiated on their behalf or how vigorously they negotiated for themselves.

Second, by virtue of their research success and activity, some departments can leverage more capital for their applicants in terms of salary and start-up, depending on the researcher's area of expertise. This inherently suggests those who start with more resources have more 'expectations' based on their department and its research activity at Utah State University in the College of Engineering. Moreover, this also implied that not all faculty members share the same level on the playing field among the newly hired cohort, although they are starting with the same tenure clock, which is six years.

Finally, as with other organizations, some USU engineering departments are very assertive about their expectations for their new faculty, whereas others are more *laissez-faire*. The variation between highly structured expectations and support and less structured expectations could contribute to faculty grant productivity at USU. Xu (2008) indicated that all faculty must juggle research, teaching, and service. Further, "As for faculty turnover, high productivity lowers turnover intention" (Rosser, 2004 as cited in Xu, 2008, p. 610). Smart (1990) also indicated that faculty members with more teaching responsibilities think less often about leaving.

Self-Efficacy Theory

Bandura's (1977; 1986; 1997) Self Efficacy Theory has continued to be a prominent perspective in educational research and many other fields, particularly engineering and engineering education. Nevertheless, the use of Self-Efficacy Theory for understanding early-career engineering faculty members' research efforts has been limited in academia, particularly in the understudied area of grant development (Hackett et al., 1985). Bandura (1977; 1982; 1986) defined self-efficacy as the belief that a person can successfully complete a behavior to achieve an outcome or attain an identified goal. In the

current context, the goal was to win federal grant money. This goal has been rewarded uniquely within the ARDES framework through promotion and tenure and/or nomination for internal awards. It was distinguished from outcome expectancy, which described a person's ability to estimate the behaviors or steps needed to achieve an outcome. For example, a person may know the course of action to take, but if they have doubt or negative thoughts about their performance, this may cause them to delay. This, in turn, may cause them to doubt whether they can complete the task. In their research work, Landino and Owen (1988) developed the terminology for the academic context; they defined "academic self-efficacy as an estimate of confidence of one's ability to perform various tasks classified as research, service, and teaching in a university setting"(p. 2).

According to Bandura (1977, 1982), "expectations of personal efficacy are based on four sources of information: performance accomplishments, vicarious experience, verbal persuasion, and physiological states" (Bandura, 1977, p. 195). Critically, both initiation and persistence of coping behaviors to achieve the outcome have relied on the personal mastery expectations, but the appropriate skills and incentives were required. Performance accomplishments were particularly influential because they relied on personal mastery experiences (i.e., grant awards vs. declines). Vasil (1992) noted success raises expectations, and repeated failures lower them.

Further, Vasil (1992) indicated research productivity increased as faculty member self-efficacy increased. Landino and Owen (1988) also found that mentoring and environmental responsiveness (e.g., setting, macro-, meso-, or micro-system) strengthened research self-efficacy as elements of vicarious learning. Surprisingly, rank did not matter; it was more about faculty members' willingness to share skills with their

peers that did. These data seemed to support that the bonds developed in engineering communities of practice contributed to the support of new members, similar to what Wenger (1998) found in other settings.

According to Landino and Owen (1988), women with low research productivity also had poor self-efficacy. If equity is the university's organizational goal, then attention via social processes, resources, and organizational resources may be required in this nested system (Tseng & Siedman, 2007). Vasil (1992) and Landino and Owen (1988) reported that males had higher self-efficacy than female faculty members in areas of research. In the Vasil (1992) study, this translated into 2.5 fewer published articles, 2.4 fewer reports, and 1.4 fewer grants received in a three-year period for female faculty members. As Landino and Owen (1988) indicated, promotion and tenure at research universities were based on research productivity, and gender-related differences adversely affected women.

Bandura (1977) observed "people process and synthesize feedback information from sequences of events over long intervals about the situational circumstances and the patterns and rates of actions that are necessary to produce given outcomes" (p. 192). Consistent with this statement, there has been a routine pattern for various federal agency grant requirements, processes, and grant application cycles. The responses from the various federal agencies have a predictable format and a period of performance. Nevertheless, Bandura (1977) also indicated discrepancies between efficacy expectations and performance form when there were ambiguous situational contexts, task factors, or poorly-defined performance requirements. All three of these situations may have readily occurred within grant writing contexts for early-career faculty members because they

often were focused primarily on preparing the narrative or project description document without allocating enough time for other required documents (i.e., temporal discounting). For example, suppose the average single investigator NSF application was 70 pages, and the project description was 15 pages. In that case, if the faculty member allocated or prioritized only the project description, they were focusing on 21.4% of the required documents. This might have led to problems, and time management was essential.

Implications for the Study Based on Self-Efficacy

According to Bandura (2006, p. 307), self-efficacy cannot be measured using a "one size fits all" measure, but rather assessment must be tailored to the particular context, which requires attention to the domain of functioning, i.e., self-efficacy in grant writing. Further, the self-efficacy data is explored in the semi-structured interview protocol. In this way, results from studies of academic self-efficacy inform the design of the pre- and post-intervention assessments as well as the intervention modules. The content must be highly specific to a defined situational contextand specified task. The modules must communicate performance requirements and processes. As a result, I have constructed separate pre- and post-intervention assessments specific to the content for each module to increase the likelihood of adequate sampling and responses to each module's domain of functioning. This quantitative assessment was complemented with an interview protocol, as well as data analytics from

the LMS and Communication System, and secondary data analysis from the university documents.

Microlearning Theory

The five-module grant writing intervention was designed using Microlearning Theory from many fields, particularly from work-based learning. According to Dietrich (1984), microlearning instruction and pedagogy had inherent interrelatedness and complexity of relationships between learners, educational content, and the implemented support technologies used for delivery and engagement. The theory also assumed the pervasiveness of digital media and technologies in educational or environmental contexts and that learners were “digitally experienced” and “expert learners” (Prensky, 2001; Leong et. al, 2020).

Hug (2006) suggested many types of microlearning, but the most prevalent kind described a single and highly focused concept of fewer than 10 minutes per segment (e.g., 'step by step'). As Emerson and Berge (2018) claimed, microlearning has been particularly suited to engaging employees, facilitating knowledge acquisition in the workplace, and enabling employees, such as early-career faculty, to apply the knowledge they have acquired. Mazareanu (2019) and Brandenburg and Ellinger (2003) pointed out that employees engaged in learning when needed, and on-demand learning accommodated the growing need for lifelong learning and skills upgrades in a "fast-paced, multitask-oriented environment with digitally savvy learners" (Leong et al., 2020, p. 3).

As indicated previously, grant writing skills were acquired, and the nuances of federal agency requirements and processes required self-motivation and self-direction in

an online environment (Parker, 2003). Siemens (2007) maintained microlearning specifically required understanding the (a) learning environment (e.g., "classroom vs. online ecologies") and (b) structures of learning (e.g., hierarchical, and linear content to networked and organic content) (p. 53). Further, Siemens (2007) suggested future academic systems would be more likely to have the following three attributes:(a) need and application would drive curriculum, (b) they would be designed and structured to respond to changing environments, and (c) the systems would filter and synthesize multiple points of data. One of the potential challenges for online learning, according to Jacobs (2013), was that online instructors would be required to engage in continuous training and support in the learning management system and related software. However, according to Hug and Friesen (2007), microlearning had deliberately defied overt "definitions" because learning and the acquisition of learning concepts occurred on multiple levels "in terms of micro-, meso-, and macro-aspects" (p. 17). As a result, the 'knowledge economies' and the delivery potential at scale for learning access, training, reskilling, and continuous learning were substantial and potentially applicable in multiple fields and settings.

Langreiter and Bolka (2006) defined microlearning as reflecting "the emerging reality of fragmentation of information sources and information units used for learning, especially in fast-moving areas which see rapid development and a high degree of change" (p. 79). This need for a responsive and agile theory was a part of the central rationale for using the Microlearning Theory as part of my intervention. The content often changed because the federal agencies routinely changed their requirements, processes, and protocols. In addition, engineering faculty members developed

fundamental and applied research solutions that often required innovative and disciplinedtheoretical responses. Moreover, their competitive federal grant writing success affected the tenure process directly since it was a critical component of the research portion of theprobationary employment contract.

Curran (2008) defined online education as an internet-based learning technology whereby students and teachers engaged in the content. Hislop (2000) and Bollinger and Wasilik (2009) reported no significant differences in student achievement online despite social criticism. Nevertheless, Fiedler and Kieslinger (2006, pp. 80-81) clarified that microlearning from the perspectives of an "institutional setting" as compared to an "individual setting" was different. There were highly controlled hierarchical architectures within the institutional setting, including the learning management system (LMS) and communication systems such as email, messaging, which engaged the learner. The interplay between the communication and management systems can provide microlearning with unique agility not seen in the traditional classroom.

Implications from Microlearning

Muilenburg and Berge (2005) report students' perceptions of online experiences influence their engagement and willingness to remain in the course. Early-career engineering faculty members are high-achieving, experienced learners, and educators. Their willingness to engage and remain engaged was unique because they all had the same education level as typical Carnegie R1 and R2 faculty members. The design of the on-demand modules is reflective of this conceptually. Modules are deliberately segmented and designed using Microlearning Theory or, as we say in process automation engineering, "plug and play." Thus, modules can be altered when the

segment is no longer accurate or relevant without disturbing the whole course. This is likely to reduce course development time and costs and has the potential to make the curricula more flexible and agile. Nevertheless, these variables and factors have not been clearly assessed in microlearning.

Thus, Microlearning Theory is an ideal vehicle for the intervention because it allows for online, on-demand, based on content that was likely to change, and it is designed for learners who were digitally experienced upskilling in a unique setting for a highly competitive environment. Further, the intervention assumes several motivating factors for engaging within the Engineering Community of Practice, including developing a research lab and students, building a research reputation, thriving, accessing resources within the ECoP, and promotion and tenure.

Data and Results from Previous Cycles of Action Research

In the following section, I have described data and results from previous cycles. This information was used to inform the current study.

Cycle 1

In Cycle 0, I investigated faculty turnover at the department and college levels. In Cycle 1, I sought to assess the potential relationships between voluntary turnover, grant development processes, and their demographic data among early-career engineering faculty members. Two new instruments were developed, including a faculty survey questionnaire and a semi-structured interview protocol. This study took place in a mid-sized, College of Engineering with five faculty members. Four males and one female participant were purposefully sampled, and they completed the survey and interview protocol (Patton, 2002; Creswell & Plano-Clark, 2015). By selecting early-career faculty

members from the larger engineering faculty population, I purposefully sampled a group of non-tenured faculty engineers who were likely to be seeking grants as they engaged in their efforts toward promotion and tenure.

In the study, I field-tested a survey instrument and a semi-structured interview protocol. In terms of the questionnaire, demographic information was collected, including gender, race/ethnicity, marital status, children under 18 in the household, and department. I also collected selected information about their grant development practices. For the interviews, descriptive codes, categories, and analytic codes for each anonymized interview were developed from the data to yield themes (Brinkmann & Kvale, 2015; Charmaz, 2014; Saldaña, 2016). The interview coding was conducted using the same process described in Cycle 0. Specifically, I employed the constant comparative method in which I compared new text input, categories, and themes to previous ones and created new codes, categories, and themes if the new input did not fit within the already existing codes, categories, and themes (Strauss & Corbin, 1998). I also constantly reflected on these efforts to ensure the data supported the higher-level interpretations.
Moreover, I used analytic memos to document the procedures and guide my next steps in the interpretive process.

Notably, in Cycle 1, the participants identified three characteristics as necessary for successful engineering researchers who routinely won grants. Using grant support was mentioned by all five participants, four participants identified an excellent academic reputation, and communicating effectively was articulated by three participants. The preliminary data indicated a recognition of the value of grant development personnel in engineering to support "winning grants." Further, the notion that communicating their

expertise was a strength and a potential asset as they built their careers was also crucial because this can be an asset in grant development writing, as depicted in Figure 8.

Figure 8

Cycle 1 Characteristics of a Successful Faculty Researcher in Engineering

Earlier, results from Cycle 0 indicated staff members believed certain factors influenced early-career engineering faculty turnover, including salary, spousal influence, religious influence, mentoring, institutional ranking, collaboration, and community integration. In my role, I could not influence many of these components; however, collaboration and mentoring were elements of grant writing that I could influence. The results from Cycle 1 indicated that of the three essential characteristics of successful engineering faculty members who obtained grants, I could influence two directly. These characteristics were (a) utilizing grant support and (b) more effectively communicating their area of expertise in grant writing. I designed an intervention to help support early-career engineering faculty members as they navigated the grant writing process with this

information. Specifically, I intended to (a) support their understandings of agency requirements and processes and (b) develop their skills with respect to grant writing (i.e., exosystem).

Cycle 2.5

In Cycle 2.5, I examined the viability of one of the on-demand, online modules designed for the USU engineering early-career faculty members. However, because there were a limited number of early-career faculty members, I selected two faculty members from a department that hired a large number of early-career individuals. I selected one tenure-track, assistant professor and one associate professor. Both had received their doctorates at large very high-research institutions and then had chosen to work at USU.

They both completed the Module 1—NSF Resubmission in Fall 2020. Both completed the pre- and post- intervention questionnaires and the semi-structured interview. Regarding the module, both liked the content and indicated that they particularly liked the data provided about resubmitting and would like to see more statistics. I told them that I had been concerned about overwhelming the viewer.

They both were candid about the background and indicated that they preferred a more professional neutral background but realized that I must have produced them myself during the pandemic. Ideally, one indicated, someone else would be shooting the film and would change the camera angle slightly.

CHAPTER 3

METHOD

We delight in the beauty of the butterfly, but rarely admit the changes it has gone through to achieve that beauty.

—Maya Angelou, 2015

In Chapter 3, I described the rationale for the use of research methodologies, including details about the implementation of the intervention and its assessment as well as anticipated inferences (Tashakkori and Teddlie, 2002; R.R. Buss, personal communication, January 15, 2021). First, I described the study's philosophical roots and its connection to action research and mixed methods action research frameworks. Then, the problem of practice within the Utah State University, College of Engineering (COE) was described as well as the setting. The context of the ARDES and Academic EPMSC framework was discussed. Next, the COE participants and sampling were presented. Subsequently, I provided a detailed description of the intervention. The intervention included five on-demand, online learning modules to enhance early-career engineering faculty knowledge of federal grant requirements, processes, and skills. Next, I presented a description of the quantitative and qualitative data collection processes and procedures, instruments, the timeline for implementation, as well as necessary considerations for validity and credibility. Finally, I described the data analyses.

This study's primary purpose was to assess the effect of the intervention, five on-demand, online learning modules for early-career engineering faculty members'

knowledge related to requirements, processes, and skills, as well as their attitudes, and self-efficacy. Two research questions guided the conduct of this study:

> **Research Question 1**—How and to what extent did the implementation of five on-demand, online modules affect early-career engineering faculty members' understanding of grant writing (a) requirements, (b) processes, and (c) skills?
>
> **Research Question 2**—How and to what extent did the implementation of five on-demand, online modules affect early-career engineering faculty members' (a) attitudes toward and (b) self-efficacy toward writing grant proposals?

In Chapter 3, the research design's plan was based on the theoretical foundations articulated in Chapter 2 and the early knowledge gathered from planning, reconnaissance, research, and results obtained in Cycles 0 and 1 described in previous chapters or near the end of this chapter. To begin the chapter, I articulated my ontological and epistemological stances to clarify those matters with respect to the research design and approaches.

Theoretical Alignment and Research Design

The theoretical alignment and the study's ideological orientations were motivated by the multi-strand mixed methods research design for the ARDES, and the intervention proposed within the Academic EPMSC framework described in Chapter 2. Notably, mixed methods action research (MMAR) has served as a knowledge-generating and verifying approach to examine the proposed research questions. Moreover, MMAR readily accommodated the inherent complexity of 'wicked problems' and complex systems methodological approaches, data collection, and other procedures, which I have described in this chapter (Levin et al., 2012; Teddlie and Tashakkori, 1998; Thurner et

al., 2018).

Loescher (2018) described how scholars' philosophical and theoretical dispositions affected data collection interpretation in the action research studies (Creswell & Creswell, 2018). As I progressed through the program, my philosophical and theoretical dispositions have changed as a practitioner-scholar during my coursework and as an embedded member in a community of practice serving as the Grant Development Manager at USU. I often needed to change hats depending on my role or the expected roles needed within the Engineering Community of Practice (ECoP) for research grant development (Wenger, 1998; NORDP, 2020).

These changes in perspective have been described from ontological and epistemological perspectives. As Crotty (1998) and later Patel (2015) described, these changes are connected inherently to theoretical perspectives, the methodology chosen—MMAR, and the types of methods utilized to collect and analyze data for the study. I have presented details about theoretical alignments with respect to the research design. Specifically, I presented linkages between my ontology, epistemology, theoretical perspectives, methodology, and the methods to collect and analyze the data for the study. See Table 1.

Table 1

Theoretical Alignment and Research Design

Ontology	Epistemology	Theoretical Perspective	Methodology	Methods
There is no single truth or reality. Reality is continuously renegotiated, debated, interpreted, and based on the priorities and usefulness to the context.	Constructivist with a heavy Pragmatist leaning—It is problem-solving, future-oriented, and change-oriented	The world is as we perceive it. The world evolves and is made by those in power or act on their personal power. Deweyan Pragmatism Research by Design	Mixed Methods Action Research	Survey Questionnaires Statistical Analysis Semi-Structured Interview Protocols Field Notes/Memos Document Analysis Theme Identification Secondary Data Analysis

(Adapted from Crotty, 1998; Patel, 2015)

The alignment of my theoretical perspectives to other components influences my ontological and epistemological stances for the research. In my ontological stance, I recognize there are multiple worldviews and mechanisms to enact those viewpoints in multiple dimensions across time and space (Ivankova, 2015). My epistemological stance is one of being a constructivist. Nevertheless, my pragmatist leanings arise from my day-to-day engagement in my community of practice with grant development and the rhetorical need for agency responsiveness and reader engagement. As a pragmatist, I recognize that “one size” or “one response” does not fit all agencies. Therefore, I prefer

to choose methods, techniques, and procedures appropriate to problems as they arise in context (Creswell and Creswell, 2018; Ivankova, 2015; Iser, 1974, 1986). As a pragmatist, practitioner-researcher, I draw upon multiple theoretical perspectives, frameworks, and worldviews to address the problem of practice, faculty members' needs, the competitive research and development environment, and various agencies' needs.

For the purposes of this research study, the term dynamic fluidity refers to the notion that pragmatic approaches enable a researcher to pivot theoretically and methodologically as appropriate to the unique needs of the field. This dynamic fluidity provides a variety of forms of methods, techniques, procedures, data collection, and analyses to share with the field. According to Johnson and Onwuegbuzie (2004), pragmatic research methods using the mixed methods approach should comprise multiple combinations of methods and procedures to address the research questions. A pragmatic approach is well-suited for this MMAR study because such an approach allows me to take account of 'situational awareness in context (Ivankova, 2015; Kessel, 2017). Upon assessing the situation, the faculty member who is a learner or the grant writer can engage in their dynamic fluidity to inform the grant development and potentially the study design.

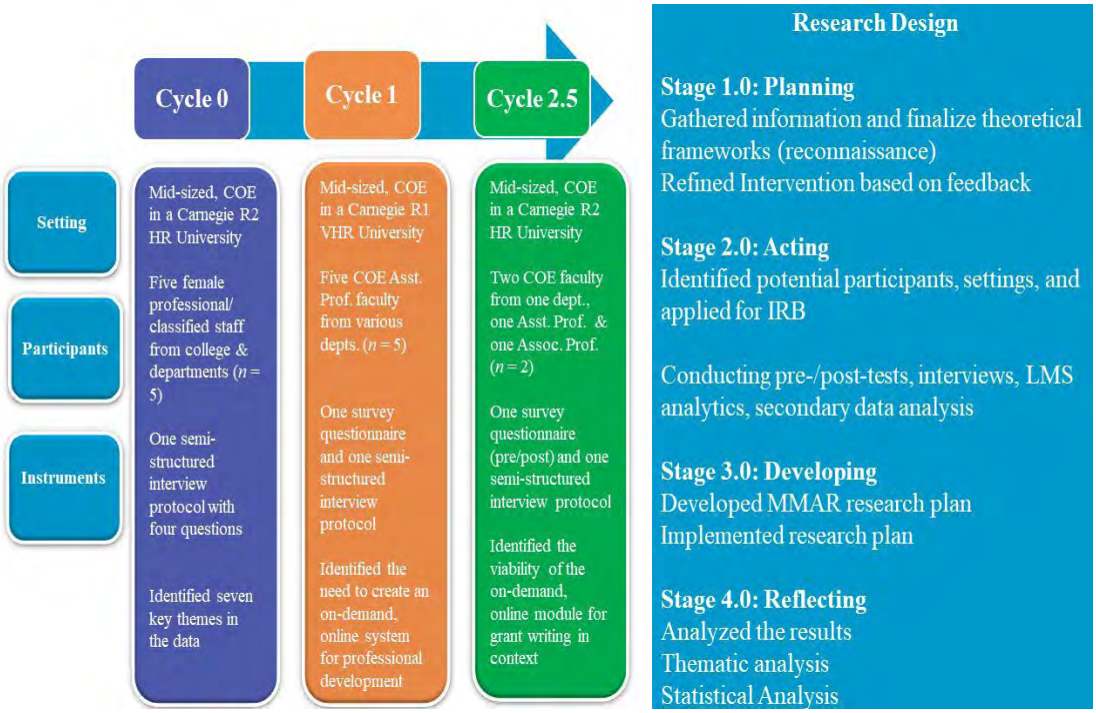
Action Research

As I described in Chapter 1 and Figure 9, this study was designed as an iterative MMAR study. Action research has been characterized by cyclical and multi-stage processes in which scholar-practitioners actively seek to solve a problem in their setting (i.e., early-career faculty members improving their professional practices (Mertler, 2017). Gustavsen and Plshaugen (2020) described how action research has developed over time,

primarily because of workplace needs and organizational anchoring outside academia. Nevertheless, commonalities have strengthened the approach, including (a) focusing on results that need to be achieved, (b) generating other projects, and (c) creating 'broader social impact' (Gustavsen, 2014; Gustavsen & Plshaugen, 2020). Importantly, the connection between theory and practice conceptually linked one of the essential aims of education research; those engaging in action research actively practiced using theory to inform their work as practitioner-scholars. In the iterative processes used in action research, the unique planning, acting, developing, and reflecting processes allowed practitioner-scholars to refine their research questions based on a flow of information (Johnson, 2008; Kessel, 2021; Mertler, 2017).

Figure 9

Cyclical Process for the MMAR Leading to the Final Research Design



Mixed Methods Action Research

Mixed methods action research (MMAR) was uniquely suited to study the problem of practice. The intervention modules were specifically designed to address federal grant development, provide professional development via on-demand, online modules, and mentor early-career engineering faculty in strategic and tactical ways about specific grant topics. To assess my specific areas of interest, which was federal grants requirements and processes, professional development, and mentoring for the Engineering Community of Practice (ECoP), I developed five surveys that employed pre- and post-intervention assessment processes to provide quantitative data for the individual modules, as well as an interview protocol to provide qualitative data. The pre- and post-intervention surveys and the interview protocol were field-tested with engineering faculty members in an earlier action research cycle. Each survey was designed to assess the module's influence on the early-career engineering faculty members regarding their understanding of requirements, processes, and skills related to the topic and their self-efficacy and attitudes. The interview protocol was designed to assess the effect of the modules overall.

The assessment of the intervention also utilized analytics with detailed quantitative data in relation to how faculty members interact (e.g., the number of videos viewed, the number of downloaded resources, clicks, etc.) and with the application programming interface (API) in the LMS (e.g., X use in a context based on module information). For example, upon downloading the SWOT analysis form and brainstorming with their collaborators (i.e., Co-PIs or consultants), the early-career engineering faculty members may have decided to increase or decrease the number of

collaborators based on the information identified. The analytics would have identified the form, such as the SWOT analysis. In another example, the number of solicitations in a particular field annually may also have influenced the number of applicants to a specific solicitation and the number of available reviewers. Neither a purely quantitative nor a qualitative study would have provided sufficient detail of the data trends and relationships (Creswell and Creswell, 2017). Hence, the use of MMAR allows for a more thorough investigation of how early-career engineering faculty members acquire knowledge awareness of federal research grant requirements, processes, and skills. Additionally, the study assesses early-career engineering faculty members' attitudes and self-efficacy following the completion of the intervention with the on-demand, online modules.

Setting

The early-career engineering faculty participants were from a mid-sized College of Engineering (COE) ranked as a Carnegie R2, high research, doctoral university. The participants were sampled purposively from the college's early-career, tenure-track faculty members in all five engineering departments. These departments included biological engineering, civil and environmental engineering, electrical and computer engineering, engineering education, and mechanical and aerospace engineering. Each department has its community of practice (CoP) (Wenger, 1998) and ABET accreditation professional learning communities (ABET, 2021; Hord & Sommers, 2008).
Within these five departments, there were 98 faculty members who were supported by 70 staff members (USU AAA, 2020).

The COE has $23.1 million in research expenditures annually on the non-

classified side of campus and over $200 million in engineering and science expenditures on the classified side of campus for the fiscal year 2020 (USU Sponsored Programs, 2020). The NSF HERD Survey ranked USU in engineering research expenditures 11th in the United States (NSF NCSES, 2021).

Participant Sampling

Table 2

USU Participant Profile for Survey Questionnaires (Pre-/Post-test) and Interview Protocols and Related Data Collection

Gender	Race/Ethnicity	Data Collection Methods	Data Collection Procedures
Male, Female, Transgender, and Other	All Categories 1. White 2. Black or African American 3. American Indian or Alaska Native 4. Asian 5. Native Hawaiian or Other Pacific Islander 6. Hispanic or Latino	Pre- and post-intervention assessment Qualtrics-Net Promoter Score (Likert), Multiple Choice, Open Ended, (on-line) Descriptive Statistics (quantitative) Semi-structured Interview Protocol (qualitative)	Conduct an online pre-intervention assessment prior to implementing the learning module and following the completion of the module conduct a post-intervention assessment. Conduct a semi-structured interview with those who complete 2 or more modules Secondary Data Collection

In this MMAR study, the early-career engineering faculty members participating in the study were purposively sampled. I used pre- and post-intervention surveys and a semi-structured interview protocol. I randomly sampled those completing the pre- and

post-intervention surveys (n = 5) for the semi-structured interviews. Internal Review Board (IRB) approval was obtained from Arizona State University (#00013934) prior to conducting the work. The research was found to be exempt by ASU. It was verified that it did not require IRB at USU or the University of Pittsburgh. The USU intervention implementation was conducted with five (n = 5) early-career engineering faculty members and one (n = 1) faculty administrator across the five COE departments.

The early-career engineering faculty participants were primarily male, and 1/3 female based on the USU population. Engineering was a naturally homogeneous group and profession; nationally, less than 17% of the engineering faculty members were females (Roy, 2019). The racial/ethnic composition was diverse due to purposive sampling. However, it tended to be more homogeneous at USU due to various factors, including the region's population composition and educational attainment. Due to gender and racial/ethnic homogeneity at USU and to ensure the intervention's validity and reliability, the researcher gathered other data, including LMS analytics and secondary data for analysis, to triangulate the data. The age range sampled was between 25 to 64 years.

Role of the Researcher

As the Grant Development Manager, my role in the COE and the ECoP was as a strategic catalyst for informing faculty members about grant development as needed, identifying critical opportunities matched to their expertise, providing informed feedback on their drafts, and strategically building their grant development skills in the direction of their research vision. On the other hand, as a teacher, a 'guide on the side,' and researcher-practitioner, I assessed the problem of practice, designed a custom early-

career grant development intervention, provided instruction in an online, microlearning format while collaborating with them on winning the federal grants and ultimately, emerging as researchers with fully funded labs.

In this study, I was an active participant in the design and implementation of the intervention in several ways. First, I identified vital targets of interest to the population through my Cycle 1 and secondary data analysis of prior grant submissions and federal agencies that support engineering grants. Second, I developed the five modules and many of the support materials included within those modules.

I designed the pre- and post-intervention surveys, which I used to collect quantitative data. I designed the semi-structured interview protocol, which I used to gather qualitative data. I gathered secondary data using available LMS analytics and institutional profile data from USU's website and a USU GRAMA request.

Intervention Design

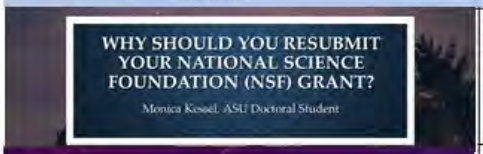
Midgley (2020) characterized an intervention as the intent to create agentic systemic change within prescribed boundaries. He argued that it is nearly impossible for any researcher to address all the potential relations among variables. However, it was possible to examine within prescribed boundaries and critique the examination within what he calls 'boundary critique' (Midgley, 2020, p. 167). For this current study, an intervention was developed to support early-career engineering faculty members with respect to federal grant writing requirements and expectations. The intervention consisted of five on-demand, online learning modules focusing on grant-writing requirements, processes, and skills. The evaluation of the intervention assessed participants' knowledge of requirements, processes, skills, attitudes and self-efficacy toward grant writing

following the completion of the modules.

The boundaries of the intervention were specific and defined for the study. The intervention modules were developed using a combination of software and hardware (e.g., MSOffice365, Zoom, Canva, Samsung S10+). The components of the modules have been presented. In Table 3, I describe modules' titles, the number of pre- and post-intervention questions on the surveys, ten validation questions, one to nine videos per module, seven to thirteen slides, and the number of additional resources per module.

Table 3

Intervention Modules Components Overview

Modules	Pre-/Post	Duration	Videos	Slides	Resources
	Thirty-seven (36) questions (QUAN) and QUAL)	23.32 minutes (video)	Nine (9)	Nine (9)	Nine (9) Citations NSF PAPPG 20-1 hyperlink One (1) Send It Back In! Infographic Four (4) Embedded Questions
	Forty-eight (48) questions (QUAN) and	37.14 minutes (15.87 video & 21.27 audio)	Five (5)	Thirteen (13)	Eleven (11) audio recordings Nine (9) Citations and Photocredits Two (2) Photos Three (3) Graphics One (1) Table Seven (7) Embedded Questions
	Forty-eight (49) questions (QUAN) and (QUAL)	40.47 minutes (23.32 video & 17.15 audio)	Seven (7)	Seven (7)	Four (4) audio recordings Nine (9) Citations and Photocredits One (1) Graphic One (1) Table Two (2) Photos Four (4) Downloads Seven (7) Resource links Seven (7) Embedded Questions
	Thirty-six (36) questions (QUAN) and (QUAL)	14.43 minutes (9.65 video & 2.21 audio)	Five (5)	Eight (8)	Four (4) audio recordings Twelve (12) Citations and Photocredits Five (5) Photos One (1) Graphic Seven (7) Embedded Questions
	Forty-three (43) questions (QUAN) and (QUAL)	15.40 minutes (54 sec. video & 14.50 audio)	One (1)	Seven (7)	Seven (7) audio recordings Twelve (12) Citations and Photocredits Seven (7) Photos Eight (8) Resource links Seven (7) Embedded Questions

In general, five asynchronous modules were designed using Microlearning Theory which emphasized short (i.e., less than 10 minutes) segments within a larger module. This design improved student-faculty learning and allowed student-faculty to identify the segments they wanted to review quickly; the design also allowed the instructor the flexibility to update or remove segments that needed changes without disturbing the whole module. The microlearning segments were comprised of agency-related content on aspecific topic within informational slides, infographics, tables, audio, and video recordings, photos, embedded resource links, and interactive questions.

Structure of Modules

As I designed the content of modules, I devised them based on concepts that were pervasive in engineering, education, and industry. These learning-centered concepts were focused on content, learning delivery, instructor flexibility, and assessment. As indicated previously, the federal ARDES was an $83.7 billion landscape and was highly competitive (Boroush M; NSF NCSES, 2021). Early-career faculty members needed professional development, mentoring, and specific content about federal grant writing to compete with others submitted to the top federal agencies. To support their success in grant writing, the modules were designed with the agencies' requirements, processes, and particulars in mindand information I gathered about 'grantsmanship' appropriate to these agencies and other professional organizations.

Moreover, as federal agencies progress, encountered barriers, or changed, they often altered their requirements and processes, posted in the Federal Register and on their websites. Because portions of the content could change, Microlearning Theory's segmentation strategy (e.g., creating stepstones) informed the online modules' design.

Therefore, the modules were more straightforward to update than a whole video with the relevant new information. As an educator, I also made some assumptions about the early-career faculty members as learners based on my own experience and supported by research about how experts acquire new information, as discussed in Chapter 2. Two of my assumptions were that as Ph.D., early-career engineering faculty members seeking tenure, they were "digital experienced" and "expert learners."

As discussed in Chapter 2, online trends have demonstrated that Americans have a decreasing attention span dropping from 12 seconds in 2000 to eight seconds in 2016 as they looked for information online (Bradbury, 2016). Davis (1993) and Wankat (2002) indicated that 10-15 minutes is substantial time to dedicate to learning online. However, when Wilson and Korn (2007) conducted direct in-class observations, they found that learner attention lapsed after 10-18 minutes, but waned after the first five minutes. Using this information, I decided to opt for a design that provided learning in "bite-sized chunks," or segments easily revisited by the learner if they were interrupted or if their attention waned. Microlearning theory provided me with a framework to deliver a segmented and coherent curriculum with targeted content. One of my primary assumptions from working in engineering and healthcare for highly educated faculty member learners was that content needs to be highly focused, learner-centered, and relevant to an immediate need in their research world. Therefore, the modules' curricular topics were highly specific to topics that were persistent challenges for faculty. That is to say, multiple curricular sources were used to create sequential cohesive content.

Module 1—NSF Resubmissions. The first module is entitled "National Science Foundation (NSF) Resubmissions."The NSF has received over 50,000 proposals annually

(NSF, 2019). USU COE faculty members routinely submitted applications to four of the seven directorates (USU, 2020). The most common for engineering faculty were Engineering (ENG) and Computer and Information Science and Engineering (CISE), followed closely by Education and Human Resources (EHR) and Mathematical and Physical Sciences (MPS). Each directorate had a different funding rate, but all averaged between 17-23%, depending on the program (NSF, 2019). On an annual basis, the programs within each directorate varied in size and the number of awards approved. Individual faculty members experience competition even before they apply because the directorate to which they submit only offer solicitations once per year or awarded few proposals.

Essentially, in some programs, there was a higher degree of award scarcity than in others. To mitigate this anxiety, I strongly have encouraged early-career engineering faculty to do several things to help themselves as they thoughtfully reposition for resubmission. These suggestions were based on the facts about the competitive research landscape at the second-largest engineering research granting agency in the United States and utilized real-world, NSF agency content for curriculum. The content was based on information from the National Science Foundation Proposal and Award Policies and Procedures Guide (PAPPG), NSF secondary documents, and data from the analysis of Dunlap's (2020) reviews at the American Association for the Advancement of Science, among others. I created videos, infographics, and utilized gallery photos to demonstrate topic areas.

In all, there are six topics related to what constituted a strong resubmission at NSF. These topics include advantaged of resubmitting, common reasons for

declination, solicitation fit, collaborator fit, Intellectual Merit, and Broader Impacts (NSF PAPPG, 2020). To provide a glimpse of what I included in this module, consider the following explanation of one of the components. To encourage an innovative mindset, I wanted to provide a new way of examining their potential collaborators. I also incorporated the SWOT analysis model (e.g., personal SWOT analysis) into this module to identify the strengths, weaknesses, opportunities, and threats related to potential collaborators and encourage them to think more thoughtfully about their collaborators (Addams & Allfred, 2013). The module was created to help them identify needs as they reposition their proposal for resubmission. Using this SWOT model in a new context, I encourage my highly educated learners to think about the routine topic of "collaborative partner" in a new way.

Module 2—Early Career Awards. The second module was called "What federal opportunities are available for early-career awards?" Some federal agencies offered early-career grant awards to cultivate and identify innovative new investigators in targeted research areas. This was not common knowledge among early-career engineering faculty members, and in my Cycle 1, most early-career engineering faculty members believed that NSF CAREER was their primary opportunity. The early-career faculty members who participated in Cycle 1 had been strongly encouraged by a dean or other faculty members to apply for a CAREER grant. Across the top six agencies for science and engineering, there was a range of reasons for providing these types of grants from the agencies. Still, at the core, there were several discernable notions that resonated among them all.

In the module, I identified commonalities among the requirements for early-

career grants, and at a higher level, I provided insights into why these unique programs exist, such as (a) offering prestigious awards of which few are given (b) investing in innovative or outstanding new investigators early in their tenure-track career, and (c) encouraging the formation of teaching and research integration. Importantly, in the module, I included data from the last five years, 2016-2020, about the number of awards given by each agency. In doing so, this communicated the competitive landscape among the agencies for which data were provided, including the NSF, DOE, NASA, AFOSR, DARPA, and ONR. I provided six steps for starting their writing on an early-career grant and other resources in the module to enable selection and decision-making about the expected requirements and processes. In the module, I defined an early-career grant compared to a regular grant to help faculty member learners discern those distinctions.

Module 3—Data Sharing Plan and Data Management. The third module was called "What are the differences between a data sharing plan and a data management plan?" The module was created to answer many questions that arise out of the day-to-day work in grant development. Many early-career engineering faculty members did not realize that data sharing and/or the data management document arose out of an Executive Order that was later passed into law by the U.S. Congress to enable and support data transparency for federally supported grant projects. This module articulated five key elements about data sharing plans and six critical elements for data management plans. Importantly, I provided examples of how this might differ across agencies. In this module, I provided links to examples and/or guidance to four federal agencies with highly detailed requirements. These agencies included NIH, NSF, DOE, and IES.

Module 4—Drafting an ONR White Paper. The fourth module was entitled "How do I draft an Office of Naval Research (ONR)White Paper?" The ONR and its labs annually have received and funded over 2,000 grants in multiple topic areas (ONR Other Information, 2020). In the latest Broad Agency Announcement (e.g., BAA), over 20 topic areas were identified as potential areas of interest. At the ONR, the one unifying factor these grants had in common was they required a "White Paper" to be submitted to the agency prior to applying for a full grant proposal. However, a "White Paper" was a unique, genre-specific document with specific reader expectations usually aligned to programmatic priorities, the program officer's (P.O.'s) existing portfolio, and current gaps in knowledge. These items may have been difficult to discern without guidance.

Within the ONR module, I explained the requirements and processes for submittinga white paper as well as provided guidance for as kind questions of the P.O. This module was structured using the segmentation common in Microlearning Theory for the online platform. The content and vertical alignment, e.g., coherent curriculum, of the ONR white paper module supported the learning and instruction for early-career engineering faculty members by defining ideas that built upon one another to communicate a series of processes that must occur to complete the process of submitting a successful White Paper (Shin et al., 2017). The approach was helpful when communicating systematic requirements and processes to support deeper knowledge acquisition (NRC, 2012).

Module 5—Special Statuses. The fifth module was entitled "Do you leverage special organizational statuses in your grants?" Many funding opportunities sought to engage underrepresented faculty members or increase funding awarded in a geographical

area. To do this, agencies recognized special organizational statuses and/or competitions. Often, many early-career engineering faculty members were unaware of these statuses at our institution or others until they encountered special terminology employed by an agency in a specified solicitation for those holding the designations. Within the module, I provided a general overview of knowing how these statuses and that status may change depending on the agency. For example, the Established Program to Stimulate Competitive Research (EPSCoR), has provided funds to enhance the competitive research capabilities in certain states. I also described the type of documentation required to demonstrate the status. I provided an interactive spreadsheet in the resources section to identify the statuses and links to websites that extensively described opportunities related to the statuses.

Summary. As described above, the intervention modules for early-career engineering faculty members' grant development were specific to federal agencies' requirements and processes. The content was based on agency, agency-funded, and professional organizations' developed data and resources, which have then been parceled into microlearning segments to facilitate the delivery of a coherent curriculum. Each module was a stand-alone piece and could have been taken in any order. Importantly, the modules were available, on-demand and online, to accommodate faculty members' varying schedules and needs with respect to engaging in the learning process. The microlearning segmentation (e.g., 2-7 minutes) allowed the faculty member to (a) identify critical areas of interest, (b) review components when interrupted and when trying to recall a specific recommendation, and (c) download relevant resources quickly. The segmentation also me to update the information in a more precise and targeted way.

For example, if ONR changed the coversheet form, the whole module did not have to be revised; only the segment containing the information about how to access and complete the coversheet would be revised. These micro-efficiencies in design would likely reduce cost in the long term.

Instruments

I developed the MMAR instruments for this study, comprised pre- and post-intervention surveys for the modules and a semi-structured interview protocol. Each of the five modules had a custom pre- and post-intervention survey developed in Qualtrics with 42-55 questions in all. Of this total, 29-42 questions were directed at the five constructs—requirements, processes, skills, attitudes, and self-efficacy—being assessed in the two research questions. A minimum of four questions per construct was used, and items were specific to each module's content. A semi-structured interview protocol was developed in a parallel manner, comprised of 18 questions, and administered using audio-only via Zoom after the modules for selected participants. The interview questions also addressed elements of the five constructs and included questions that may enhance the study's credibility.

Participants' engagement with the instruments was not uniform because they were allowed to select the modules they wanted to use as described in the Letter of Consent (See Appendix B). Thus, an individually customized bundle of modules (See Appendix I) was provided to the participants based on their selections. Before accessing each module,participants completed the pre-intervention assessment surveys (See Appendices C-G). Upon completion of the module, they completed the post-intervention assessment survey.After all the modules selected in their bundle were completed, the

interviewer scheduled and conducted a semi-structured interview (See Appendix H) if they chose to participate in that part of the study.

In the instruments, the five constructs were defined for the instruments as follows:

1. Requirements were defined as explicit items articulated via solicitation/RFP which the applicant's documents and request must conform such as font size, margins, heading, budget size, period of performance, scope of work, topic, etc.
2. Processes are defined as items internal or external which required more than one level of input and iteration to accomplish the task.
3. Skills are defined as the learnable abilities in a particular area to improve competitiveness.
4. Attitudes were a conceptual evaluation of a situation or process which could beeither positive or negative.
5. Self-efficacy was the belief that one had the ability to accomplish a grant writing research goal in context.

Procedure

Research Questions 1 and 2

For Research Question 1, pre- and post-intervention surveys (quantitative) were utilized to assess how the on-demand, online modules affected early-career faculty members' awareness of the (a) requirements, (b) processes, and (c) skills for grant development. The data were triangulated by using a semi-structured interview protocol as well as secondary data analysis.

For Research Question 2, pre- and post-intervention surveys (quantitative) were

utilized to assess how the on-demand, online modules influenced the (a) attitudes and (b) self- efficacy of early-career engineering faculty toward grant writing. The data were triangulated using a semi-structured interview, LMS analytics, and secondary data analysis.

Data Collection. Table 4, I have described the data collection strategy for the overall study. For Research Question 1, the procedures included communicating with the purposively sampled participants using exempted and approved marketing materials, providing a letter of consent (LOC), and a copy of the ASU IRB Exemption (See Appendix A). The returned and signed LOCs were collected and securely stored from eachparticipant. A list of the five modules was provided in the LOC. After each participant completed the LOC, a survey link was generated for the pre-intervention survey for each module they wanted to take (See Appendices C-G). A link to each module participants wanted to take was sent to the participants. An example of a typical question for the modules was “do you have the appropriate registrations and agency IDs to apply for the National Science Foundation (NSF) grant Resubmission, etc.” A seven-point Likert scale then followed the question. After completing the module, the participant received a post- intervention survey. I scheduled a semi-structured interview (See Appendix G) via Zoom (audio only) with the participant and interviewed them. A typical question during the interview was, “How would you describe your grant writing process?” The responses were coded and analyzed for themes as described in Chapter 4.

Data Analysis. I transferred the quantitative data collected in the pre- and post-intervention surveys to SPSS. I analyzed the data using descriptive statistics. Descriptive Statistics were used because my surveys came from a small sample. I analyzed the pre-

and post-intervention survey data for evidence of growth in awareness of federal grant writing (a) requirements, (b) processes, (c) skills, (d) attitudes, and (e) self-efficacy following the modules.

For the qualitative data, I utilized an AI-transcription software to do the initial transcription. Then, I manually verified the accuracy and corrected them. Subsequently, I conducted and initial coding of the transcripts using the same process described in Cycle 0 and Cycle 1. Specifically, I developed process and initial codes for the concepts from theinterviews using Strauss and Corbin's (1998) constant comparative method. Subsequently, I gathered the codes into categories, then theme-related components and then aggregated these theme-related components into themes. I carefully reflected on the data at each step to ensure the data supported my interpretations. I used analytic memo procedures to monitor and guide the interpretive efforts.

Timeline for the Study

In Table 4, I provided a timeline conduct the study. It provided information regarding the timing of various study efforts, the actions taken, and the procedures that were followed. Initial work included securing IRB approval, identifying participants, gathering LOCs, and so on. Subsequently, participants engaged with the modules at their own pace and completed the post-intervention survey. They repeated thisprocess for each module they wished to complete. I interviewed a selected group of participants. Details about these processes have been provided in Table 4.

Timeline

Table 4

Timeline for the Study

Sequence	Actions	Procedures
May 19-August 12	Recruitment communication email prepared and sent to potential participants	• Email sent to potential participants with LOC and IRB Exemption copy
May 24—August 12	Collection of Individual LOCs	• Collect and securely store LOCs from each participant
July 12	Generation of survey links and bundles for the pre- and post-intervention surveys	• Send survey links to the participants
On-going as needed July 01-August 12	Prior to each module, provide the pre-intervention survey	• Send pre-intervention survey prior to initiation of each module
May 19	Generation a master list of participants and their unique identifiers	• Secure and store the master list of participants and their unique identifiers
July 12—August 12	Enrollment of participants in five modules	• Provide a link to participants with all five modules
On-going as needed July 12—August 22	Following the completion of each module issue post-intervention survey	• Send post-intervention survey following completion of each module
July 20	Randomly select from the participants who complete the pre-/post-intervention survey participants who will participate in the semi-structured interview	• Schedule Zoom audio interview with participants
August 22—September 01	Transcribe and Code Interviews	• Transcribe Interviews using AI-Transcription • Manually verify and correct transcription • Code transcripts
September 01—October 10	Identify Categories and Themes in Interviews	• Utilize Categories to identify themes in interviews • Qualitative Analysis
September 01—September 30	Analyze data from pre- and post-intervention surveys	• Conduct pre- and post-intervention surveys analysis in SPSS • Quantitative Analysis

September 15—October 15	Review Themes in Interviews	• Identify points of triangulation with primary and secondary data • Qualitative Analysis
September 15—October 15	Write results and discussion	• Prepare results and discussion

CHAPTER 4

DATA ANALYSIS AND RESULTS

Research is formalized curiosity. It is poking and prying with a purpose.

—Zora Neale Hurston, 1942

In the previous three chapters, I described the problem of practice in its context, provided the problem statement, and articulated the theoretical frameworks and methodologies that informed this mixed methods action research (MMAR) study. The ARDES and Academic EPMSC framework with the Engineering Community of Practice (ECoP) were described in Chapter 2, whereas the setting, participants, methodology, and procedures were explained in Chapter 3. Data analyses and results from the implementation of the methodologies and procedures have been articulated in this chapter. The data were reflective of the MMAR approach in which I gathered quantitative and qualitative data from original primary and secondary data sources to answer the two research questions, including:

> **Research Question 1**—How and to what extent did the implementation of five on-demand, online modules affect early-career engineering faculty members' understanding of grant writing (a) requirements, (b) processes, and (c) skills?
>
> **Research Question 2**—How and to what extent did the implementation of five on-demand, online modules affect early-career engineering faculty members' (a) attitudes toward and (b) self-efficacy toward writing grant proposals?

The chapter consisted of three sections in which I reported data analysis procedures and the results of the MMAR study. Within the first section, data analysis procedures have been reported. Next, the quantitative data and results were presented from the survey

questionnaires, one for each module, along with analytics from the learning management system (LMS). Triangulation from these items and secondary data sources from the organization and national reporting were used. Finally, I have presented the qualitative data in the third section of the chapter.

Quantitative and Qualitative Data Sources

The mixed-methods data sources were derived from quantitative and qualitative sources. Data were obtained from five paired, pre-, and post-intervention surveys for the quantitative scores, one for each module. I developed the survey instruments. These instruments assessed five constructs, including requirements, processes, skills, attitudes, and self-efficacy for grant writing. Descriptive statistics have been reported for these constructs by module. The next quantitative source of data was analytics information from the learning management system (LMS). For these data, I have reported data derived from participants' engagement in their modules, including, for example, modules viewed, videos completed, beginning and completion times, and so on as well as participants' comments. Quantitative data for the study were acquired during July 2021. Five early-career engineering faculty members and one faculty administrator completed two or more modules and the modules' surveys. Incomplete modules were not used in reporting the results. The response rate for early-career engineering faculty was 5 of 30, 16.67%, and for faculty administrators was 1 of 8, 12.5%. I have provided descriptive statistics for these data. Qualitative data were obtained from interviews, which were audio-recorded,transcribed, and then coded. Additionally, qualitative data included user feedback provided in the LMS. In all, five participants were interviewed.

Data Analysis Procedures

I analyzed the quantitative and qualitative data using SPSS 25.0, Dedoose 9.0.17, and Excel. I analyzed the survey data using descriptive statistics for each module. In addition, I presented descriptive statistics for the LMS analytics data. The quantitative data sets were small; therefore, caution should be exercised when reviewing the modules' reliabilities, means, and SDs.

To conduct the qualitative analysis, I drew upon transcripts developed using an AI-transcription tool and manually corrected codes and related memos, which were analyzed using Dedoose software 9.0.17, designed for mixed methods, and Excel. This software was chosen because it facilitated the use of the constant comparative method across (Strauss & Corbin, 1998) codes, categories, theme-related concepts, and themes. In the first coding process, I coded transcripts using process and concept codes. Then,I identified categories, devised theme-related components, and arrived at themes using Dedoose and manually in Excel. Finally, I utilized these to identify four themes that emerged for Cycle 3. The four themes included *Knowledge*, *Online Learning*, *Grant Writing Process*, and *Winning the Next Grant*. Each theme was visualized in a thematic network that included the categories, theme-related components, and the theme.

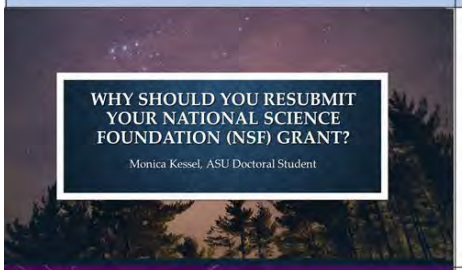
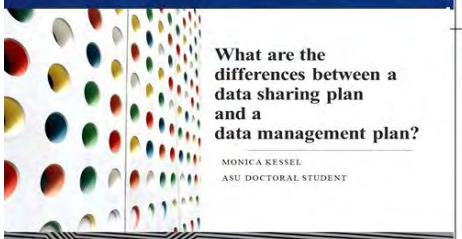
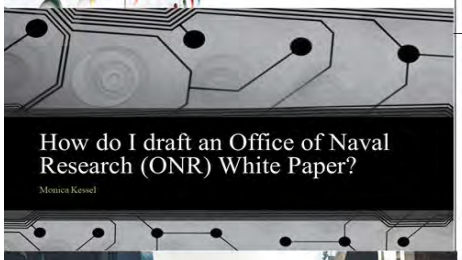
Quantitative Data Results

Participants were asked to complete a minimum of two or more modules, and five participants were invited to participate in a semi-structured interview. The mean time

participants took to complete the modules has been presented in Table 5 as compared to the modules' duration. For Table 5, no means, were presented for Modules 3 or 5 since there was only one participant for each.

Table 5

Comparison by Module Between Duration and Participant Engagement Means

Modules	Duration of Modules	Participant Means
	23.32 minutes	43.34 minutes
	37.14 minutes	94.64 minutes
	40.47 minutes	n/a
	14.43 minutes	23.08 minutes
	15.40 minutes	n/a

Quantitative Results from the Pre- and Post-Intervention Survey Instruments

In the following section, I have provided results from the survey data.

Reliabilities of Survey Scales Across the Modules

I have presented Cronbach alpha reliabilities for pre-intervention assessments for the five constructs/variables from the surveys for Module 1—NSF Resubmissions, Module 2—Early-career Awards, and Module 4—ONR White Paper in Table 6. The other two modules only had one participant each, and therefore reliability could not be calculated. In some instances, items were deleted to increase the reliabilities of the scales. Again, it was important to note that the same sizes were small with n = 4, 3, and 5, respectively. Items were deleted because they did not perform as intended due to the small sample size. Thus, caution should be taken when interpreting these metrics. Reliabilities for the pre-intervention assessments ranged from .67 to 1.00, with a median of .88. All but one of these reliabilities exceeded .70, the usual level for acceptable reliability (Nunnally, 1978; Nunnally & Bernstein, 1994).

Table 6

Cronbach Alpha Reliabilities for Pre-Intervention Assessments for Five Constructs from the Surveys for Modules 1, 2, and 4

Variable	Module 1		Module 2		Module 4	
	α	# Items	α	# Items	α	# Items
Requirements	.67	2	.91	4**	1.00	2
Skills	.90	6	.76	10	.92	5
Processes	.86	7	.81	7**	.92	5
Attitudes	.85	6	.92	7	.77	5*
Self-Efficacy	.97	6	.80	5**	.88	4**

*— Note: 1 item was deleted from this scale.
**— Note: 2 items were deleted from each of these scales.

Results of the Survey Data for the Five Modules

For each of the Modules, I have presented pre- and post-intervention data for all five constructs. Means and standard deviations have been presented if there were more than one participant in the module. Generally, the increases in scores were quite modest, but they varied by the module as would be expected. For Module 1— Resubmitting a National Science Foundation (NSF), these were based on a reduced number of items. Grant, pre- intervention scores were in the slightly agree range, 5, to agree range, 6. Increases ranged from 0.37 for attitudes to 0.89 of a point for processes, and post-intervention scores were in the agree range, 6. See Table 7 for the means and SDs for the five constructs for Module 1.

Table 7

Pre- and Post-Intervention Means and Standard Deviations for Five Constructs from Module 1—Resubmitting a National Science Foundation (NSF.) Grant for n = 4

Variable	Pre-Intervention		Post-Intervention	
	M	SD	M	SD
Requirements	6.00	0.71	6.38	0.48
Skills	5.33	1.05	6.13	1.03
Processes	5.18	1.06	6.07	1.07
Attitudes	5.67	0.89	6.04	1.04
Self-Efficacy	5.04	1.44	5.92	1.14

Note. Care must be taken in interpreting these means because of the small sample size. Means and SDs were computed based on a reduced number of items as noted in Table 6.

In Module 2—Submitting an Early-career Awards Grant, pre-intervention scores were generally in the slightly agree range, 5, although meeting requirements was much lower. Increases ranged from 0.19 for attitudes to 2.25 points for requirements, and post-intervention scores were in the slightly agree range, 5 to the agree range, 6. See Table 8 for the means and SDs for the five constructs for Module 2; these were based on a reduced number of items.

Table 8

Pre- and Post-Intervention Means and Standard Deviations for Five Constructs from Module 2—Submitting an Early-career Award Grant for n = 4

Variable	Pre-Intervention		Post-Intervention	
	M	SD	M	SD
Requirements	2.33	1.53	4.58	2.24
Skills	4.77	1.07	5.67	0.81
Processes	5.14	0.86	6.00	0.86
Attitudes	5.24	0.97	5.43	1.08
Self-Efficacy	5.13	0.90	6.00	0.60

Note. Care must be taken in interpreting these means because of the small sample size. Means and SDs were computed based on a reduced number of items as noted in Table 6.

For Module 3—Differences in Data Sharing and Data Management Plans, there was only one participant. I have reported the scores for that participant in Table 9.

Table 9

Pre- and Post-Intervention Means for Five Constructs from Module 3—Differences in Data Sharing and Data Management Plans for n = 1

Variable	Pre-Intervention	Post-Intervention
	M	M
Requirements	5.80	6.80
Skills	5.29	6.73
Processes	5.45	6.67
Attitudes	6.00	6.83
Self-Efficacy	5.56	6.56

Note. Care must be taken in interpreting these means because there was only one participant.

In Module 4—Drafting an Office of Naval Research White Paper, pre-intervention scores were generally between the slightly agree range, 5, the agree range, 6. Increases ranged from 0.10 for self-efficacy to 1.20 points for requirements, and post-intervention scores generally fell in the agree range, 6. See Table 10 for the means and SDs for the five constructs for Module 4; these were based on a reduced number of items.

Table 10

Pre- and Post-Intervention Means and Standard Deviations for Five Constructs from Module 4—Drafting an Office of Naval Research (ONR) White Paper for n = 5

Variable	Pre-Intervention		Post-Intervention	
	M	SD	M	SD
Requirements	5.20	2.39	6.40	0.65
Skills	5.77	0.58	6.17	0.58
Processes	5.87	0.72	6.07	0.65
Attitudes	5.44	0.78	5.84	1.19
Self-Efficacy	6.00	0.31	6.10	0.52

Note. Care must be taken in interpreting these means because of the small sample size. Means and SDs were computed based on a reduced number of items as noted in Table 6.

For Module 5— *Leveraging Special Organizational Statuses in Your Grant*, there was only one participant. I have reported the scores for that participant in Table 11.

Table 11

Pre- and Post-Intervention Means for Five Constructs from Module 5—Leveraging Special Organizational Statuses in Your Grant for n = 1

Variable	Pre-Intervention	Post-Intervention
	M	M
Requirements	5.50	6.00
Skills	6.00	6.00
Processes	5.60	6.00
Attitudes	5.50	5.83
Self-Efficacy	6.00	6.00

Note. Care must be taken in interpreting these means because there was only one participant.

Quantitative Results from the LMS Analytics Data

The participants accessed the modules using their Unique IDs, which they self-generated during their pre-intervention assessments and received a password generated from the LMS. The LMS did not track IP addresses, which was consistent with IRB requirements. Still, it did track beginning and ending times since one of the premises of the intervention was that on-demand, online grant writing modules would be supportive of early-career engineering faculty members. The LMS captured the beginning and

completion times using Coordinated Universal Time (UTC). Then, I converted the time to Mountain Standard Time to determine whether the Engagement Duration occurred during regular hours of operation at the university or at another time that was convenient to the participant. For Modules 1, 2, and 4, participants' beginning, and completion times were recorded and examined.

The LMS analytics for Module 1 indicated participants accessed the modules at all hours of the day. Two of the four participants accessed the modules outside of regular business hours for offices during the summer. Participants 2 and 6 engaged with Module 1 for the most extended times. See Table 12.

Table 12

LMS Beginning and Completion Times and Engagement Duration for Module 1— NSF Resubmissions n = 4

Participant	Beginning Time	Completion Time	Engagement Duration	Occurred after 4:30PM
Participant 2	2021-07-27 14:56:59 UTC	2021-07-27 16:12:17 UTC	1:15:18 hr.	
Participant 3	2021-07-19 17:01:45 UTC	2021-07-19 17:26:19 UTC	0:24:34 min.	
Participant 5	2021-07-29 22:34:57 UTC	2021-07-29 22:54:32 UTC	0:19:35 min.	
Participant 6	2021-08-22 02:25:34 UTC	2021-08-22 03:20:26 UTC	0:54:52 min.	

The LMS analytics indicated participants accessed Module 2 at various times throughout the day, primarily in the late afternoon and evening. Two of the four participants accessed Module 2 outside of the regular business hours, and both of these participants completed the module in substantially less time. In the semi-structured interview, Participant 3 indicated that he sped up the speech indicating, "And the nice thing about the videos is that we can watch them on hyperspeed." This may be true of Participant 5, as well. Participants 1 and 2 were on the opposite ends of the spectrum, taking considerably more time than the Module 2 was designed to take. Nevertheless, both indicated in their semi-structured interviews that they intended to apply for NSF CAREER grants, and one had been exploring other options until they found out through Module 2 that they were not qualified.

Table 13

LMS Beginning and Completion Times and Duration of Interaction for Module 2—Early-career Awards n = 4

Participant	Beginning Time	Completion Time	Engagement Duration	Occurred after 4:30 PM
Participant 1	2021-07-12 19:16:43 UTC	2021-07-12 21:31:00 UTC	02:14:17 hrs.	
Participant 2	2021-07-27 16:12:32 UTC	2021-07-27 19:34:28 UTC	03:21:56 hrs.	
Participant 3	2021-07-16 23:24:16 UTC	2021-07-16 22:55:32 UTC	00:28:44 min.	
Participant 5	2021-07-29 22:55:19 UTC	2021-07-29 23:09:58 UTC	00:14:39 min.	

For Module 4, LMS analytics data indicated participants accessed it at all times of the day. Three of five participants completed the brief module after 4:30 PM. Engagement duration ranged from a minimum of near 12 minutes to just over 44 minutes. The data from the LMS analytics indicated participants accessed the modules in the on-demand, online format.

Table 14

LMS Beginning and Completion Times and Duration of Interaction for Module 4—ONR White Paper n = 5

Participant	Beginning Time	Completion Time	Duration	Occurred after 4:30 PM
Participant 1	2021-07-12 18:48:29 UTC	2021-07-12 19:16:35 UTC	00:28:06 min.	
Participant 3	2021-07-16 22:34:10 UTC	2021-07-16 22:51:44 UTC	00:17:34 min.	
Participant 5	2021-07-29 22:55:19 UTC	2021-07-29 23:09:58 UTC	0:14:39 min.	
Participant 6	2021-08-22 03:21:04 UTC	2021-08-22 04:05:11 UTC	00:44:07 min.	
Faculty Administrator	2021-07-28 20:49:07 UTC	2021-07-28 21:01:01 UTC	00:11:54 min.	

Results for the Qualitative Data

During the first coding round, the semi-structured interviews were coded using the constant comparative method using process and concept coding (Glaser, 1965; Saldaña, 2016). Some of the questions and the responses were not process-oriented, and that was when concept coding was used. Two examples of questions illustrating when concept coding was prioritized for use from the protocol have been provided below.

"From your perspective, describe three skills of a successful researcher who wins

grants."

"Describe three tools that you use to support your grant writing."

Following the first coding round, all the codes were systematically reviewed to identify any commonalities, and I began to identify categories. These categories resulted in the secondary codes in Dedoose in which process and concept codes from the first coding round were combined; these were refined several times, and new patterns began to emerge. Next, the theme-related components were constructed by arranging the categories into a more extensive network. Finally, theme-related concepts were gathered into themes.

The credibility of interpretation of qualitative data has been imperative in mixed-methods action research to ensure interpretations made about the data were warranted. To ensure the credibility of the qualitative findings, I sought to develop consistency and eliminate bias in the interpretations. I did this by employing the constant comparative method throughout the various steps in the qualitative analysis. Moreover, I reflected carefully on each step of the analysis process to confirm that the data supported my interpretations. Finally, I used analytic memos to conduct and direct the data analysis and interpretation processes.

In all, there were four themes. I created a figure in PowerPoint for each theme that included the categories, theme-related components, and themes, which I converted to JPEG. At this point, I let it sit for a few days, and then revisited the images and compared them against the original codes and transcripts. I wanted to verify that the thematic network was reflective of responses to the semi-structured interviews. I found that the images were consistent with the data, and below I have presented my detailed exploration

and analysis of each of the themes. I have provided a way to systematically conceptualize and analyze the linkages among the qualitative data in the visual representations.

The four themes that emerged from the semi-structured interviews included *Knowledge*, *Online Learning*, *Grant Writing Process*, and *Winning the Next Grant*.

Figure 10

Themes from the Qualitative Data

Each of the themes was aligned with Research Questions 1 and 2. In the remainder of this chapter, I have described each of the themes and provided excerpts from the semi-structured interviews to support the themes.

Theme 1—Knowledge

The *Knowledge* theme was derived from the semi-structured interviews, and it was related to answering Research Questions 1 and 2. Responses to five of the eighteen questions in the protocol were related to the theme. In each of these questions overlapping codes arose in the categories resulting in five theme-related components including: a) Explicit Knowledge, b) Cognitive Dissonance, c) Implicit Knowledge, d) Domain Knowledge, and e) Tacit Knowledge.

Table 15

Knowledge Theme Categories, Theme-Related Components, and Theme

Categories	Theme-Related Components	Theme
Providing more information	Explicit Knowledge	Knowledge
Personal Status as an Agency Requirement		
Avoiding Reading the Solicitation		
Detailed instructions/headings		
Learning through the solicitation		
Checking the Deadline		
Believing I am prepared then looking at the solicitation	Cognitive Dissonance	
Change in how I thought it would be		
Non-technical Support	Implicit Knowledge	
Understanding the Proposal Writing Process		
Learning is a process		
Recent proposal funded at X agency		
Feeling guidelines are strict		
Understanding coming from experience with X agency		
Feeling information is insufficient		
Knowing I can ask someone or figure it out		
Revising for the X agency	Domain Knowledge	
Same process for everyone at the same time of year		
Developing a pre-proposal		
Waiting for pre-reviews for a specific period		
Preparing contents of a letter of intent		
Knowing how to communicate with X agency		
Knowing through Grant Writer		
Writing the Proposal for X agency		
Domain-Specific Research Support		

Domain-Specific Research Support/Grant Writer		
Sharing of Domain Knowledge by Peers		
Connecting Domain Support with Ed. & Outreach		
Integrating Research Narrative		
Budget/Budget Document Support for X agency		
Biosketch/CV Document Support for X agency		
Recognizing novice faculty need help in a lot of places	Tacit Knowledge	
Recognizing Faculty Diverse Needs		
Recognizing the larger context		

Explicit Knowledge

Explicit knowledge arose as an initial theme-related component because it was directly connected with the construct of *Requirements* in Research Question 1. To provide context, explicit knowledge was communicated primarily in academic writing, but this may also have included videos, podcasts, social media, and other technology platforms. Collins (2010) defined explicit knowledge as that which can be "explicable" by elaboration, transformation, mechanization, and/or explanation (p. 81). For most of the participants, the explicit knowledge was oriented around the Solicitation/RFP. For example, the faculty administrator indicated, "not just providing information" was enough to support early-career engineering faculty members. Participant 1 expanded on this notion further by indicating,

> So, one way that I think is helpful is colleagues who are open to sharing information about their previous applications, be it successful or not successful. And that gives a lot of information about how to tackle the writing process, the

> expectations, the sections, the type of information that's in there. Now, besides that, it would also be a nice addition to have writing groups. And that also depends on each person's type of like work, because some are better in working alone, but then others like to be in a group and chat about like ideas or to talk through their thoughts.

Participant 3 described the importance of the explicit knowledge in the solicitation but indicated that it was a complex matter when they commented,

> I guess the way that they want you to come to know is through their… solicitation. Right. So, they've tried to explain all of that and their solicitation, and that's important to go through. It's also a lot to swim through….

The notion that the explicit knowledge expressed in the solicitation/RFP can be avoided was also expressed by Participant 2, who said, "I don't think I actually looked at the…solicitation for that one." However, Participant 1, like Participant 3, also expressed a tactic in which a production schedule based upon the deadline was developed from the explicit knowledge expressed as a deadline, "I usually look for the solicitation that's in my area. I then look at the deadline, and I work my time back for a few days before the deadline." Reverse engineering a production schedule based on a deadline and requirements was not uncommon.

Explicit knowledge was valuable because that was how funding agencies made grant requirements known to potential applicants. These solicitation/RFP requests require close attention to detail and vary from agency to agency from everything to margin size, font, required headers, no headers, required attachments, and special formatting of supplementary documents.

Cognitive Dissonance

Cognitive dissonance emerged as a theme-related component because it was directly related to the constructs of *Attitudes & Self-Efficacy* in Research Question 2. Cognitive dissonance has been defined as "holding two conflicting beliefs, attitudes, behaviors which cause mental discomfort and leads to an attempt to restore balance" (McLeod, 2018, February 5; Festinger, 1957). I identified two exemplar instances of cognitive dissonance that were not related to the promotion and tenure process. Participant 1 claimed, "I would say, in general, we think that we're very … prepared, but then looking through the solicitation, it takes a lot of digging to find that information." In another instance, Participant 3 expressed cognitive dissonance about the alignment of their work with a funding agency when they said,

> So, in my opinion, …it should be the Air Force, but AFOSR, I would say, should be the agency that aligns with my research. But what I've found is that that's not the case, that ONR I've had an easier time aligning with them, and I'm still trying to figure out why that is.

It was essential to acknowledge that in "meaning-making" for the *Grant Writing Process* and acquiring *Knowledge* that it was normal to experience cognitive dissonance (Ignelzi, 2000, p. 5). Participant 1 and Participant 3 were at different points in their early-career cycles, yet the experiences of cognitive dissonance remained a normal part of the process of seeking research funding.

Implicit Knowledge

Implicit knowledge has been difficult to define but is recognized as "that which can be demonstrated, not necessarily callable on command, but related to task

performance" (Berry, 1987, p. 147). It arose as a theme-related component because it wasdirectly connected with Skills, Processes, Attitudes, and Self-Efficacy constructs in Research Questions 1 and 2. Frappaolo (2008) indicated that for organization's "value and leveragability of implicit knowledge was vast and represented a new frontier in knowledge management" (p. 23). The categories of implicit knowledge expressed by the early-career faculty members were diverse and rich with the expression of their personal experiences in context.

Grant writing was not an armchair sport. It required learning by doing at some point. The following examples illustrated two ways the *Grant Writing Process* as curricula could be acquired as knowledge. Participant 1 described this when they said, "I think…I understand…now, so every time I work on a proposal in the area or for a specific agency, I tend to learn more and understand more." This knowledge of the process of being in the "hunt" is then "valued" by their peers in their micro-system and sometimes beyond. The interviewer and Participant 2 discussed how this knowledge was communicated as demonstrated in this interview dialogue.

> Participant 2: I think one of the …biggest things … that's resonated with me in this whole process is really spending the time to write up a high-quality proposal. And I mean, you can't take forever on them, obviously, but in that first meeting that we had last August, you had mentioned, Monica, that, you know, we'd rather have you submit less proposals that are of higher quality and have a higher chance of being funded than just sending in a bunch of crap to say you're submitting and that's probably not going to get funded. And …until the last institution I was at, they really pressed you to constantly be submitting. So, I was in that mindset.

Interviewer: Did I use the technical word crap?

Participant 2: No, you did not use the word "crap." I used crap.

Interviewer: So many institutions have that strategy, but it is not wise.

Participant 2: No, it's…like a lot of my other colleagues…that are assistant professors… it's… it's just it's messing with their mental health because they feel like they need to be writing all the time, too, whereas I feel like I can take a proposal and really hone an idea and really make it something that I'm proud of.

The process of taking one's time and energy to develop a high-quality proposal was apparent in two ways. First, the presentation by the grant development manager about the statistical performance of those using a "shotgun" approach during the annual early-career meeting with faculty members was one-way ideas are shared. Second, via the use of colleague networks. This is implicit knowledge being leveraged to support early-career faculty members' successes.

Participant 3, who felt that initially there was a misalignment between the training USU provided to early-career faculty members and their research grant writing needs when they asserted,

> I haven't seen formal training for grant writing. That's not true, because they do send you in the first year. They send you to a three-day workshop. And I went to that three-day workshop, but in three days … you get a bucket load of information, and a lot of it is not directed at you because, for example, I think NIH was the … agency that they hounded on to really know, which is a very large agency that a lot of people get funding through. So, it makes sense that they would choose NIH, but I don't. I've never, and probably [will] never apply to

> NIH. And so, although they were teaching me things that you can apply to other agencies, they were a little bit specific to NIH. And so, … it's also just a lot you have a new job, you're teaching new classes, you're trying to start a lab, and now you have this grant writing workshop, and it's just a lot to take in. And so, I didn't digest as much. It was kind of in one ear and out the other.

Sometimes there is a misalignment between what/who the university aspires to be and what will be helpful to early-career faculty members. It is not to say that the trainer may not be excellent, but it may be a case of poor fit in terms of agency choice. During the last five years, USU has received less than $5 million per year from NIH (NSF NCSES, 2021). This is an example of implicit knowledge misalignment in the grant writing process for early-career engineering faculty members. The trainer had deep domain knowledge, but the early-career faculty member could not "suspend their beliefs" long enough to apply it to their research funding context.

Domain Knowledge

Domain knowledge has many emerging definitions, but for this study, the following elements are acknowledged "domains are not all alike" (Glaser et al., 1987), typically have been more "structured and procedurally rich" (Phillips, 1987), and many contained problems, objectives, or tasks (i.e., requirements) with agreed-upon processes communicated via a solicitation/RFP to achieve recognizable outcomes or outputs.

Alexander (1992) indicated that domain knowledge varied between novices and experts. More than one participant discussed the development of budgets and budget justifications. Participant 1 indicated "budgeting" could be added as a budget module, and Participant 5 indicated they began with their budget justification as a starting point

for their grants. Nevertheless, domain knowledge experts such as experienced faculty member grant writers and grant writers would ask for which agency? The reason for this question was that budget and budget justifications for the NSF do not look like one for NASA or the Office of Naval Research. They used the same required Office of Management and Budget categories, but their formatting, requirements, and layouts have been different. Like budgets, the scenario for pre-proposals, white papers, letters of intent, biosketches/CVs were parallel. Nevertheless, every agency had its unique fingerprint; domain experts knew this and possessed specialized domain-specific knowledge. Research development professionals have often been the personnel who have become the agency-specific experts to complement research investigators' knowledge and thereby incorporate domain-specific knowledge, which is responsive to agency and submission requirements.

One of the critical skills of an emerging early-career engineering faculty member was to recognize that a domain expert can complement their research work,

> By working one-on-one with a professional grant writer that is like assigned to us, basically, and can fill out all of this stuff and get to know us well enough and get a working relationship so that … so that writing grants are more efficient. (Participant 3)

Thus, domain knowledge experts reduce cognitive load and the associated stress connected with overall document production.

Tacit Knowledge

Collins (2010) defined tacit knowledge as that which "has not or cannot be made explicit" and can be intuitive, insight, or wisdom (p. 85). The faculty administrator made

two observations that indicated insight or wisdom, which were not readily measurable, nor were they explicit knowledge: “faculty are diverse” and “novice faculty need help in many places.” The faculty administrator observed that the type of information provided for more senior faculty members as compared to novice faculty members was not likely going to be the same when they stated,

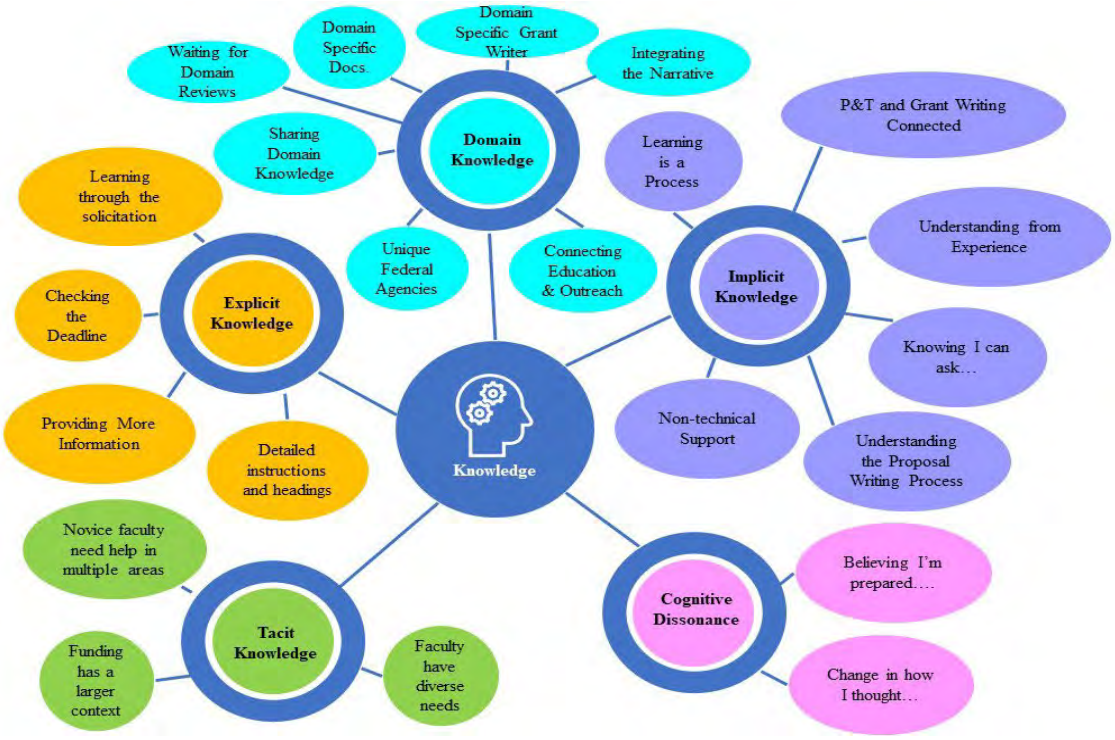
> Our faculty are … diverse [and for more experienced faculty] just keeping them informed [works]…. on the other hand, for the novice faculty member who has not written many proposals before, they probably need help in a lot of places, not just to give them information in this proposal, but also have them … understand the proposal writing process and how to improve their writing skills.

In other words, the grant writer cannot take a one-size-fits-all approach. Early-career faculty members had unique needs related to their understanding of the proposal development process, which required a different level of professional development.

On the other hand, Participant 5 described their insight at discovering the “big-picture” related to agency funding. Engineering faculty members of varied rank and maturation accessed different tacit knowledge as they worked during the *Grant Writing Process*.

Figure 11

Knowledge Theme Network



Theme 2—Online Learning

The *Online Learning* Theme was represented across four of the eighteen questions of theprotocol. These questions were designed to address aspects of Research Question 2. Responses to these questions resulted in theme-related components that included (a) microlearning from the modules, (b) attitudes about research and grants, (c) other users ofthe modules, and (d) ideas for future curricula.

Table 16

Online Learning Theme Categories, Theme-Related Components, and Theme

Categories	Theme-related Components	Theme
Learn About a New Agency	Microlearning	Online Learning
Collaboration		
Flexible (Time)		
Accessible		
Infographic		
Module Organization		
Having Guidance	Attitudes	
More Confident		
Negative First Year Stressors		
Worth Doing		
More Excited		
Willing to Try Something New		
Other Academic Faculty	Other Users	
K-12 Teachers		
Anyone Seeking Funding		
Professional Organizations		
Graduates		
Post-doctoral researchers		
Organizational Processes	Future Curricula	
Budgets/Budget Justifications		
Federal Agency Overviews		
Proposal Examples		
Variety of Speakers		

Microlearning

Early-career engineering faculty members liked the microlearning format for the online implementation of the grant writing learning modules. In particular, the flexibility to access the modules at any time during their schedule was highlighted by several faculty members who were simultaneously working on grants, writing manuscripts,

working with their students in their labs, and scheduling family vacations because data collection occurred during summer. In addition, faculty members appreciated the organization and clarity of the modules' components. The deliberate segmentation of the curricula provided the ability to introduce a topic, discuss the topic, recap, and direct participants to specific resources within the modules. Generally, modules were constructed in 3- to 5-minute segments, which faculty members felt they could revisit and review selected information as needed. For example, Participant 2 remarked,

> The biggest thing that I loved about the modules is that it was a very logical progression through everything to where I could sit down and go through the module and hit all of, hit all of these different components within each topic. So, I did the resubmitting one and then the early-career opportunities, and the thing I really liked about those was the linearity of the process towards like, OK, if I wasn't, if I didn't feel as confident in one area, I can always go back to it again, and rewatch those videos.

Participant 3 echoed positive support for the flexibility and convenience of the modules, "And so now that I'm a few years into my career having this online video and I like the online video format because I could watch it at any time…" Participant 5 indicated the following about the module experience:

> I remember on the survey like going in before reading the modules. I remember like checking…I forget what the scale is, but you know…the positive and the somewhat prepared, fairly prepared. And I remember coming out of those modules, you know … being like, oh yeah. Very prepared, like across the board. And so, like definitely my scores went up, and so I think the modules… put some

> stuff in context? Thinking [of] some things that I probably take for granted now… that weren't obvious when I was new because I think you always can improve.

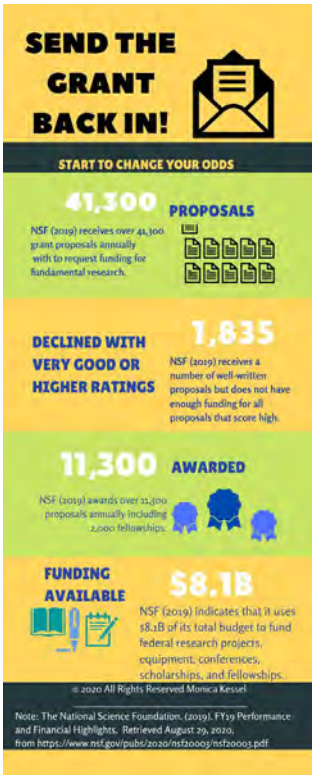
Further, several faculty members commented upon the different design approaches of the modules. One indicated a preference for interactive as compared to informative approaches within the ONR module. In the ONR module, I had experimented with "navigating" a faculty member through the initial stages of drafting a white paper. It inspired action, as Participant 1 indicated,

> I like the approach of walking through a solicitation and figuring out the topic. Then the idea of like, this module is interactive instead of it being very informative. So, obviously, the other modules are very informative, and they have a ton of information in them. But the delivery method, in my way of like learning things, works better with an interactive approach where I have to go to a link and look for something, and then, look for the area of research and then think about an idea that I want to write down. So, I personally prefer that.

Many commented they liked the statistics that were provided and the infographic. This outcome was similar to one obtained in Cycle 2.5, where participants requested more statistics or numbers. I had been concerned with flooding the modules with statistics and data, but participants commented on their helpfulness. These data may have provided a kind of user credibility to the learning modules. For example, I developed the infographic using National Science Foundation data and Canva and included it in the National Science Foundation Resubmission module.

Figure 12

Example of an Infographic Created for the National Science Foundation Resubmission Module



Other design features included the ability to access and download resources in two locations in the modules: (a) at the point of instruction in each segment and (b) under the Resources Tab at the end. Participant 1 indicated that they "noticed a few under some of those slides," and Participant 2 indicated, "Oh, I totally would use them. I already downloaded the ones that were in the modules that I did…. I already have downloaded those and already have them stashed in an easy space to access them."

A number of participants expressed the idea the modules gave them a mechanism to explore a new federal agency. By this, I understood that the modules provided explicit

and implicit agency context and content for them to analyze and synthesize when they decided the programs or agencies to which they would apply in the future. There were both positive and negative responses faculty members shared. Some were encouraged as the participant below to try new agencies or explore new concepts in those agencies. For example, Participant 1 claimed, "And I think that was a good tool to help in identifying if ONR was a good fit for me."

Similarly, the Faculty Administrator acknowledged new understandings when they said, "What is the difference between the data sharing plan and data management plan? No, I never knew the difference at the National Science Foundation." Although data sharing plans are standard at the National Institutes of Health and other DHHS agencies, many other agencies use data management plans. There was an appreciation for the efficiency with which the participants could make decisions after watching the modules. Participant 1 indicated,

> I need to identify whether I would fit in their areas of research, but then once that's done, I believe that the module's objective would have been met. And I don't expect myself going back to it multiple times, especially because of the type of information that is in it.

On the other hand, some decisions from one faculty member's perspective were disappointing because they realized the limitations of their citizenship status regarding the Department of Defense agencies disqualified them from applying for the Young Investigator Programs. One participant noted,

> Simply for the requirement of being an LPR [Legal Permanent Resident] or a citizen. And that's right, and so continuing the same point, it's for a young

> investigator. It's probably not aligned with the time that an LPR is granted, which means that by the time a young investigator is an LPR, they might disqualify for other reasons, such as the time from graduating to the time of application. And that would be another way of being disqualified.

This information was disappointing; nevertheless, providing eligibility information allowed faculty members to focus on agencies for which they were eligible. Assembling the curricular information took me several weeks, and an early-career faculty member may not have known about the variety of programs available nor systematically how to compare them. The modular synthesis of complex information for multiple agencies was helpful and afforded participants a broad range of information. Another participant indicated that they struggled with one of the topics discussed in the modules,

> …. I feel like these are always things that you can refine like I've said. I struggle with is something basic or not. And in separate conversations, I've said that the technology readiness levels, you know, I don't have a good intuition for it. And so, it's just something I need to be constantly keeping up on top of…

The modules helped identify and encouraged their reflection on potential areas of weakness that an early-career applicant might have as they compete in a particular area or agency.

Attitudes

Participants expressed a range of associated positive emotions related to the modules and negative sentiments associated with various onboarding early-career stressors. These attitudes demonstrated a shift in their feelings, emotions, orientation, or mindsets toward grant writing in some cases. In other cases, these attitudes provided hope

that in the future, the modules might be available to provide support as they sought future funding. One example of a positive attitude and orientation was expressed by Participant 2, who maintained,

> I feel like at USU, you know, we have such great resources. So, I say it's not necessarily a confidence or a certainty that I myself alone know all the ins and outs to write a successful proposal, but that I feel very supported in the resources that I have here to write a successful proposal. So, because I you know, my department head is a past program officer, and then we have you in the college and you, you know, so I don't know how you remember half of the stuff you remember about all these different grants and solicitations and things. But… I feel like that is such a huge help. Our folks in sponsored programs, they're really great. And so, I just I feel like I'm very much supported to where that if I do run into something that I can't identify on my own, I know who I can go to ask for help.

In another positive way, Participant 5 suggested, "it's too easy to fixate on the things you can do better going forward, but then to recognize the things that you're already doing better than how you were, so that improved." By accessing the ability to recognize the areas, one needs to work on without fixating, one has already moved forward. It is plausible that the online modules support the early-career faculty members in "recognizing" these areas and provide additional information about the federal agency context; the process of engagement may inherently reduce personal "fault-finding" in their grant writing process.

On the other hand, modules also triggered memories of negative prior experiences, compounded by the stress of being an early-career faculty member. One example was offered by Participant 3, who remembered their first year,

> And so, it's, and it's also just a lot you have a new job, you're teaching new classes, you're trying to start a lab, and now you have this grant writing workshop, and it's just a lot to take in.

Similarly, Participant 5 expressed another source of anxiety related to approaching a new program or agency,

> And so, and some…program officers recognize that more than others, but. I wish. I wish I was better. I don't know how to do this. I wish I was better. And when I approach a new target, being able to approach it with that more experienced mindset of, OK, well, you know, like. What? You know, how can I streamline this effort a little bit more so I can be asking questions sooner and I can be tailoring my stuff sooner?

Interviews demonstrated the modules revealed attitudes about embedded institutional support and lack of support indicated that the 'These emerged from respondents' consideration of different aspects of their experience at USU including thoughts about current situations and recall of the onboarding process where there was a lot of early stress.

Other Users

Faculty member participants were asked who, besides engineering early-career faculty might benefit from the grant writing modules. Surprisingly, participants communicated a wide range of potential end-users. These potential end-users included (a)

other academic faculty, (b) graduate students (c) post-doctoral students, (d) K-12 teachers, (e) professional organizations, and (f) anyone seeking funding. Thus, participants viewed the information as being accessible to a variety of audiences seeking federal funding. For example, Participant 3 mentioned,

> I also think that it could be…valuable for graduate students who are thinking about a career in academia. And this is a real eye-opening experience to see how the funding works, you know, so and it could help them understand if this is really something that they want to do, you know, go beg for money for the rest of their life as a career.

In addition to academic audiences, the faculty administrator indicated that the modules may be helpful to those who are looking for "funding to support their organization" and "professional organizations."

Future Curricula

Participants had several ideas about potential future curricula that could be added to the modules or entirely separate modules. The primary request from nearly all the participants was the request for more proposal examples within the modules. Participant 3 recommended additional content in this way:

> I would have liked to see more of an overview of… possible funding agencies and what their topics are that they fund. It'd be nice to have some kind of a slide. So, if you wanted to start with NASA, for example, and so within NASA, then you would show all the different directorates and what types of things they generally fund. Because when I come in as a new hire, a new faculty member, I'm not

familiar with ONR, AFOSR, and ARO. I don't know all these different agencies and what they like to fund.

They wanted to review both winning and failing proposals. Notably, they wanted discussion about why things may have been funded or failed to obtain funding. In addition, many asked that budget and budget justification examples be included in the modules. One participant indicated that varying speakers might add interest. Others suggested that various organizational processes might be added, including "the post-award process, which is something like …. still kind of a black box for me" and "process for submitting to SPO [Sponsored Programs Office]."

Figure 13

Online Learning Theme Network

Theme 3—Grant Writing Process

The *Grant Writing Process* theme arose from the semi-structured interviews and addressed aspects of Research Questions 1 and 2. The theme was present in three of the eighteen questions in the protocol. In each of these questions, overlapping codes arose in the categories, and the following six theme-related components were identified: (a) brainstorming, (b) connecting, (c) editing, (d) personnel accessed, (e) solicitation/RFP, and (f) writing. The Grant Writing Process theme was primarily related to pre-award grant writing processes. Early-career engineering faculty members did not distinguish between pre- and post-award writing efforts as they described their grant writing processes.

Table 17

Grant Writing Process Theme Categories, Theme-Related Components, and Theme

Categories	Theme-related Components	Theme
Generating ideas	Brainstorming	Grant Writing Process
Outlining		
Figuring what can be played with		
Exchanging ideas		
Cultivating Relationships	Connecting	
Making Institutional Connections		
Talking back & forth w/Program Officer		
Talking with Office of Sponsored Programs (SPO)		
Needing more time	Editing	
Iterative		
Revising based on feedback		
Checking format and guidance		
Reading it/Not	Solicitations/RFPs	
Sometimes Vague		

Topics Posted		
Webinars		
Budgets	Writing	
Narrative/Scope of Work		
Pre-proposals/white papers		
Focus on content		
Supplementary Docs		
Summary/Abstract		
Students	Personnel Accessed	
Sponsored Programs Office		
Program Officer		
Faculty (Peers)		
Grant Writer		

Brainstorming

Brainstorming was identified as an initial theme-related component. The engineering faculty members employed different mechanisms for ideating and converting those ideas into frameworks to initiate writing. For example, Participant 5 indicated they "…. make a list of [what] the documents and deadlines are" whereas another Faculty Administrator indicated "…. we brainstorm different sections of the proposal." Many of the participants used various idea-generating techniques as a critical starting point for their grant writing process. For example, one said,

> I more gravitate towards ideas that I find interesting, and then I go out and look at solicitations from different … funding agencies and then see if there's one of those that my idea kind of aligns with that I could then submit. And so. So, yeah. So, I start out with that, and then I just kind of get the bones of the idea out into a white paper. And then, I even just kind of start outlining what the project will look like from my head. And then, I go back and kind of revise it to where it would be better suited for the actual agency that I want to submit to. And sometimes that changes as I write. So, it's a very iterative process (Participant 2).

Some begin by generating ideas from their areas of interest, as in the case above. Others allow their target funding agencies to drive the topic selection and then ideate on those topics. One of the Faculty Administrator's demonstrated a more systematic approach when they said,

> First of all, generating ideas, you know, and that includes a survey to make sure I meet the needs of the sponsoring office, sponsoring, you know, agency. Then I'll talk to the program office … to make sure my idea fits within their needs and then ask for comments about my white paper.

Ideating usually involved dialogue with other faculty peers or potential team members and an exchange of ideas. Brainstorming was a critical step in the grant writing process because if the idea or topic did not fit within the program target, it did not matter how well written it was, fit mattered for fundability.

Connecting

Connecting developed as a theme-related component and demonstrated various ways the engineering faculty members communicated with different people for a variety of purposes during the grant writing process. Faculty members made a range of connections from internal offices to external agencies and faculty members at different points in the development process. The purposes for communicating varied from ideation, negotiation of topic details, cultivating relationships, acquiring new team members, and finalizing submission details. Participant 3 indicated their rationale for doing it early in the grant writing process when they stated,

> I guess I spend more time talking to agencies and trying to find out what they're looking for so that I can make sure that I'm not wasting my time and their time by writing a grant that's not going to get funded or that they're not interested in.

The previous illustration exemplified high value for efficiency in connecting during the grant writing process. Therefore, they opted for precision on topic ideation upfront by connecting with the Program Officer early as a tactic.

With regard to connecting via discussion boards, Participant 1, indicated, "… speaking with peers in the same department or school or institution might [be enabled online] … peers from other institutions, we could probably exchange ideas," and this was an important aspect of the notion of potentially adding discussion boards to the modules. With the tenure clock ticking and graduate students to graduate, no one had time to waste, least of all early-career engineering faculty members.

Other faculty members connected with the Office of Sponsored Programs, a.k.a. SPO, for clarification, mainly since the routing software was a bit difficult to navigate, as Participant 5 noted when they described the required internal process,

> I guess we do our submissions are in Kuali we actually submit ourselves on a … portal, but I still prepare everything in Kuali because it's a procedure. That's what we need. So Kuali, it's got a steep learning curve. There's… it's a really buggy interface.

These were a part of the macro-system and micro-system connections at the university.

Editing

Editing emerged as a third theme-related component. A variety of discussions occurred in and around editing, particularly as it related to time. The next few quotes

illustrated this ongoing issue with time during the editing part of the grant writing process. Participant 5 indicated, "once they have documents, and then hopefully there's still time left to edit, often it feels like … at that point we're down to the deadline, and it's just kind of triage cleanup. Does that make sense?" Based on that quote, there was a sense that editing most often occurred in haste, but the same Participant 5 claimed,

> I mean, you are at the college [level], and so when … I have a couple of weeks left to spare, and I can go through some more drafts, I can do some more edits. I love sending it to you, and I love sending it to other colleagues to read over. It's really nice. Like for me, it helps me to this day. Like, this is not my responsibility anymore. This is out of my hands for a couple of days while someone else reads. And that helps me to come back to it with a fresh set of eyes once they send it.

Operational dissonance during the editing process seemed to be dictated by time, or rather lack of it. When the participant was asked what additional support they needed in grant writing, they indicated, "Honestly, things would be most helpful, and this is almost a non-answer is if I could just have more time."

Participant 3 recognized that attending to the guidance and formatting requirements was essential for the editing process. They indicated

> You've got to follow their guidelines, and I think I can see why from their standpoint. But it's a bit of a pain from our standpoint because we have to … each of them seems to be a little bit different. They're asking for different things. They're asking for different emphases … underneath these headings. And so, you have to understand what not only the name of that heading but what they're really looking for within that heading in order to be successful.

Attention to detail was what Participant 3 communicated in his comments about the editing process, but this also required additional time in the editing component of the grant writing process. Finally, Participant 2 and the Faculty Administrator indicated it was an "iterative process." Although Participant 3 did not communicate this overtly, the processes they described above were iterative. Finally, Participant 5 indicated that as time allowed, they enjoyed the iterative process and feedback during the editing process, as indicated by the second quote.

Solicitation/RFP

Solicitation/RFP was identified as a theme-related component. This presented many ways faculty members engaged or decided not to engage with the solicitation or request for proposal (RFP) and to accompany explanatory materials, including webinars in which information was presented. Solicitations/RFPs ostensibly provided explicit knowledge about funding considerations and preferences from the funding agencies to potential applicants. To provide context for the participant discussion, it should be noted that solicitations/RFPs ranged in size from one page on a webpage to moderate-sized, less than 20 pages to over 100 hundred pages. All solicitations/RFPs were accessible via grants.gov or sam.gov and their agency websites, but many of the detailed webinars that supported the solicitations/RFPs were only found on agency websites.

Results indicated the participants were not unified on whether they read andunderstood the solicitations. Participant 2 indicated, for example, that previous experience was important in their understanding of solicitations when they said,

> guess a lot of that comes from so in terms of my experience with NSF, like

> I think I just inherently have a good understanding of what they're looking for typically and how to get that across. But I wouldn't say that that's because … because I read through the solicitations and understood everything that they were saying in that solicitation; a lot of that just comes from prior experience.

At another time during the interview, Participant 2 described their confusion about the solicitation and how they relied on faculty within the department to help them select the right track when they claimed,

> Initially, … I was initially having issues trying to figure out I knew I wanted to go to NSF, and I wanted to go to EHR and improving undergraduate education, but there are so many different sublevels that that program that I was just like, oh, my gosh, solicitation which level? And so that one, I really had to kind of rely on my more seasoned faculty colleagues to help me kind of figure out exactly which one I wanted to … apply to.

This example demonstrated how the micro-system works to enable the early-career faculty member to consider grants. At this point, faculty members or other team members consider what aspects of the solicitation or topic area could be dynamic or iterated upon as the idea was developed.

For more than one participant, there was a sense that the solicitations/RFPs were not always clear or sufficiently detailed. The Faculty Administrator Participant indicated this matter when they suggested,

> sometimes they put very detailed instructions about what particular projects or directions they want to fund, and sometimes the proposal is very vague. OK, why

> don't we just know the very big picture, but we don't know that much detail in that case. We have to talk to that program officer [on a] case by case [basis].

These examples demonstrated how the faculty member was seeking clarification at the exosystem level, the funding agency.

Moreover, the process for grant announcements has not been uniform across agencies. Participant 5 described the combination of topic announcements, webinars, and solicitation releases as a part of his grant writing process when he indicated,

> DOE. I feel like I understand really well, it's, it's this one size fits all, shoehorn it all into the same process and annual call. So next week, they're going to have the webinars for the year. And so, you put it on your calendar, you show up at 9:00 a.m. Eastern time to 7:00 a.m., so you just commit to waking up early that week. Thankfully, they give you the itinerary, so you don't have to stay on the call constantly for four days. But the itinerary changes a lot. So, you do have to check-in at the start of every day, and then once they announce the topics, it's off to the races.

In this response, the participant clearly described how some federal agencies put out topics and webinars with their solicitations, which result in national events that allow many faculty members from around the nation to participate.

Writing

Writing emerged as a theme-related component, and it seemed writing was the most pervasively misunderstood element of the *Grant Writing Process* theme. Writing has included more than just the narrative or the scope of work, which was reflected in their responses. Grant writing has been comprised of multiple documents that needed to

be prepared and which typically had their specification requirements. These specifications were delineated in the solicitation as explicit knowledge as discussed in the initial theme-related concept. Through working in a particular area, faculty members gained implicit and domain knowledge, which allowed their responses to be more precise and agile than other competitors; they became situationally aware and attuned to their funding agencies of choice (Kessel, 2017, May 9). In other words, their situational awareness increased, and these tactical choices were made more evident in the *Winning the Next Grant* theme. Nevertheless, each faculty member chose when and how in the process they engaged in those documents, and these tactics helped them to reach their overarching goal of submission. You cannot win what you do not submit.

Developing budgets and budget justifications were starting points for nearly half of the participants, but they used different mechanisms than sometimes officially prescribed. Participant 3 indicated,

> I am actually using that spreadsheet to do my budget estimating because it's the most accurate way I know without going full-on, Kuali, which is a headache. So that's another tool, I guess I would say, for my budget planning.

Likewise, Participant 5 indicated they preferred to begin with the budget and budget justification because it helped them to think of the elements of the scope of work when they stated,

> I often start with the budget, just because the budget tells me how many students I can support, and that kind of tells me the scope of the work that I can do. So, I think most projects you do; you try to have a grad student every year and then, you know, if you can squeeze in a little bit more money for undergrads, you

> squeeze in more money for travel and supplies and everything else. I guess it depends on the project and that I mean, that doesn't count equipment grants. Right? Or travel grants? I guess, are their own thing, too. But yeah, I do the budget first, and that kind of gives me a sense of what my scope is.

While developing the budget first may seem counter-intuitive to the average person, it represents their training. The budget determined the solution fit. Engineers have been trained to provide real-world solutions to real-world problems even when they were doing fundamental research. They identified the topic and the budgetary constraints to formulate potentially viable solutions and articulate potential risks or challenges. This tactic ensured that the scope of work was the right fit for the proposed budget.

Where the writing of various documents began to be different for many of the participants was the order in which they chose to do them. For example, Participant 5 described the following process, "Sometimes I'll do other supporting documents if I just want low hanging fruit to knock out not having to worry about so like the …CV or the current and pending, then I usually write the narrative." Most faculty members began with a white paper to "get the bones down" and check with the Program Officer "for comments" (Participant 2; Faculty Administrator). Participant 5 also observed,

> I usually write the abstract last, like the summary last. Some people recommend that you write it first. I find that. I have a much better idea of what I'm summarizing once I've already written it, so that doesn't work for me.

These examples demonstrated how many components there were and how individual the order was for each participant to initiate them during the grant writing process.

The *Grant Writing Process* theme was dynamic and demonstrated conceptual frameworks utilized in various ways to move the grant writing process forward. In Figure14, I have presented the categories, theme-related concepts, and the Grant Writing Process theme in a visual format.

Figure 14

Grant Writing Process Theme Network

Theme 4—Winning the Next Grant

The *Winning the Next Grant Theme* arose out of participants' responses, which were connected to Research Questions 1 and 2. The theme was future-oriented because many of the responses of the early-career engineering faculty members were

representative of attitudes about topics and intentions to modify or not alter behaviors with respect to future processes. The theme is derived from five of the 18 interview questions. Overlapping codes arose and led to the categories, and subsequently to five theme-related components that included (a) Mirroring, (b) Persisting, (c) Perspective Taking, (d) Prioritizing, and (e) Future Research.

Table 18

Winning the Next Grant Theme Categories, Theme-Related Components, and Theme

Categories	Theme-Related Components	Theme
Being very relationship-based Program Officers in DoD	Mirroring	Winning the Next Grant
Finding out what they're interested in, what they fund, and what their future looks like for their portfolio, where they're headed		
Trying to make sure that my work aligns		
Going back and forth with them		
Presenting a few ideas to them		
Talking to some grant winners, past grant winners to get that experience		
Asking about lessons learned		
Not expecting the first interaction to yield funding	Persisting	
Watching for the funding opportunities year after year		

Seeing new ones sometimes via email or someone else		
Being run by deadlines		
Understanding how to look for solicitations		
Trying to see the process from their prospective	Perspective Taking	
Needing similar formatting and design to locate info. quickly		
Being especially important at a research university		
Being less important for a teaching institution		
Being part of the expectation		
Wishing they weren't connected		
Wanting to fund people they trust to do a good job		
Commenting in one of the modules		
Seeing the difference and similarity between DMP and DSP		
Reviewing proposals		
Agencies need to present the requests in a simpler way		
Thinking about the implementation level about what will be done		
Learning is very steep when it’s something new		
Seeing it as an initial evaluation	Prioritizing	
Seeing it as an initial framework		
Understanding how I can tailor them		
Being very difficult to advance your research without grant money		

Winning grants is one of the major metrics to evaluate their performance toward tenure		
Winning for research universities, grant writing and tenure promotion, and academic performance are very well connected and important		
Recognizing that the solicitation is cross-listed across agencies		
Being a good tool to identify if ONR is a good fit for me		
Talking about other agencies allows a point of comparison with early-career		
Being confident that I could put a proposal together	Future Research	
Feeling confident on a scale of 1 to 10, a 9		
Feeling like USU has such great resources		
Having the right preparation and understanding		
Changing EC goal because of module-info		
Understanding the change at the beginning of their career		
Articulating the intellectual merit of my work		
Being able to see the long-term impact of my work		
Doing more with my broader impacts		
Formulating hypotheses		
Having a lifelong learning process with grant writing		

Mirroring

Mirroring was identified as a theme-related component. Mirroring was defined as "emulating or reflecting speech, affect, behavior, or other qualities in context" to establish relationships and to build rapport (APA, 2021). It communicated an intention to establish rapport, typically with a program officer or agency, but it included other faculty member peers and personnel as well to acquire information about how to position to win the next grant. Participant 3 clarified how this process worked when they described,

> Somebody early on told me that, you know, these … funding officers and this is a little different because … I get a lot of funding through the DoD. So, this is different than NSF, but in the DoD, they are very relationship-based. And so, you have to spend time getting to know these program officers.

Participant 5 echoed some similar sentiments regarding their early-career award at a DoD agency when they maintained,

> And then, on the strength of those relationships, I was able to get my … YIP from [name of agency deleted]. And the guy has flat out said, look, it's a weird portfolio. It's like … lots of different science in there. I don't know that he's especially interested in my topic area. As much as he's flat out said that he likes that there are the close ties to [name of agency deleted] and that I am working with people there. And that was the thing that got him most excited about life. So, DoD feels very relationship-driven to me.

Many DoD agencies were relationship-driven because they had long-term visions and priorities. The various DoD solicitations have been unique in their requirements and areas of interest, which required close attention to the topic and programmatic alignment.

However, this was not exclusive to DoD, and Participant 5 shared how a senior researcher elucidated the following about agencies, portfolios, and alignment when they claimed,

> …. when I was starting out, I remember now this more senior researcher who is no longer with our department. I don't know for you the names on the recording, but he would always talk about agencies in terms of their total budget and their number of grants and like this big bird's eye view of trying to understand. And that always seems like, well, I'm not applying to an agency. I'm applying to my own program like I just want to understand one program, but … as you look at things more and more as a portfolio and as you understand more and more. Oh, look at these … grant officers; they're trying to fit into a bigger structure … I've had more and more appreciation for this bird's eye view.

Although Participant 5 did not initially understand the importance of the exosystem (e.g., federal agencies and budgets) an explanation of their personal research as they developed and received funding, they began to understand and see the connections more clearly. Participant 2 expressed similar confusion when they said,

> I don't think I quite knew how to implement a lot of the advice that you were giving me since I wasn't quite here yet. But now that I know the lay of the land of the institution more, and I've participated in that PWI, it's just yeah, all the advice that you've given has been so helpful and has really helped me tighten up a lot of the ideas and really put them in a format where they would be more, I guess attractive to funding agencies.

These exemplars suggested mirroring in grant writing was developmental and became more sophisticated as the engineering faculty member received mentoring, training, and funding.

Finally, another overt strategy for mirroring was to ask for information, and multiple participants used this approach. For example, the faculty administrator indicated they "talk to some past grant winners …. and get that experience," and Participant 1 found value when their peers "…[what] I think is helpful is colleagues who are open to sharing information about their previous applications, be it successful or not successful."

Persisting

Persisting, also known as perseverance, was identified as a second theme-related concept. Persistence was a "quality or state of maintaining a course of action or keeping at a task and finishing it despite obstacles (such as opposition or discouragement) or the effort involved" (APA, 2021). This meant the "first interaction with a program officer may not yield funding," but the point was to work on the relationship because this was a career and a research program that faculty members were building (Participant 3).

Participant 5 described persistence despite discouragement about required resubmissions as one of three characteristics of a successful researcher when they claimed,

> How you handle these resubmissions … when I was first starting out, I would put just months and months and months of work into one proposal, and … it would be really personal to me whether it succeeded or failed. And so, over time, as I've had more and more proposals, I've come to view it more as this is a portfolio of work. And so, it's not any one success, but it's, you know, like collectively, if you

> submit enough and if you do a good job, and then eventually some of them are going to hit, and there's an element of luck, sometimes bad things get funded anyway because they were good enough. Sometimes good things get beat out by better things, sometimes really good things. It just wasn't the timing ... like it was a bad program officer, or the program officer has something else too similar already in their portfolio, and so, like, there's some persistence … you don't give up on the first try. You're willing to revise and resubmit when the opportunities are available. And what that means is sometimes you submit something, you put your best foot forward. You don't want to embarrass yourself, but you do sometimes put something forward. You don't expect it to succeed on the first try--be great …. But … if you expect it to resubmit, you expect to learn everything you can from the first submission. And you think the long game, it's like, well, I'll win it on the second or third try. I think that you know, cushions some of the hurt, too. It sometimes, it is hard not to take it personally, especially in the moment.

Participant 2 mentions they saw this as being able to separate oneself from their work when they said,

> So first, I'll say separation and again, separation in terms of not taking so maybe objective a better a better word, not taking feedback personally, not taking outcomes personally, even … in writing the proposal, recognizing that there's always going to be a flaw somewhere that … you can always improve on it. And so, letting your …. perfectionist in you go and not and not essentially equating your proposal with an extension of you, which for me can be really hard,

> especially as I'm trying to make a name for myself in the field and the type of work I do. And so, to me, I am very much a part of my proposals, but I've been trying to put a little bit of separation in there, so I'll keep moving forward and not get discouraged.

Participant 3 described it as "grit," which included both perseverance and passion toward a long-term goal or state (Duckworth, 2016). Participant 3 described those characteristics when they acknowledged,

> I think it's a grit … there's a certain [amount]. I have to say, the biggest skill that I've seen people who are successful … is that they simply have the stamina to weather the storm of grant writing, the challenge of grant writing. Know there is a lot of people who would like to earn like to get the money, but it takes a lot of a lot of effort to convince somebody to fund you, you know, at the half a million- or million-dollar level for a project. And so, the thing I see the most, I guess, is the grit, the will to do it.

This might include capitalizing on the mundane and routine like "watching for the same funding opportunities," "seeing new ones via email," or simply making sure you have an "understanding of how to look for solicitations" (Participant 5, Participant 1). Persistence meant showing up for oneself in grant writing consistently.

Perspective Taking

Perspective Taking emerged as a theme-related concept within the larger theme. Galinsky et al. (2008) described perspective-taking as "the act of perceiving a situation or understanding a concept from an alternative point of view, such as another individual," and in the grant writing context, it is the Program Officer, panel reviewers, or those

implementing the research. As described earlier, the faculty administrator indicated there was a clear connection between grant writing and promotion and tenure at a research university like USU, but they also indicated "…for a teaching institution [another institution] they do not put too much [emphasis on] research grant writing." The faculty administrator juxtaposed research universities and teaching universities in the context of grant writing and P&T to articulate their perspectives. The skill can be helpful to engineering faculty members as they attempt to "make meaning" of their contexts and grant writing processes (Gillies et al., 2014; Ignelzi, 2000). Participant 3 described their use of this approach when they stated,

> …. I try to see it from their perspective to some extent, that they've got to have a way to evenly [evaluate]. They've got to have grants coming in that are similarly formatted and designed so that they can get the information that they want quickly. And so, they kind of force a format on you that you have to conform to, which may or may not be the format you would naturally write in, but you have to conform to that format because they're looking at hundreds of these. They've got to be able to find the right headings and the right bullets … to digest what each of these PIs is proposing.

In this example, the participant was taking the perspective of the agency and potentially the reviewers. In another instance, Participant 2 described an experience as a federal agency reviewer when they described,

> I was on a panel, and I was getting very frustrated while reading the … proposals because I couldn't tell what they were doing. And so that really reminded me, OK, you need to really make sure you're articulating things because I was just

getting really frustrated.

In this instance, Participant 2's experience as a panel reviewer in the federal agency context (e.g., exosystem) helped them understand and see the importance of clearly "articulating" information. Another example was articulated by the faculty administrator, who indicated, "so after listening to your… watching your module, I can see now they're really helpful for me to understand the difference and the similarity between the two [data sharing as compared to data management]. Providing points of comparison were strategies for these expert learners as they attempted to make meaning and consider perspectives in their grant writing process.

Finally, another example of perspective taking was one of the faculty members taking on the perspective of a grant writer staff member. Participant 3 observed the online modules,

> And it's like I can see your points and that was really valuable to … hear your perspective from somebody who … has made a career out of grant writing other than being a faculty member, you know yourself that … you … see this you're [Monica as grant writer] in this even more than I am.

Thus, engineering faculty members demonstrated perspective taking abilities that allowed them to consider various roles, which aided them as they considered the grant writing process.

Prioritizing

Prioritizing was a fourth theme-related component to emerge under the Winning Theme. Prioritizing has been a common tactic used by busy people with complex workloads. Many of the participants had developed their own tactics for prioritizing

information or grant writing during their research process. Participant 1 indicated they tried to “recognize if a solicitation was cross-listed across multiple agencies” and prioritized the one that fits best. Participant 5 demonstrated prioritization as they preparedfor the DOE grants when they claimed,

> It’s always the same, and so you practice at it, you get better at it, but it feels … really clunky ..., so full proposals are due in February. You make sure you submit everything on NEUP.gov. Then you wait for June, find out whether you get it or not. If you do get it, projects don’t start until October because of the federal fiscal year. And so, it’s 14, 15 months from finding out what a topic is to, if you get funded, being able to actually start the project, and if you’re not funded, then … you’re rejected in June.

In another example, the faculty administrator described the module in the following manner when they affirmed,

> Another module that I have taken from you is to write the white paper for ONR. No, I have never submitted any papers, including white papers, to ONR …. That’s the first experience. So at least I know where I can start. That’s good. So, I think that you have provided excellent resources all through those modules.

Prioritizing was a common experience and one that helped people create order and organization in their worlds. It was not surprising that it was utilized by engineering faculty members to facilitate their efforts.

Future Research

Future Research emerged as a final theme-related component under this theme. In competitive research environments, early-career engineering faculty members were experts in their fields by virtue of their courses of study and previous education. In Future Research, three major elements surfaced, including (a) confidence in future funding, i.e., self-efficacy, (b) articulating future goals for research, and (c) identifying areas where they wanted to improve in their grant writing or research. When asked how confident were they that they could write a fundable grant all except one stated that they could "put a winning proposal together" or felt "confident on a scale of 1 to 10, a 9." (Participant 5, Participant 3, Participant 2). The faculty administrator was slightly more cautious and qualified their statement about confidence in writing a winning proposal when they said, "depending on the information in the call for proposal."

In addition, when participants were asked about their next research goal, each of them was able to articulate it clearly. This was a developed skill because not everyone, upon arrival, had a vision for their future research. For example, Participant 5 indicated,

> And so, I think for the next phase that I'm kind of pointing towards as well, when you've got a hammer, everything looks like a nail, right? Like … I've got all these … cool techniques and instruments that they should actually measure things with, not just, you know, keep coming up with new methods, but I should actually… discover new things about materials. So that's probably the direction I should be spending more [time] towards.

The participant was taking what they had and seeing it being used in a new way. Likewise, Participant 3 sought to enrich their research by building on what they had for their future when they confirmed,

> My next research goal. I would like to shift gears in my research towards bioinspired, and I know that a lot of what I do we touted as being bioinspired already, but in my book. It's been only tangentially bioinspired, and we've used that more of [like] a buzzword. I'd actually like to really get into the bioinspired stuff, and that's a more challenging thing in aeronautics to get funded than the applied because a lot of my funding sources …. I'd like to actually move the same methodologies and things that I'm using to study these more applied things that I'd like to move over to bioinspired to understand how nature has evolved. You know, I mean, nature is light years ahead of us, still in aeronautics. And there are many things we don't understand.

There were no small ambitions here. All the participants expressed dynamic visions for their research, including the faculty administrator who expressed a research goal for themselves as well as their department when they said,

> I have two goals as [an] individual faculty [member]and as a department head. As an individual faculty [member], I want to write a small proposal in my area of expertise, which is … technology to enhance education before I have written some proposals to use the technology to improve student learning …. That's my personal goal. And then, as a department head, I think I know my next goal is to write a department-level proposal and get all the team together …. and work with the College of Engineering. Then, we can make a real difference. The faculty

> administrator demonstrated they can develop personal goals, work with the collective group of faculty members in the department (e.g., micro-system) and other members within the College of Engineering (e.g., meso-system) to develop a proposal inthe future. This exemplified complex systemic future visioning.

Finally, each of the participants could articulate items upon which they personally wanted to work "improve their grant writing." Some exemplars include Participant 1's desire for more opportunities with respect to "formulating hypotheses" and Participant 3 wanting to gain experience "articulating the intellectual merit of my work." The faculty administrator expressed a similar point of view when they maintained,

> Overall, you know, I have read a lot of proposals. I think if I have good ideas, I can turn good ideas into a good fundable project. I have no question about that. And in terms of skills, probably I have to learn what you know, that's kind of a lifelong learning process because sometimes we don't know how reviewers will respond to our writing.

The experienced faculty administrator observed that the federal grant writing process is a lifelong learning process and is based on the subjectivity of reviewers and scoring criteria established by federal agencies.

Figure 15

Winning the Next Grant Theme Network

Summary of Qualitative Data

Taken together, the qualitative data revealed four themes—*Knowledge, Online Learning*, *Grant Writing Process*, and *Winning the Next Grant*. These themes demonstrate high value for interconnection, domain, and implicit knowledge, and in general, provide insight into highly competitive research environment that early-career engineering faculty operate. Notably, this research provides qualitative information about strategies and tactics utilized by early-career engineering faculty as they engage in their own meaning-making process with federal agencies and their grant requirements. This work begins to identify adaptive intentions and behaviors they exhibit when offered an intervention that may support their grant writing development. As the research for online professional development grows, the thoughtful and honest feedback of the

facultywill inform the design and the curricula for expert learners and others. In general, this is an understudied area of ARDES and in the formation of early-career engineering faculty.

Research questions 1 & 2 have been answered through this MMAR and secondary data analysis. The data show in Modules 1, 2, and 4 that these early-career engineering faculty (i.e., expert learners) were able to make improvements in the grant writing knowledge in requirements, processes, and skills. Furthermore, this data is evidenced through the qualitative data in how their attitudes, and, to some degree, their self-efficacy was positively impacted. The on-demand, online format was a successful mode of delivery.

CHAPTER 5

DISCUSSION

Each of us is born with a box of matches inside us,

but we can't strike them all by ourselves.

—Laura Esquivel, 1995

In this study, I use a mixed methods action research (MMAR) design as I implement and evaluate the intervention in which I provide information using five on-demand, online modules to assist early-career engineering faculty members in developingnew understandings about grant writing in a highly competitive federal research landscape. Using iterative cycles of action research, I construct five modules with specific information, attendant survey questionnaires, and semi-structured interview protocols used in the dissertation study, Cycle 3 of my action research work. Despite the small sample size, results from quantitative survey data show the intervention led to modest gains scores for Modules 1, 2, and 4. From the qualitative data, results from five semi-structured interviews yield four cross-cutting themes: *Knowledge*, *Online Learning*, *Grant Writing Process*, and *Winning the Next Grant*. Together, these data yielded responses to the following research questions:

> **Research Question 1**—How and to what extent did the implementation of five on-demand, online modules affect early-career, engineering faculty members' understanding of grant writing (a) requirements, (b) processes, and (c) skills?

Research Question 2—How and to what extent does the implementation of five on-demand, online modules affect early-career, engineering faculty members' (a) attitudes toward and (b) self-efficacy for writing grant proposals?

This research contributes to the understanding and knowledge in four areas at the intersection of online learning and professional development in education, talent development in human resources, and the newer, emerging field of research development.

Complementarity of the Quantitative and Qualitative Data

In this small MMAR study, the quantitative and qualitative data demonstrate some modest levels of complementarity. Complementarity refers to the extent to which the quantitative and qualitative point to the same outcomes (Greene, 2007). To determine complementarity, I examine the quantitative and qualitative data for Modules 1, 2, and 4, which had multiple participants.

For Module 1—NSF Resubmissions, there are modest to moderate gains between 0.37 and 0.89 of a point for skills, processes, attitudes, and self-efficacy. Similarly, in Module 2—Early-career Awards, data indicate moderate gains between 0.86 and 0.90 of a point for skills, processes, and self-efficacy. In Module 4—Office of Naval Research White Papers, there are modest gains between 0.20 to 0.40 of a point for skills, processes, and attitudes. Together, the quantitative data indicate modest to moderate gains in scores on these variables, which is more fully explicated below.

Consistent with these quantitative increases, participants provided responses during the interviews indicating increases in their knowledge of *Skills*, *Processes*, *Attitudes,* and *Self-Efficacy*, including the confidence to engage in grant writing. For example, the *Online Learning* theme includes a very clear, theme-related component of

attitude. Participants indicate they are more excited about the grant process, willing to try something new, and more confident, which indicates they have greater self-efficacy. Similarly, evidence from the *Knowledge* theme suggests participants have a greater understanding of domain knowledge-related skills and processes associated with grant development and grant writing. Information from the *Winning the Next Grant* theme suggests that within the future research, theme-related component, participants felt more confident overall as well as in their abilities to develop a proposal. Thus, despite the small sample size, there is some support for complementarity in the data as noted.

Phillips and Carr (2006) indicate trustworthiness is improved through triangulation, which is gathering various kinds of data. As I conducted my work, I used data triangulation (Denzin, 1970; 2012), especially during Cycle 3, the dissertation study. In particular, I engage in triangulating data by using surveys and interviews, gathering data from internal communications, USU GRAMA information, and USU AAA. I use varied sources support the credibility of the research effort.

Explaining the Results Based on Ecological Systems Theory

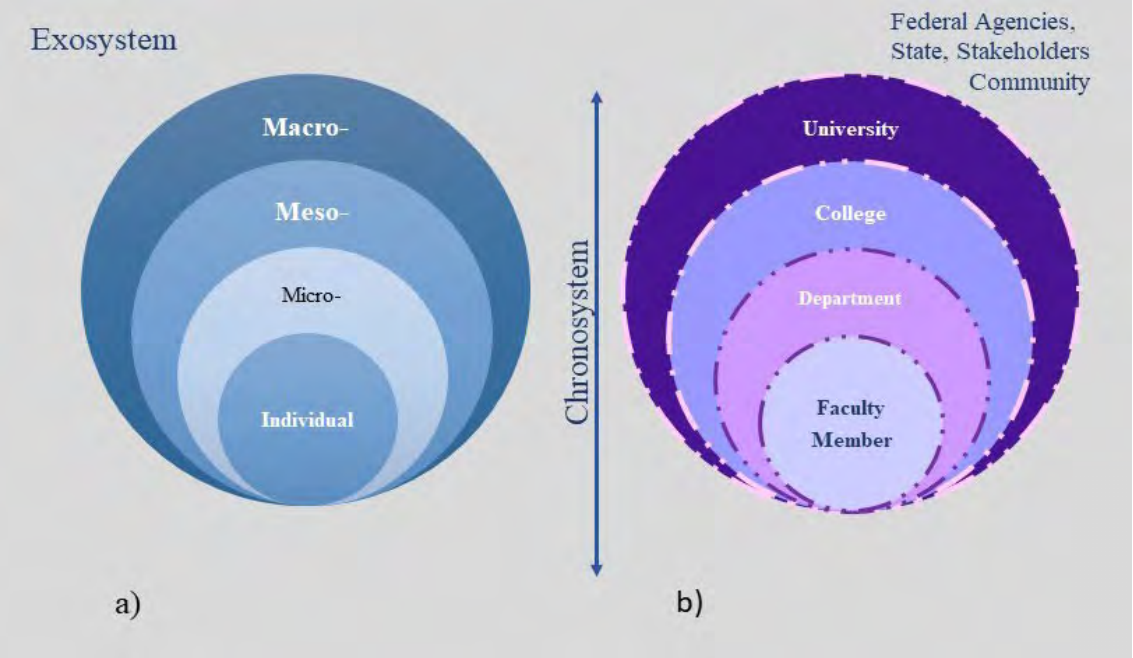
Bronfenbrenner's Ecological Systems Theory (1979;1986) guides the development of the research and the intervention. EST is used as a conceptual framework for developing the Academic Research Development Ecological System (ARDES) and the Academic Ecological Process Model of Systems Change (EPMSC) framework I describe in Chapter 2. The data suggest the model depicted in Chapter 2 should be modified to capture the ability of faculty members to access people, resources, social processes, and information across the micro-, meso-, macro-, and exosystems. The qualitative data suggest early-career engineering faculty members access ARDES

elements during their grant writing process. They seek to determine requirements, discernprocesses, and develop their skills in the *Knowledge*, *Grant Writing Process*, and *Winning the Next Grant* themes. They also expressed areas for future curricula and other users in the *Online Learning* theme.

As they engage in the grant writing process and discuss their efforts, it is clear early-career engineering faculty members move back and forth among the various levels of Bronfenbrenner's EST. The dashed lines indicate the permeability and fluidity of how early-career faculty members navigate the ARDES model in context. Although there are recognizable identities and structures within departments, colleges, universities, and community/federal stakeholders, there are clear and routine opportunities to engage and leverage all ecosystem levels during the grant development process. The integration challenges the notion that the faculty members are solely or somehow "siloed" as they engage in the research grant writing process (National Research Council; 2014; 2019). Figure 16 depicts the change in the model based on data from the study.

Figure 16

ARDES Model Modification (a) Bronfenbrenner's EST (b) Modified ARDES Model



Notably, operational functionality in one domain does not necessarily guarantee operational success in grant writing. For example, Participant 5 indicates they "struggle with NSF but have done well at DOE, DoD…." Participant 3 expresses a similar observation. Participant 2 claims they win "only NSF," and the Faculty Administrator wins primarily "NSF." Thus, diverse portfolios among early-career engineering faculty members would be unique.

The Academic EPMSC framework allows people, resources, social processes, and information within the ARDES to be accessed in support of the grant writing process on behalf of the university. Notably, not every early-career engineering researcher or faculty administrator began with the same resources. Nevertheless, they undergo the same probationary period and the same tenure process (e.g., College of Education resources

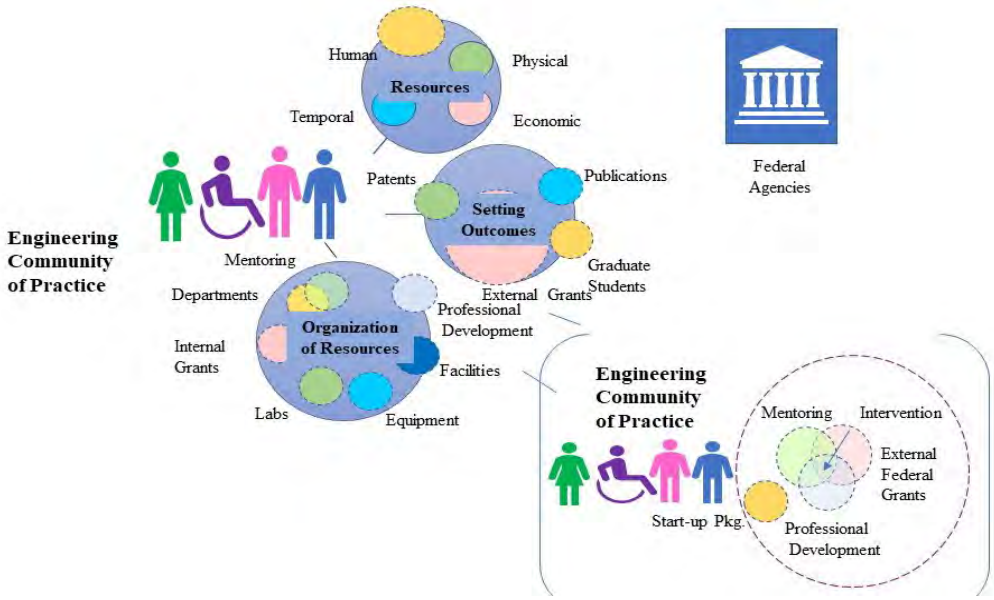
compared to College of Engineering start-ups). The qualitative data and USU Promotion & Tenure Policy indicate that tenure is earned through a meritocratic process, adding pressure to the promotion and tenure process. Notably, USU turnover of engineering faculty members is high, with seven tenure-track vacancies. It is plausible that such a highly demanding process and competitive environment are too demanding for some engineering faculty members and other factors. These factors may warrant additional future research.

Figure 17 depicts the proposed change in the Academic EPMSC framework for the ECoP based on the study data and the university data. There are multiple changes in the figure, including the faculty being depicted as being more diverse because there are people of differing genders, orientations, racial/ethnicities, people with varying abilities, and underserved backgrounds. I wanted to acknowledge these factors in the new graphic.

Second, I wanted to depict the magnitude of external funding, the human turnover, and staff presence within the engineering community of practice, and the close ties early-career faculty members have with their peers in their departments based on the qualitative data. According to USU AAA (2020), engineering has experienced declining enrollments for the last five years. Perhaps, there are only so many priorities that early-career faculty can be expected to have. Moreover, I added the federal agencies, which served as an orienting factor for the early-career faculty members. These aspects were also reflected in early-career faculty members' role statements, including the allocations of large percentages of time to research funded by grants required of them to succeed at USU.

Figure 17

Academic EPMSC Framework for ECoP Modification in Context



Self-Efficacy Theory also guides the development of the research study and the intervention. In Chapter 2, I note that personal efficacy is "based on four major sources of information: performance accomplishments, vicarious experience, verbal persuasion, and physiological states" (Bandura, 1977, p. 195). The qualitative data are consistent with these four sources are reflected in *Online Learning* and *Winning the Next Grant* themes in their theme-related components and categories.

I use questions in the semi-structured interview to capture participant feedback in these areas. Two exemplars of these questions include "How certain are you that you have the necessary information to write a funded grant?" and "Describe three potential topics that could be added to the on-demand, online grant modules to support PIs."

Participants express multiple positive attitudes within the Online Learning theme,

suggesting the modules are “verbally persuasive.” This may also be why they used parallel words about their experienced physiological states like “excited” and self-efficacious circumstances like “confident.” Further, participants indicate the modules are “accessible, collaborative, and flexible,” which contributes to this overall positive assessment as is evident in the theme-related components of Attitudes, Microlearning, and Other Users.

In addition, participants express through the theme-related components of Perspective Taking and Mirroring elements of vicarious experience in the Winning the Next Grant theme. The theme-related components occur in multiple ways when participants take the perspectives of potential reviewers or program officers. These participant attitudes sometimes resulted in behavioral changes such as “writing more clearly” or “getting in alignment.” These behaviors often help them be more competitive by being aware of the other perspectives at play in the competition. In other words, this is not about “their research” rather, it is about how “their research can meet the agencies’ needs” or “how their capabilities can meet the agencies’ needs.”

As indicated previously, Bandura (1977) observes “people process and synthesize feedback information from sequences of events over long intervals about the situational circumstances and the patterns and rates of actions that are necessary to produce given outcomes” (p. 192). Many of those who used Domain or Implicit Knowledge leveraged this strategy. Consistent with this statement, there has been a routine pattern for various federal agency grant requirements, processes, and grant application cycles. The responses

from the various federal agencies have a predictable format and a period of performance. These also figured prominently in the *Knowledge* and *Grant Writing Process* themes.

Emerging Perspectives

The research identified two emerging perspectives related to Research Questions 1 and 2. These emerging perspectives were Reader-Response Theory and Role Theory.

Genre Theory and the Importance of Reader Response Theory in Grant Writing

As I indicate in Chapter 1, the grant writing genre is unique and valuable in many ways beyond being a persuasive form of scientific writing. Swales (1990) and other linguistic scholars suggest at least three reasons for attempting to understand the genre better. One of the primary reasons is that using the ARDES framework required individuals to mentor and educate faculty members to produce academic and research writing. Within the ARDES framework, federal grant development supports faculty members' efforts toward tenure, their development of a professional reputation as a scholar-researcher, and their acceptance into the ECoP. Myers (1990) and Connor and Mauranen (1999) describe grant writing as something almost all researchers do before publishing articles and a hallmark of achieving professional writing skills.

Further, Widdowson (1979) claims the high number of clearly identifiable syntactic features in a genre is helpful in elucidating scientific authorship; in other words, there is a higher probability of the influence of sociolect in the genre (e.g., identification of insiders versus outsiders). It is essential to acknowledge that many of the grant genre's linguistic and rhetorical studies arose from a desire to improve English-as-a-Second-Language instruction and communication and are closely related to these fields.

Trudgill (1983) defines sociolect as language related to its speakers' social

background (e.g., occupational groups, friendship groups, family groups) rather than the geographical background. Within the ARDES framework, a variety of sociolects are operational, including “SPO,” “Biosketch,” and “Current and Pending.” In the ECoP, there are also multiple sociolects such as “ONR,” “Cost-Volume,” and “TPOC.” Notably, faculty members will benefit by recognizing federal agencies have multiple sociolects, which may be rhetorically advantageous to discern as “the link between language and success,” which has been described by Halliday (2007, p. 175). Iser (1979, 1986) describes a third and critical point of the genre; readers have expectations about what they would read and how it would be communicated. Most often, embedded in the grant reviewers’ expectations are genre-specific notions that the writer was attempting to address as they present a solution to a problem. Thus, the grant genre is highly performance-based and solution-driven. Taken together, meeting the requirements of the genre while communicating their interests and research work can be challenging for early-career, engineering faculty members, and others to overcome without guidance and support. Swales (1990) and others discuss the academic grant proposals’ rhetorical and linguistic hallmark to persuade. Myers (1990) suggests grant proposals are intended to “persuade without seeming to persuade” (p. 42). Notably, grant proposals are not limited to academic institutions; the analyses of ‘rhetorical moves’ have been studied in both academic settings and non-profit arenas (Christensen, 2011; Connor & Mauranen, 1999; Swales, 1981; Swales, 1990).

Within science, technology, engineering, and mathematics, there are attempts to begin to understand grant development through linguistic and rhetorical analyses as well

as quantitative analyses. Christensen (2011) explained competitive NSF CAREER grants' linguistic and rhetorical nuances compared to regular grants. In particular, he notes engineering CAREER grants are constructed differently. Campbell (2000) studies a large number of mathematics and biological sciences faculty members at multiple institutions to develop a 'Federal Funding Success Factors in Biology and Mathematics' model. Cole (2006) acknowledges the competitive grant landscape and seeks "to identify factors that contribute to success in acquiring federal funding" (p. 6) by employing Campbell's model. Cole (2006) demonstrates the effects for biological science faculty who report that they receive NSF funding. The faculty members report 52.8% of them receive additional specialized grant training, and 20.44% receive reduced teaching loads. Notably, over 80% of the biological sciences respondents are tenured. Cole (2006) concludes his results are consistent with Campbell (2000), who found that "dollar value of awards and number of awards" are the most critical factors and that the model could be enhanced to meet better their institutional needs (p. 84).

Role Theory

According to Biddle (1986), Role-Theory has been used to understand positions' roles, expectations, and norms. I would specifically like to examine research development or grant writer roles in various domains. The qualitative data strongly suggest those who perform research development or grant writer roles provide critical domain knowledge to the engineering research proposals. Nevertheless, the details about this information are vague when professional organizations are contacted and when the Bureau of Labor Statistics is queried. However, from NORDP employment postings, it is potentially possible to discern a basis for their domain knowledge in various domains.

Limitations

There are a few limitations of this study that must be noted. The data collection occurred during the COVID-19 pandemic in Utah. Many engineering faculty members had been teaching online, and I, too, had been working online from home for health and safety reasons since March 2020. I was asked to return to the office in May 2021 after my vaccination and faculty members were asked to return in August. Many faculty members were fatigued by the many hours juggling students, family, labs, Zoom, and were looking forward to traveling just as I issued my data collection email in June 2021. I received Letters of Commitment, but many did not start the pre-tests until July 2021 after the holiday. I also asked them to complete two modules to ensure there was comparative data, but in hindsight, it was too much for many early-career engineering faculty members to take on even though the modules were short, and it was summer. These unforeseen issues arose during my study, which are dissimilar to those typically encountered during data collection.

Care must be taken in interpreting data for the faculty members who participated in this study. Specifically, differences in responses may occur among faculty members who represent different disciplinary areas; for example, biological engineering, aerospace engineering, and engineering education faculty members based on areas of interest, background knowledge, and research focus from which they are seeking funding. While the various engineers may apply to the same agency such as the National Science Foundation, and they will all need to be responsive to the same requirements of Intellectual Merit, Broader Impacts, Current and Pending, Biosketch, etc. In other words, despite their disciplines they will need to conform to the requirements and processes of

the agency, but how they respond within each directorate and program may be different. This is where their domain and implicit knowledge may be deeply valuable.

Other limitations include typical threats to validity, including (a) history, (b) maturation, (c) the experimenter effect, and (d) the Hawthorne effect. Threats based upon history, or specific events occurring contemporaneously with the intervention, have been mitigated by the brief timeframes in each module, which are provided. Nevertheless, there is potential for a history threat because some may have explored other related materials, for example, if they did not complete the module in one session. Another area of concern is maturation. Maturation has been mitigated by assessing the constructs in each module's pre- and post-intervention surveys and customizing the modules' content. Data analytics within the modules will provide information about which items were downloaded, clicked upon, and viewed more than once to mitigate history and maturation threats to validity.

The experimenter effect is any influence an individual researcher may bring to the research, particularly the interpretation of the results. APA (2021) defines this as an intentional or unintentional bias that arises due to participant interaction or failure to observe and interpret the data. This type of cognitive bias may arise due to various factors. To a great extent, the experiment effect is mitigated by using three strategies, including (a) the pre- and post-intervention surveys questionnaires are standardized and delivered electronically, (b) the semi-structured interview protocol has standardized questions, and (c) the semi-structured interview is conducted via audio-only in Zoom and is recorded with permission. The Hawthorne effect is a concern because I work with participants in an ECoP. The early-career faculty members may feel treated in a special

manner and participate because I provide the intervention. To mitigate this, I emphasize that their absolute honesty would allow for improvements to be made and that there are no consequences to them personally.

With respect to interpreting the qualitative data, I take several steps to ensure the credibility of interpretations of the data. As noted in the data qualitative data analysis procedures, I employ the constant comparative method throughout the interpretive processes (Strauss and Corbin, 1998). Additionally, I engage in careful reflection at each step of the interpretive process to ensure the data support the new interpretations. I use analytic memos to monitor and direct my interpretive efforts. The use of the MMAR framework also mitigates challenges to credibility by using triangulation.

Implications for Research

Results from this small MMAR research study show early-career engineering faculty members demonstrate modest benefits from the on-demand, online grant writing modules to improve their knowledge about requirements, processes, and skills, as well as attitudes and self-efficacy for grant writing. They express a range of emotions and knowledge, and skills about grant writing and the grant writing process, suggesting there is a substantial amount of work to be done with respect to professional development for these early-career faculty members.

Although the online platform and the microlearning strategy appeal to all of them, their high digital literacy as engineering faculty members likely contributes to the appeal, which may not be accurate for other expert learners.

> Weinstein and Van Mater Stone (1993) indicated the following about experts that make them challenging audiences: a) they know more, b) their knowledge is better organized and integrated, c) they have strategies and methods for getting to knowledge, using it, applying it, and integrating it, and integrating it, d) they have different motivations for their work (multifaceted), and e) they often do things in a self-regulated manner (p.32). (Kessel, 2021, May 24)

Other results from this study indicate experts are highly attuned to specific problems. They are more aware of novices when they check for errors, have difficulty comprehending, and experience frustration. I believe additional research into expert learners, particularly faculty members who are expert grant writers and grant winners, is warranted to explore their highly developed skills and apply those to early-career faculty members who are just beginning the grant writing processes.

In their responses, early-career engineering faculty members provide interesting feedback and suggestions about the future directions for online modules and grant training. It may be interesting to conduct Participatory Action Research (PAR) with engineering or STEM faculty members in the future.

Implications for Practice

The entire research process and feedback from participants provides an opportunity for reflection in every Cycle. I appreciate the sincerity and the thoughtfulness of the professional/classified staff who responded to my initial questions about turnover during Cycle 0. Their responses and time commitment to the study demonstrate how attuned the professional and classified staff are to faculty lives. In addition, during Cycle 1, the engineering early-career faculty members offer thoughtful feedback about their grant writing processes, which inform my Cycle 2 in terms of the need for efficient, professional development in grant writing. I considered multiple online approaches, but none seemed designed for expert learners seeking to develop new skills in a parallel area of expertise. After developing several modules for Cycle 2.5, participants field-tested a module to whether it was “useful” and “informative.” They enjoyed the module and provided aesthetic recommendations because my equipment recorded the modules from home during the pandemic.

Based on the feedback from multiple participants across the action research cycles, I plan to update the curricula and standardize the background. I also want to add more statistics, proposal examples, and infographics to the slides because faculty members seem to appreciate a numerical orientation that appears to be highly motivating to them. Participants also suggest a variety of speakers will enhance the effectiveness of

the modules: this is one I think I could implement. I plan to act upon some of their suggestions based on the Online Learning theme and build on my own ideas related to other agencies. By developing and using the current modules and new ones that will be developed, I hope to build robust support for early-career faculty members in engineering and STEM.

In Summer 2021, I contacted the NSF NCSES because there was a new question on the NSF HERD survey. It was not the graduate students or the post-doctoral students but personnel contributing to research (M. Gibbons, personal communication, July 1, 2021). The data is a little soft because it is a first-year collection, but the number is large. If this data is even one-third accurate, it will begin to identify the thousands of research development professionals and sponsored program personnel that make the ARDES in the U.S. operational. I am watching it. I hope you do too. Dr. Holly Falk-Krzesinski, Founding President of NORDP, stated,

> Research development professionals enhance their institutional competitive advantage through capacity building. And through NORDP, research development professionals enhance the research ecosystem by working beyond institutional boundaries toward collective competitiveness (2021).

Faculty are not alone in the ARDES. Thousands are supporting them who have never been acknowledged until the NSF NCSES requested the data.

Summary

Early-career engineering faculty members are valuable and talented employees who face substantial challenges as they are placed on a probationary employment contract and then reviewed by a committee of their peers for promotion and tenure. To meet the

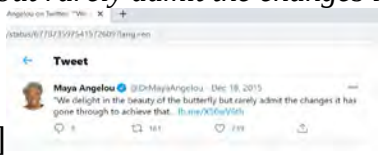
expectations of the promotion and tenure process, most early-career engineering faculty members have more than 50% of their time designated to research, which necessitates grant writing because they need support for their research work. Only a few of the recent participants had received training in grant writing during their graduate programs, yet they will be required to compete for and obtain funding during the majority of their professional academic research careers. I anticipate this MMAR study will contribute to the knowledge in the grant development field. Further, I expect that this work will benefit others by building research capacity among early-career engineering faculty members, and others in the larger engineering research community. Recognition of the contributions of research development professionals in the ARDES has been slow in materializing at universities. Nevertheless, the emergence of multiple professional organizations as well as the new data being gathered in the NSF HERD appears to endorse the contribution of grant development professionals at academic institutions in the future.

Notably, through the use of these modules on grant development, early-career engineering faculty members are supported in a new and innovative way that is attuned to their complex lives. The on-demand, online microlearning format is used because academic, life demands, and requirements are complex. Knowledge of grant writing requirements, skills, and processes should not be a barrier to fulfilling faculty members' dreams of teaching and researching in areas about which they are deeply passionate.

REFERENCES

Addams, L. and Allfred, A.T. (2013). The First Step in Proactively Managing Students' Careers: Teaching Self-SWOT Analysis. Academy of Educational Leadership Journal, *17*(4), 43–51.

Alexander, P.A. (1992). Domain Knowledge: Evolving Themes and Emerging Concerns. *Educational Psychologist*, 27(1), 31—51. doi.org/10.1207/s15326985ep27014

Angelou, M. [@DrMayaAngelou]. (2015, December 18). *We delight in the beauty of the butterfly but rarely admit the changes it has gone through to achieve that*. [Image Attached] 

[Tweet]. Twitter. https://twitter.com/drmayaangelou/status/677873597541572609?lang=en

American Association of University Professionals (AAUP). (1940). *1940 Statement of Principles on Academic Freedom and Tenure with 1970 Interpretive Comments*. AAUP. https://www.aaup.org/file/1940%20Statement.pdf

American Association of University Professionals (AAUP). (2019-2020). *Average Percent Change in Salaries for All Faculty in Nominal and Real Terms for Institutions Reporting Comparable Data for Adjacent One-Year Periods, and Percent Change in the Consumer*. AAUP. 20–21.

American Psychological Association (APA). (2021). *APA Dictionary of Psychology*. APA. https://dictionary.apa.org/experimenter-effect

American Psychological Association (APA). (2021). *APA Dictionary of Psychology*. APA. https://dictionary.apa.org/mirroring

American Psychological Association (APA). (2021). *APA Dictionary of Psychology*. APA. https://dictionary.apa.org/persistence

Austin, A. E., & Rice, R. E. (1998). Making Tenure Viable Listening to Early-career Faculty. *The American Behavioral Scientist*, *41*(5), 736–754. doi.org/10.1177/0002764298041005009

Bandura, A. (1977). *Social Learning Theory*. Prentice Hall.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Clinical and Social Psychology*, *4*, 359–373. doi.org/10.1521/jscp.1986.4.3.359

Bandura, A. (1997). The anatomy of stages of change. *American Journal of Health Promotion, 12*(1), 8–10.

Baumgartner, F.R. (2013). Ideas and Policy Change. *Governance*. 26, 239–258. doi.org/10.1111/gove.12007

Berry, D.C. (1987). The problem of implicit knowledge. *Expert Systems*, *4*(3), 144–152.

Biddle, B. J. (1986). Recent Development in Role Theory. *Annual Review of Sociology, 12*, 67–92. http://www.jstor.org/stable/2083195

Blackburn, H. (2017). The Status of Women in STEM in Higher Education: A Review of the Literature 2007–2017. *Science and Technology Libraries*, *36*(3). doi.org/10.1080/0194262X.2017.1371658

Bluteau, P., Clouder, L., & Cureton, D. (2017). Developing interprofessional education online: An ecological systems theory analysis. *Journal of Interprofessional Care*, *31*(4), 420–428. doi-org.ezproxy1.lib.asu.edu/10.1080/13561820.2017.1307170

Bollinger, D. and Wasilik, O. (2009). Factors influencing faculty satisfaction with online teaching and learning in higher education. Distance Education, *30*(1), 103–116.

Boroush M; National Center for Science and Engineering Statistics (NCSES). 2021. U.S. R&D Increased by $51 Billion in 2018, to $606 Billion; Estimate for 2019 Indicates a Further Rise to $656 Billion. NSF 21-324. Alexandria, VA: National Science Foundation. Available at https://ncses.nsf.gov/pubs/nsf21324/. https://ncsesdata.nsf.gov/herd/2019/html/herd19-dt-tab054.html

Bradbury, H. (2016). Enough with Lewin already! *Action Research*, 14(3), 327–239.

Brandenburg, D.C. and Ellinger, A.D. (2003). The future: Just-in-time learning expectations and potential implications for human resource development. *Advances in Developing Human Resources*, *5*(3), 308–320.

Brinkman, S. and Kvale, S. (2015). (3rd Ed.) *Interviews: Learning the Craft of Qualitative Research Interviewing*. SAGE Publication, Inc.

Bronfenbrenner, U. (1979a). *The Ecology of Human Development: Experiments by Nature and Design*. Harvard University Press.

Bronfenbrenner, U. (1986b). Ecology of the family as a context for human development: Research perspectives. *Developmental Psychology, 22*, 723–742.

Brutkiewicz, R. R. (2012). Research faculty development: An historical perspective and ideas for a successful future. *Advances in Health Sciences Education, 17*(2), 259–268. doi.org/10.1007/s10459-010-9261-4

Buss, R.R. (January 15, 2021) *personal communication*

Campbell, E. D., (2000). *Federal funding success factors in biology and mathematics* (Order No. 9999078). Available from ProQuest Dissertations & Theses Global. (304626847). Retrieved from http://login.ezproxy1.lib.asu.edu/login?url=https://www.proquest.com/dissertations-theses/federal-funding-success-factors-biology/docview/304626847/se-2?accountid=4485

Carroll, D. A. (2005). Are state governments prepared for fiscal crises? A look at revenue diversification during the 1990S. *Public Finance Review*, 33(5), 603–633. doi.org/10.1177/1091142105276440

Carter, R.G., Mundorff, K., Risien, J., Bouwma-Gearhart, J., Bratsch-Prince, D., Brown, S.A., Campbell, A.L., Hartman, J.C., Hasemann, C.A., Hollenbeck, P.J., Lupiani, B., McCarty, O.J.T., McClure, I.D., (2021). Innovation, entrepreneurship, promotion, and tenure. *Science, 373*(6561), 1312–1314. doi.org/10.1126/science.abj2098

Center for American Progress. (2020, November 24). *Performance-Based Funding of Higher Education - Center for American Progress*. https://www.americanprogress.org/issues/education-postsecondary/reports/2012/08/07/12036/performance-based-funding-of-higher-education/

Center for Postsecondary Research Indiana University School of Education. (2020). *The Carnegie Classification of Institutions of Higher Education Look Up*. https://carnegieclassifications.iu.edu/lookup/srp.php?limit=0%2C50&clq=&start_page=lookup.php&backurl=lookup.php&search_string=Utah+State+University&submit=FIND

Charmaz, K. (2014). *Constructing Grounded Theory* (2nd Ed.). Thousand Oaks, CA. SAGE Publications Inc.

Christensen, D.M. (2011). *Understanding the National Science Foundation Career Award Proposal Genre: a rhetorical ethnographic, and system perspective*, Utah State University. https://digitalcommons.usu.edu/etd/923/

Christensen, C. M., & Eyring, H. J. (2011). *The Innovation University*. Jossey-Bass an Imprint of Wiley.

Cole, S. S. (2006). *Federal funding success factors: A replicated quantitative analysis* (Order No. 3238278). Available from ProQuest Dissertations & Theses Global. (304908439). http://login.ezproxy1.lib.asu.edu/login?url=https://www.proquest.com/dissertations-theses/federal-funding-success-factors-replicated/docview/304908439/se-2?accountid=4485

Coleman, J.S. (1988). Social capital in the creation of human capital. American Journal of Sociology. 94 (Suppl.), 546.

Coley, E. & Sabharwal, M. (2007). Foreign-born academic scientists and engineers: Producing more and getting less than their U.S.-born peers? Research in Higher Education., *48*(8), 909–940.

Colie, R. L. (1973). The Resources of Kind: Genre-Theory in the Renaissance. Berkeley University of California Press.

Collins, H. (2010). Tacit & Explicit Knowledge. The University of Chicago Press.

Connor, U. and Mauranen, A. (1999). Linguistic Analysis of Grant Proposals: European Union Research Grant. Sociology, 18(1), 47–62. doi.org/10.1016/S0889-4906(97)00026-4

Council on Government Relations. (1999). *The Bayh-Dole Act: A Guide to the Law and Implementing Regulations*. Council on Government Relations. https://www.cogr.edu/sites/default/files/The_Bayh-Dole_Act-__A_Guide_to_the_Law_and_Implementing_Regulations.pdf

Creswell, J. (2017). Mindfulness Interventions. *Annual review of psychology. 68*(1), 491–516. doi.org/10.1146/annurev-psych-042716-051139

Creswell, J. W. and Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches.* SAGE Publications Ltd.

Creswell, J.W. and Plano-Clark, V.L. (2015). Understanding Research: A consumer's guide (2nd edition). Pearson.

Crotty, M. (1998). The Foundations of Social Research: Meaning and Perspective in the Research Process. SAGE Publications, Inc.

Curran, C. (2008). Online learning and the university. In W.J. Bramble & S. Panda (Eds.), *Economics of distance and online learning: Theory, practice, and research* (pp. 26–51). New York: Routledge.

Davis, F. (1993). User acceptance of information technology system characteristics, user perceptions, and behavioral impacts. *International Journal of Man-Machine Studies*. *38*(3), 475–487. doi.org/10.1006/imms.1993.1022

Deem, R. (2001). Globalisation, New Managerialism, Academic Capitalism and Entrepreneurialism in Universities: Is the local dimension still important? *Comparative Education, 37*(1), 7–20. doi.org/10.1080/03050060020020408

Defense Laboratories Office. (2013). Engagement Guide Department of Defense University Affiliated Research Centers (UARCs). p. 12. https://www.sdl.usu.edu/downloads/uarc-engagement-guide.pdf

De Gagne, J.C., Woodward, A., Park, H. K., Sun, H., Yamane, S.S. (2019). Microlearning in health professions education: a scoping review protocol. *JBI Evidence Synthesis, 17*(6), 1018–1025.

DiPrete, T.A. and Eirich, G.M. (2006). Cumulative advantage as a mechanism for inequality: A review of theoretical and empirical developments. *Annual Review of Sociology*, 32, 271–297. doi.org/10.1146/annurev.soc.32.061604.123127

Duckworth, A. (2016). *Grit: The Power of Passion and Perseverance*. Scribner.

Dundar, H., & Lewis, D. R. (1998). Determinants of Research Productivity in Higher Education. *Research in Higher Education*, *39*(6). 607–631.

Dunlap, C. (2020). Research Competitiveness Program. *Lessons Learned from 10,000 Proposal Reviews: Top Reviewer Criticisms and How to Avoid Them*. American Association for the Advancement of Science.

Ehrenberg, R.G. (2012). American Higher Education in Transition. *Journal of Economic Perspectives*. *26* (1), 193-216. doi/10.1257/jep.26.1.193

Eisenberg, R.S., Robert Cook-Deegan, R. (2018). Universities: The Fallen Angels of Bayh-Dole?. *Daedalus* 2018, *147* (4), 76–89. doi: https://doi.org/10.1162/daed_a_00521

Emerson, L.C., and Berge, Z.L. (2018). Microlearning: Knowledge management applications and competency-based training in the workplace. *UMBC Faculty Collection*. doi.org/10.34105/j.kmel.2018.10.008

Esquivel, L. (1995). *Like Water for Chocolate*. Doubleday.

Eugene, R. (1998). Making tenure viable: Listening to early-career faculty. *The AmericanBehavioral Scientist, 41*(5), 736–754. http://login.ezproxy1.lib.asu.edu/login?url=https://www-proquest-

com.ezproxy1.lib.asu.edu/scholarly-journals/making-tenure-viable-listening-early career/docview/1877229284/se-2?accountid=4485

Falk-Krzesinski, H. (October 15, 2021). personal communication

Festinger, L. (1957). *Theory of Cognitive Dissonance*. Stanford University Press.

Fiedler, S. and Kieslinger, B. (2006). Adapting to Changing Landscapes in Education Micromedia & e-Learning 2.0 Gaining the Big Picture Proceedings of Microlearning Conference. Innsbruck University Press.

Frappaolo, C. (2008). Implicit Knowledge. *Knowledge Management Research & Practice*. *6*. 23–25.

Gaiman, N. (2016). *The View from the Cheap Seats: Selected Nonfiction*. Harper Collins

Galinsky, A.D., Maddux, W.W., Gilin, D., White, J.B., (2008, April). Why it pays to get inside the head of your opponent: the differential effects of perspective taking and empathy negotiations. *Psychological Science*,19(4), 378–384. https://mba.tuck.dartmouth.edu/pages/faculty/judith.white/docs/2008_Galinsky_PS.pdf

Gibbs, G.R. (2012). Thematic Coding and Categorizing. In: *Analyzing Qualitative Data*. SAGE Publications, Ltd.

Gibbons, M. (July 1, 2021). personal communication

Gillies, J., Neimeyer, R.A., and Milman, E. (2014). The Meaning of Loss Codebook: Construction of a System for Analyzing Meanings Made in Bereavement. *Death Studies*,*38*(4), 207–216. doi.org/10.1080/07481187.2013.829367

Glaser, B.G. (1992a). *Basics of grounded theory analysis*. Sociology Press.

Glaser, B.G. (1978b). *Theoretical sensitivity*. Sociology Press.

Greene, J.C. (2007). *Mixed Methods in Social Inquiry*. John Wiley & Sons.

Gustavsen, B. (2014). Social impact and the justification of action research knowledge. *Action Research Journal*, *12*(4), 339–356.

Gustavsen, B. & Plshaugen, Y. (2015). How to succeed in action research without really acting: tracing the development of action research to constructivist practice in organizational worklife. In *The SAGE Handbook of Action Research* (pp. 409-416). SAGE Publications Ltd. doi-org.ezproxy1.lib.asu.edu/10.4135/978147392

Government Accountability Office. (2018). *Science Technology Engineering and Mathematics Education Report to Congressional Committees United States*. Retrieved at https://www.gao.gov/assets/gao-18-290.pdf

Halbach, T. and Solheim, I. (2018). Gamified Micro-learning for Increased Motivation: An Exploratory Study. *International Association for the Development of the Information Society*. *https://files.eric.ed.gov*

Halliday, M.A.K. (2007*). Language and Education: Volume 9*. A&C Black.

Hearn, J. C., & Anderson, M. S. (2002). Conflict in Academic Departments: An Analysis of Disputes Over Faculty Promotion and Tenure. *Research in Higher Education*. *43*(5), 503–529.

Herodotou, C., Rienties, B., Boroowa, A., Zdrahal, Z., and Hlosta, M. (2019). A large-scale implementation of predictive learning analytics in higher education: the teachers' role and perspective. *Education Tech Research Development*, 67, 1273–1306. doi.org/10.1007/s11423-019-09685-0

Hislop, G.W. and Ellis, H.J.C. (2004). A Study of Faculty Effort in Online Teaching. T*he Internet and Higher Education*, *7*(1), 15–31.

Hord, S.H. and Sommer, W.A. (2008). *Leading Professional Learning Communities*. Corwin Press.

Hug, T. (2006). Microlearning: a new pedagogical challenge," *Microlearning: Emerging Concepts, Practices, and Technologies after e-Learning. Proceedings of Microlearning 2005,* Innsbruck University Press. 8–11.

Hug, T. and Friesen, N. (German ed.) (2007). Outline of a microlearning agenda. (T. Hug Ed.) In *Didactics of Microlearning Concepts, Discourses, and Examples*. Waxmann Press. 15–37.

Hurston, Z.N. (1942). *Dust Tracks on a Road*. Harper Perennial.

Ignelzi, M.G. (2000). Meaning-Making in the Learning and Teaching Process. *New Directions for Teaching and Learning, 2000*, 5–14.

Ivankova, N. (2015). *Mixed Methods Applications in Action Research from Methods to Community Action*. SAGE Publications Ltd.

Iser, W. (1974a). *The Implied Reader: Patterns of Communication Prose Fiction from Bunyon to Beckett*. The John Hopkins University Press.

Iser, W. (1986b). *Prospecting: From Reader Response to Literary Anthropology*. The John Hopkins University Press.

Jacobs, P. (2013). The Challenges of Online Courses for the Instructor. Research in the Higher Education Journal. ERIC, 1–20. https://files.eric.ed.gov/fulltext/EJ1064633.pdf

Jaschik, S. (2020, September 23). *New Push for a Shift in Promotion and Tenure: A proposal to add innovation and entrepreneurship to tenure and promotion criteria*. Inside Higher Ed. https://www.insidehighered.com/news/2020/09/30/proposal-add-innovation-and-entrepreneurship-tenure-and-promotion-criteria

Johnson, A. P. (2008). A short guide to action research (3rd ed.). Allyn and Bacon.

Johnson, R.B. and Onwuegbuzie, A.J. (2004). Mixed Methods Research: A Research Paradigm Whose Time has Come. *Educational Researcher*. 33, 14–26. doi.org/10.31012/0013189x033007014

Johnsrud, L. K. and Heck, R.H. (1994). A University's Faculty: Identifying Who Will Leave and Who Will Stay. *Journal for Higher Education Management*, *10*(1), 71–84. https://eric.ed.gov/?id=EJ494998

Johnstone, D. B. (2002). *Article in The Welsh Journal of Education / Cylchgrawn Addysg Cymru*. doi.org/10.16922/wje.11.1.3

Kelly, J. G., Ryan, A. M., Altman, B. E., and Stelzner, S. (2000). Understanding and changing social systems: An ecological view. In J. Rappaport, & E. Seidman (Eds.), *The handbook of community psychology*. 133–159. Plenum.

Kessel, M. (2017, May 9). [Lecture slides on federal agency assessment and analysis]. Situational Awareness. Proposal Writing Institute. Utah State University. usu.app.box.com/file/63827752717

Kessel, M. (n.d.). About [LinkedIn Page] LinkedIn. Retrieved January 2, 2019, https://www.linkedin.com/in/monicakessel413/

Kessel, M. (2021, May 24). [Recorded Lecture & slides on federal agency competitive benchmarks]. Intellectual Merit &Broader Impacts: Strategies to Think About in Design and Reviews. Proposal Writing Institute. Utah State University. usu.app.box.com/file/

Landino, R.A. and Owen, S.V. (1988). Self-efficacy in university faculty. *Journal of Vocational Behavior*. *33*(1), 1–14. doi.org/10.1016/0001-8791(88)90030-9

Langreiter, C. and Bolka, A. (2005). Snips & Spaces: Managing Microlearning. https://bolka.at

Larsen, M. (September 20, 2021). personal communication

Larsen M. (September 29, 2021). personal communication

Lemnios, Z. J. (2010, June 23). *FY 2010 DoD UARC Management Plan*. https://rt.cto.mil/wp-content/uploads/2019/09/UARC-Mgmt-Plan-Jun-23-10-FINAL-6811-with-Signed-Memo.pdf

Leong, K., Sung, A. Au, D., Blanchard, C. (2020). A review of the trend of microlearning. *Journal of Work-Applied Management*. 2205–2062. doi.org/10.1108/JWAM-10-2020-0044

Levin, J. (2011). The Emergence of the Research Development Professional. *The Chronicle of Higher Education*, 1–6. http://chronicle.com/article/The-Emergence-of-the/126906/

Levin, K. et al. (2012). Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Science*, 45, 125–152. doi.org/10.1007/s11077-012-9151-0

Lin, N. (2008). A Network Theory of Social Capital (Eds. Dario Castiglione, Jan van Deth and Guglielmo Wolleb) In *Handbook on Social Capital*, Oxford University Press.

Loescher, S. T. (2018). *Hope as Strategy: The Effectiveness of Innovation of the Mind*. ProQuest.

Mauranen, A. (2019). Academically Speaking. H. Ken and L.C. Wong (Eds.), In *Specialised English: New Directions ESP and EAP Research and Practice*. Routledge https://www.taylorfrancis.com/chapters/edit/10.4324/9780429492082-2/academically-speaking-anna-mauranen?context=ubx&refId=5e8a0736-a01d-4a02-826c-699d6ca058bb

McLeod, S. (2018, February 5). *Cognitive Dissonance*. Simply Psychology. https://www.simplypsychology.org/cognitive-dissonance.html

Miao, K. (2012, August). *Performance-Based Funding of Higher Education A Detailed Look at Best Practices in 6 States*. Center for American Progress. https://cdn.americanprogress.org/wp-content/uploads/issues/2012/08/pdf/performance_funding.pdf?_ga=2.256950155.1411801618.1605472055-115672416.1605472055

Midgley, G. (2020). Systemic Intervention. H. Bradbury (Ed.), In *The Sage Handbook of Action Research*. 157-166. SAGE Publications Ltd. dx.doi.org/10.4135/9781473921290

Midgley G (2008). Systems thinking, complexity and the philosophy of science. *Emergence: Complexity and Organization*, 10(4), 55–73.

Mertler, C. A. (2017). *Action Research* (5th ed.). SAGE Publications, Inc.

Miegroet Van, H. (2018). *Advancement to the Highest Faculty Ranks in Academic STEM: Explaining the Gender Gap at USU*. Utah State University DigitalCommons@USU.

Moore, T. L., & Ward, K. (2010). Institutionalizing Faculty Engagement through Research, Teaching, and Service at Research Universities. *Michigan Journal of Community Service Learning Fall*. http://classifications.carnegiefoundation.org/

Morse, J. M. and Niehaus, L. (2009). *Mixed Method Design: Principles and Procedures*. Left Coast Press.

Muilenburg, L.Y., and Berge, Z.L. (2005). Student barriers to online learning: A factor analytic study, *Distance Education, 26*(1), 29-48, doi.org/10.1080/01587910500081269

Myers, G. (1990). *Writing biology: texts in the social construction of scientific knowledge*. University of Wisconsin Press.

National Academies of Sciences, Engineering, and Medicine (NAEMS). (2016). *Optimizing the Nation's Investment in Academic Research: A New Regulatory Framework for the 21st Century*, Washington, D.C.: The National Academies Press. doi.org/10.17226/21824

National Foundation for American Policy (NFAP). (2017, October 1). The Importance of International Students to American Science and Engineering. NFAP Policy Briefs. Retrieved https://nfap.com/wp-content/uploads/2017/10/The-Importance-of-International-Students.NFAP-Policy-Brief.October-20171.pdf

National Organization for Research Development Professionals (NORDP). (2021). *What is Research Development?* NORDP. https://www.nordp.org/what-is-research-development

National Research Council. (2012). Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. Committee on Defining Deeper Learning and 21st Century Skills, James Editors, Board on Testing and Assessment and Board on Science Education, Division of Behavioral and Social Sciences and Education. National Academies Press. doi.org/10.17226/13398

National Research Council. (2014). *Convergence*. National Academies Press. doi.org/10.17226/18722

National Research Council. (2019). *Fostering the Culture of Convergence in Research.* National Academies Press. doi.org/10.17226/25271

National Science Foundation. (2020). "Proposals and Award Policies and Procedure Guide NSF 20-1 (OMB Control Number 3145-0058). Retrieved August 29, 2020, from https://www.nsf.gov/pubs/policydocs/pappg20_1/nsf20_1.pdf

National Science Foundation. (2019). FY19 Performance and Financial Highlights. Retrieved August 29, 2020, from https://www.nsf.gov/pubs/2020/nsf20003/nsf20003.pdf

National Science Board, National Science Foundation. (2020). *Science and Engineering Indicators 2020: The State of U.S. Science and Engineering*. NSB-2020-1. Alexandria, VA. https://ncses.nsf.gov/pubs/nsb20201/

National Science Foundation (NSF), National Center for Science and Engineering Statistics (NCSES). (2020). *Table 54. Total and federally financed higher education R&D expenditures in engineering, ranked by FY 2018 total: FYs 2015–18 (Dollars in thousands)*. Higher Education Research and Development (HERD) Survey. https://ncsesdata.nsf.gov/herd/2018/html/herd18-dt-tab054.html

National Science Foundation (NSF), National Center for Science and Engineering Statistics (NCSES). (2021). *Table 54. Total and federally financed higher education R&D expenditures in engineering, ranked by FY 2019 total: FYs 2015–19 (Dollars in thousands)*. Higher Education Research and Development (HERD) Survey. https://ncsesdata.nsf.gov/herd/2019/html/herd19-dt-tab054.html

Northeast Sustainable Agriculture Working Group (NESAWG) & United States Department of Agriculture (USDA). (2020). *Map of Land Grant Universities | NESAWG*. USDA, Northeast Sustainable Agriculture Working Group. https://nesawg.org/resources/map-land-grant-universities

Nunnally, J. C. (1978) Psychometric Theory. (2nd ed.) New York: McGraw-Hill.

Nunnally, J. C., Bernstein, I. H. (1994) Psychometric Theory. (3rd ed.) New York: McGraw-Hill.

Office of Management & Budget (OMB). (2020). *Part 200-Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards Subpart A-Acronyms and Definitions Acronyms*.

Office of Naval Research (2020). About ONR. Scientific Review. Other Information https://www.onr.navy.mil/work-with-us/funding-opportunities

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and policy in mental health*, *42*(5), 533–544. doi:10.1007/s10488-013-0528-y

Park, S. M. (1996). Research, Teaching, and Service: Why Shouldn't Women's Work Count? *The Journal of Higher Education. 67*(1), 46–84. doi.org/10.1080/00221546.1996.11780249

Parker, A. (2003). Motivation and incentives for distance faculty. *Online Journal of Distance Learning Administration*. 6(3). http://www.westga.edu/~distance/ojdla/fall63/parker63.htm

Patel, L. (2015). Desiring Diversity and Backlash: White Property Rights in Higher Education. *Urban Review*. 47, 657–675. https://doi.org/10.1007/s11256-015-0328-7

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods* (3rd ed). SAGE Publications Ltd.

Peirson, L. J., Boydell, K. M., Ferguson, H. B., & Ferris, L. E. (2011). An Ecological Process Model of Systems Change. *American Journal of Community Psychology, 47*(3–4), 307–321. doi.org/10.1007/s10464-010-9405-y

Phillips, D.C. (1987). *Philosophy, science, and social inquiry.* Pergamon Press.

Portes, A. (1998). Social Capital: Its Origins and Applications in Modern Society. *Annual Review of Sociology*, 24, 1–24. doi.org/10.1146/annurev.soc.24.1.1.

Prensky, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon* (MCB University Press). 9(5), 1–6. https://marcprensky.com

Quadlin, N. (2018). The Mark of a Woman's Record: Gender and Academic Performance in Hiring. *American Sociological Review*, *83*(2). doi.org/10.1177/0003122418762291

Rausch, D. K. (1989). The Academic Revolving Door: Why Do Women Get Caught? ADVANCE Library Collection. Paper 560. *CUPA Journal*, 40(1), 1–16. http://digitalcommons.usu.edu.advance/560

Roy, J. (2019, July 15). *Engineering By the Numbers*. American Association for Engineering Education. www.asee.org/colleges

Rovito, S.M., Kaushik, D., Aggarwal, S.A. (2021, August 30). The impact of international scientists, engineers, and students on U.S. research outputs and global Competitiveness. (J. Shalhut and Y. Petri Eds.) *MIT Science Policy Review*. 2, 15–25.

Sabharwal, M., & Corley, E. (2009). Faculty job satisfaction across gender and discipline. *Social Science Journal*, *46*(3), 539–556. doi.org/10.1016/j.soscij.2009.04.015

Saldaña, J. (2016). *The Coding Manual for Qualitative Researchers* (3rd Ed.). SAGE Publications, Inc.

Salkind, N. (2010). *Encyclopedia of Research Design* (N. Salkind, Ed.). SAGE Publications, Inc. doi.org/10.4135/9781412961288

Seneca, L.A. (2020, September 12). *Quotable Quote*. Goodreads. https://www.goodreads.com/quotes/17490-luck-is-what-happens-when-preparation-meets-opportunity

Serrano Velarde, K. (2018). The Way We Ask for Money… The Emergence and Institutionalization of Grant Writing Practices in Academia. *Minerva*, *56*(1), 85–107. doi.org/10.1007/s11024-018-9346-4

Shin, N., Choi, S., Stevens, S.Y., Krajcik, J.S. (2017). The Impact of Using Coherent Curriculum on Students' Understanding of Core Ideas in Chemistry. International Journal of Science and Math Education, 17, 295–315. doi.org/10.1007/s10763-017-9861-z

Siemens, G. German ed.) (2007). Connectivism: Creating a Learning Ecology in Distributed Environments. (T. Hug Ed.) In *Didactics of Microlearning Concepts, Discourses, and Examples*. 53-67. Waxmann Press.

Slaughter, S., & Leslie, L. L. (1997). *Academic Capitalism: Politics, Policies, and the Entrepreneurial University*. John Hopkins University Press. 6–17.

Smart, J.C. (1990). A causal model of faculty turnover intentions. *Research High Education.* 31, 405–424. doi.org/10.1007/BF00992710

Stankovic, J. and Aspray, W. (2003). *Recruitment and Retention of Faculty in Computer Science and Engineering*. Computing Research Association. 35–36. https://archive.cra.org/reports/r&rfaculty.pdf

Strauss, A., and Corbin, J.M. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Sage Publications, Inc.

Sullivan, K. (Principal Investigator). (2008-2012). ADVANCE Partnerships for Adaptation, Implementation, and Dissemination (PAID) Award: PROMOTE - Improving the promotion to full processes at western public universities (Project No. 0820273) [Grant]. National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=0820273&HistoricalAwards=false

Sullivan, T. A., Mackie, C., Massy, W. F., & Sinha, E. (2013). Improving measurement of productivity in higher education. In *Improving Measurement of Productivity in Higher Education*. National Academies Press. doi.org/10.17226/13417

Swales J. (1981). Aspects of article introductions. *Aston ESP Research Reports*, 1. Republished by Michigan University Press (2011).

Swales J. (1990). *Genre Analysis: English in Academic and Research Settings*. Cambridge University Press

The Carnegie Classification Institution of Higher Education. (2020). *Basic Carnegie Classifications Description*. https://carnegieclassifications.iu.edu/classification_descriptions/basic.php

Tahmooresnejad L, Beaudry C. (2018, 29 August). Do patents of academic funded researchers enjoy a longer life? A study of patent renewal decisions. *PLOS ONE*, 13(8): e0202643. doi.org/10.1371/journal.pone.0202643

Tardy, C.M. (2003). A genre system view of the funding of academic research. *Written Communication*. 20(1), 7–36. https://doi.org/10.1177/07410883003253569

Tashakkori, A. and Teddlie, C. (1998). *Mixed Methodology: Combined Qualitative and Quantitative Approaches*. SAGE Publications Ltd.

Tashakkori, A. and Teddlie, C. (2002). *Handbook of Mixed Methods*. Sage Publications, Inc.

Thomas, J. R. (2016). *March-In Rights Under the Bayh-Dole Act*. www.crs.gov

Thurner, S., Klimek, P., and Hanel, R. (2018). *Introduction to the Theory of Complex Systems*. OxfordUniversity Press.

Trudgill, P. (1983). *On-dialect: Social and geographical perspectives*. Wiley-Blackwell

Tseng, V., & Seidman, E. (2007). A systems framework for understanding social settings. *American Journal of Community Psychology*, *39*(3–4), 217–228. doi.org/10.1007/s10464-007-9101-8

U.S. Congress. (1862, July 2). *Land-Grant College Act*. Morrill Act. https://www.senate.gov/artandhistory/history/resources/pdf/Land_Grant_College_Act_1.pdf

usaspending.gov. (2021, September 30). Spending Explorer: *Grants and Fixed Charges*. usaspending.gov. usaspending.gov/explorer/object_class

Utah State University. (1997). *Policy Manual Faculty Number 405 Subject: Tenured and Term Appointments: Evaluation, Promotion and Retention Effective*.

Utah State University. (2021). *Policy Manual Faculty Number 405 Subject: Tenured and Term Appointments: Evaluation, Promotion, and Retention Effective*. https://www.usu.edu/policies/405/

Utah State University. (2020a). *Utah State University History and Traditions*. usu.edu/about/history/

Utah State University. (2020b). *Utah State University Policy 405: Tenured and Term Appointments: Evaluation, Promotion, and Retention*. https://www.usu.edu/policies/405/

Utah State University. (2020c). *Utah State University Statewide Campuses*. statewide.usu.edu/locations

Utah State University College of Engineering. (2013). Creating Tomorrow Fall 2013. *Creating Tomorrow Fall*. https://digitalcommons.usu.edu/engineering_magazines/2

Utah State University College of Engineering. (2014). Creating Tomorrow Today Fall 2014. *Utah State University College of Engineering*. https://digitalcommons.usu.edu/engineering_magazines/1

Utah State University College of Engineering. (2020a). *College of Engineering Retreat Fall 2020*.

Utah State University College of Engineering. (2020b). *Utah State University College of Engineering Accreditation & Assessment*. https://engineering.usu.edu/about/abet

Utah State University College of Engineering. (2021). *College of Engineering Retreat Fall 2021*.

Utah State University College of Engineering, & Jensen, M. (2017). Utah State Engineer Fall 2017. *Utah State Engineer Fall 2017* (Issue Fall). yumpu.com/en/document/view/59456642/utah-state-engineer-fall-2017

Utah State University College of Engineering, & Jensen, M. (2018). Utah State Engineer 2018. *Utah State Engineer 2018* (Issue Fall). yumpu.com/en/document/view/62171625/utah-state-engineer-2018

Utah State University College of Engineering, & Jensen, M. (2019). Utah State Engineer | 2019. In *Utah State Engineer | 2019*. yumpu.com/en/documents/read/62898162/utah-state-engineer-2019

Utah State University College of Engineering, & Jensen, M. (2020). Utah State Engineer | 2020. In *Utah State Engineer | 2020*. yumpu.com/en/documents/read/64641206/utah-state-engineer-2020

Utah State University College of Engineering, & Jensen, M. (Ed.). (2015). Creating Tomorrow 2015. In *Creating Tomorrow 2015*. yumpu.com/en/documents/read/54511643/creating-tomorrow-2015-flipbook

Utah State University College of Engineering, & Jensen, M. (Ed.). (2016). Creating Tomorrow Fall 2016. In *Creating Tomorrow Fall 2016*. yumpu.com/en/document/view/56087914/creating-tomorrow-fall-2016

Utah State University Kuali, & Perry, D. (2020). *Proposals 2013-2020*.

Utah State University Office of Analysis, Assessment, and Accreditation. (2020). USU: Faculty. usu.edu/aaa/employee.cfm

Utah State University Office of Analysis, Assessment, and Accreditation. (2020). *Fall FTE (Full Time Equivalent) by Overall Level*. https://usu.edu/aaa/enrollmentsataglance.cfm

Utah State University Office of Controller. (2020). *2020 Annual Financial Report*. https://www.usu.edu/controllers/files/reports/2020-Financial-Report.pdf

Utah State University Office of Research. (2019, May). *Office of Research Utah State University 2019 Annual Report*. research.usu.edu/wp-cotent/uploads/2020/05/Annual-Reports-2019-FINAL.pdf

Utah State University Office of Legal Affairs (2021, July-Oct.) Start-up Packages for Engineering 2013-2019. (USU GRAMA Request)

Utah State University Sponsored Programs Office. (2013). *Utah State University Awards by College For Period June 2013*. (USU GRAMA Request)

Utah State University Office of Research Sponsored Programs Office. (2020). *Research Awards June 2020*. (USU GRAMA Request)

Varadarajan, D. (Spring 2016). Of Fences and Definite Patent Boundaries, *Vanderbilt Journal of Entertainment and Technology Law*, 18, p. 18.

Vasil, L. Self-efficacy expectations and causal attributions for achievement among male and female university faculty. *Journal of Vocational Behavior*, 43(3), 259-269. doi.org/10.1016/0001-8791(92)90028-X

Wankat (2002). Improving Engineering and Technology Education by Applying What is Known About How People Learn. *Journal of SMET Education*, 3(1&2), 1-6.

Weinstein, C.E. and Van Mater Stone, G. (1993). Broadening Our Conception of General Education: The Self-Regulated Learner. *New Directions in Community Colleges*, 81, 31–39.

Wenger, E. (1998). *Communities of Practice Learning, Meaning, and Identity* (J. S. Brown, Ed.). Cambridge University Press.

Widdowson, G.W. (1979). *Explorations in Applied Linguistics.* Oxford University Press.

Wilson, K., & Korn, J. H. (2007). Attention during Lectures: Beyond Ten Minutes. *Teaching of Psychology*, *34*(2), 85–89. doi.org/10.1080/00986280701291291

Xu, Y.J. (2008). Gender disparity in STEM Disciplines: A Study of Faculty Attrition and Turnover Intentions. *Research in Higher Education*, 49, 609–624. doi.org/10.1007/s11162-008-9097-4

Zeng, X., Duch, J., Sales-Pardo, M., Moreira, J., Ribeiro, H., Amaral, L., Radicchi, F., & Woodruff, T. (2016). Differences in Collaboration Patterns across Discipline, Career Stage, and Gender. *PLoS Biology*, *14*(11). doi.org/10.1371/journal.pbio.1002573

APPENDIX A

ARIZONA STATE UNIVERSITY INTERNAL REVIEW BOARD (IRB) LETTER

EXEMPTION GRANTED

Ray Buss
Division of Educational Leadership and Innovation - West Campus
602/543-6343
RAY.BUSS@asu.edu

Dear Ray Buss:

On 10/18/2021 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	Enhancing Engineering Early-career Faculty Awareness of Research Requirements, Processes, and Skills in Grant Writing Using an On-demand, Online Intervention
Investigator:	Ray Buss
IRB ID:	STUDY00013934
Funding:	None
Grant Title:	None
Grant ID:	None

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 10/18/2021.

In conducting this protocol, you are required to follow the requirements listed in theINVESTIGATOR MANUAL (HRP-103).

If any changes are made to the study, the IRB must be notified at research.integrity@asu.edu to determine if additional reviews/approvals are required. Changes may include but not limited to revisions to data collection, survey and/or interview questions, and vulnerable populations, etc.

Sincerely,

IRB Administrator

cc: Monica Kessel

APPENDIX B

LETTER OF CONSENT

Dear Colleague:

My name is Monica Kessel, and I am a doctoral student in the Mary Lou Fulton Teachers College (MLFTC) at Arizona State University (ASU). I am working under the direction of Dr. Ray Buss, a faculty member in MLFTC. This study will measure the impact of an intervention designed to benefit early-career engineering faculty members who are attempting to develop skills in federal grant writing related to requirements, processes, and skills and assess your attitudes and self-efficacy following the completion of the on-demand online module(s) toward grant writing.

We are asking for your help, which will involve your participation concerning your knowledge, experiences, attitudes, and beliefs about personal details related to your experience after you have accessed the on-demand, online modules developed by Monica Kessel for early-career engineering facultymembers related to federal grant writing topics. There are three components to participating in this intervention research: (a) the pre-/post-survey test (i.e., 10-12 minutes), which will be taken in Qualtrics online before and after each of the on-demand, online modules, (b) you will then participate in online modules of your choice, and (c) finally, I would like to conduct an interview with some of you about the online modules and grant writing afterward. The online modules vary in duration between 14 and 47 minutes. Each is segmented by topic and is intentionally brief. We anticipate the one-time interview to take 20-30 minutes total. I would like to audio record this interview using Zoom to facilitate transcription.The interview will not be recorded without your permission. Please let me know if you do not want the interview to be recorded, you also can change your mind after the interview starts. Just let me know. You can select two to five modules from the following:
Module 1: Why should you resubmit your National Science Foundation (NSF) grant?
Module 2: What federal opportunities are available for early-career awards?
Module 3: What are the differences between a data sharing plan and a data management plan?
Module 4: How do I draft an Office of Naval Research (ONR) white paper?
Module 5: Do you leverage special organization statuses in your grants?

Participants for this study have been identified and verified using a master list from the College of Engineering public profile. This data will be kept on file for seven years in encrypted cloud storage. This data will be kept separate from a master participant list, which will contain each participant's unique identifier, department, and institution to protect the participant's confidentiality.

Your participation in this study is voluntary. If you choose not to participate or withdraw from the studyat any time, there will be no penalty whatsoever. You must be 18 years of age or older to participate and an engineering tenure-track faculty member.

In the survey, to protect your confidentiality, I will ask you to create a unique identifier known only to you. To create this unique code, use the first three letters of your mother's first name and the last four digits of your phone number. For example, if your mother's name was Sarah, and your phone number was
(435) XXX-6789, your code would be SAR6789. The unique identifier will allow us to match your post- intervention survey and interview responses and your retrospective, pre-intervention responses when we analyze the data. The benefit of participation is the opportunity for you to reflect on and think more aboutthe potential for on-demand, online support to be provided to faculty members from the university and engineering faculty.

Interview responses will also inform future iterations of the study and likely lead to future efforts to support talented faculty. Thus, there is potential to enhance the experiences of our future faculty and students. There are no foreseeable risks or discomforts to your participation.

Your responses will be confidential. Results from this study may be used in reports, presentations, or publications, but your name will not be used. The information you provide will be de-identified becauseof your unique identifier. If you have any questions concerning the research study, please contact the research team–Dr. Ray Buss at ray.buss@asu.edu or (602) 543-6343 or Monica Kessel at mlkessel@asu.edu or (208) 329-6905.

Thank you,

Monica Kessel, Doctoral Student

Ray Buss, Professor

Please let me know if you wish to be part of the study and audio record your responses by verbally indicating your consent. If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact Dr. Ray Buss at (602) 543-6343 or the Chair of Human Subjects Institutional Review Board through the ASU Office of Research Integrity and Assurance at (480) 965-6788.

Consent Statement

By providing my signature below, I provide consent for my data in the pre-/post-test survey questionnaires and interview protocol to be used by Monica Kessel, an Arizona State University doctoralstudent in the MLFTC.

Print Full Name

Signature

Signing here indicates that your knowledge of and consent to the terms outlined in the preceding disclaimer. You will not be able to continue unless a signature is provided. Thank you.

Date MM/DD/YYYY

APPENDIX C

SURVEY QUESTIONNAIRE MODULE 1 NSF RESUBMISSIONS

Mary Lou Fulton Teachers College
Arizona State University

Deidentifier

ID. I release permission for my deidentified responses to be used for the Arizona State University doctoral dissertation by Monica Kessel. By participating in this survey you are consenting to the use of your information in the proposed research. In the survey, to protect your confidentiality, I am asking you to create a unique identifier known only to you. To create this unique code, use the first three letters of your mother's first name and the last four digits of your phone number. Thus, for example, if your mother's name was Sarah and your phone number was (435) XXX-6789, your code would be SAR6789. The unique identifier will allow us to match your post-intervention survey responses and your retrospective, pre-intervention responses when we analyze the data.

Question Block 1

Q1. I have the appropriate registrations and agency IDs to apply for the National Science Foundation (NSF) grant Resubmission, etc.

- ○ Strongly agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q2. I can successfully meet the NSF grant Resubmission required specifications.

- ○ Strongly agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q3.
I can write my ideas well enough to meet NSF Resubmission requirements.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q4.
My NSF grant Resubmission will meet the priorities of the program and agency.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 2

Q5.
I can route the NSF grant Resubmission to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q6. I can conduct information gathering or reconnaissance for an NSF grant Resubmission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q7. The request for application or solicitation related to my NSF Resubmission and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q8. There is alignment between my scope of work and the NSF priorities.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q9. I can develop appropriate NSF Resubmission grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q10.
I can communicate my methodology and techniques effectively in my NSF Resubmission

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 3

Q11. I can talk to an NSF program officer about the new grant project.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q12.
I can establish the need for this NSF Resubmission and the new research.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q13. My NSF project summary reflects my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q14. I can clearly articulate how my team and/or I am uniquely qualified to do the work.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q15.
I can demonstrate a connection between the research and teaching in my NSF Resubmission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 4

Q16.
I look forward to brainstorming new grant ideas.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree

Q17. I value being supported by my colleagues and department when I draft my NSF Resubmission.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q18. I enjoy collaborating with other departments and/or other universities.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q19. I have a positive attitude towards writing federal grants.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q20. I appreciate the grant writing process because I feel positive, creative energy.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q21. I enjoy writing the education and training portion of a grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q22. I am confident that I can identify the right collaborator for my NSF Resubmission.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q23.
I am confident that I can write a fundable grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q24.
I am confident that I can communicate with a program officer about my NSF Resubmission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q25.
I am confident that I can prepare my NSF Resubmission on-time and within budget.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q26.
I am confident that I can communicate my expertise in a variety of ways to NSF.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q27.
I am certain I can write an innovative grant in my field.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q28. What is your tenure rank?

- ☐ Assistant Professor
- ☐ Associate Professor
- ☐ Professor
- ☐ _____ Other

Q29. What is your department?

- ○ Mechanical & Aerospace Engineering
- ○ Electrical & Computer Engineering
- ○ Civil & Environmental Engineering
- ○ Biological Engineering
- ○ Engineering Education
- ○ Chemical Engineering
- ○ Other

Q30. Are you in a tenure track position?

- ○ Yes
- ○ No

Q31. What is your gender?

- ○ Male
- ○ Female
- ○ Non-binary
- ○ _____ Other

Q32. What is your race?

- ○ White
- ○ Black or African American
- ○ American Indian or Alaska Native
- ○ Asian
- ○ Native Hawaiian or Pacific Islander
- ○ _____ Other

Q33. What is your ethnicity?

- O Hispanic/Latino/ or of Spanish origin
- O Not Hispanic or Latino

Q34. What age group do you belong?

- O 18 - 24
- O 25 - 34
- O 35 - 44
- O 45 - 54
- O 55 - 64
- O 65 - 74
- O 75 - 84
- O 85 or older

Q35. What is your marital status?

- O Married
- O Widowed
- O Divorced
- O Separated
- O Never married

Q36. Do you have children under the age of 18 years of age?

- O Yes
- O No

APPENDIX D

SURVEY QUESTIONNAIRE MODULE 2 EARLY-CAREER AWARDS

Mary Lou Fulton Teachers College
Arizona State University

Deidentifier

ID. I release permission for my deidentified responses to be used for the Arizona State University doctoral dissertation by Monica Kessel. By participating in this survey you are consenting to the use of your information in the proposed research. In the survey, to protect your confidentiality, I am asking you to create a unique identifier known only to you. To create this unique code, use the first three letters of your mother's first name and the last four digits of your phone number. Thus, for example, if your mother's name was Sarah and your phone number was (435) XXX-6789, your code would be SAR6789. The unique identifier will allow us to match your post-intervention survey responses and your retrospective, pre-intervention responses when we analyze the data.

Question Block 1

Q1. I have the appropriate registrations and agency IDs to apply for the NSF CAREER.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q2. I have the appropriate registrations and agency IDs to apply for the DOE Early Career Awards.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q3. I have the appropriate registrations and agency IDs to apply for the ONR YIP.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q4. I can successfully meet the NSF CAREER required specifications.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q5. I can successfully meet the ONR YIP required specifications.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q6. I can successfully meet the DOE Early Career required specifications.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q7.
I can write my ideas well to meet early career program requirements for NSF CAREER.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q8.

I can write my ideas well to meet early career program requirements for ONR YIP.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q9.

I can write my ideas well to meet early career program requirements for DOE Early Career.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q10.

My NSF CAREER grant will meet the priorities of the program and agency.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q11.
My ONR YIP grant will meet the priorities of the program and agency.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q12.
My DOE Early Career grant will meet the priorities of the program and agency.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 2

Q13.
I can route the early career grant to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q14. I can conduct information gathering or reconnaissance for an NSF CAREER.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q15. I can conduct information gathering or reconnaissance for an ONR YIP.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q16. The request for application or solicitation related to my NSF CAREER and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q17. The request for application or solicitation related to my early career grant and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q18. There is alignment between my scope of work and the agency's priorities.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q19. I can develop appropriate early career grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q20.
I can communicate my methodology and techniques effectively in my early career grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 3

Q21. I can talk to an NSF program officer about the new early career grant project.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q22.
I can establish the need for this early career award and the new research.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q23. My project summary reflects my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q24. I can clearly articulate how my team and/or I am uniquely qualified to do the work.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q25.
I can demonstrate a connection between the research and teaching in my NSF CAREER.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 4

Q26.
I look forward to brainstorming new grant ideas.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q27. I value being supported by my colleagues and department when I draft my early career grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q28. I enjoy collaborating with other departments and/or other universities.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q29. I have a positive attitude towards writing federal grants.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q30. I have a positive attitude towards writing federal grants.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q31. I appreciate the grant writing process because I feel positive, creative energy.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q32. I enjoy writing the education and training portion of a grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q33. I am confident that I can identify the right collaborator(s) for my NSF CAREER.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q34. I am confident that I can identify the right collaborator(s) for my ONR YIP.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q35.
I am confident that I can write a fundable grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q36.
I am confident that I can communicate with a program officer about my NSF CAREER.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q37.
I am confident that I can prepare my early career grant on-time and within budget.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q38.

I am confident that I can communicate my expertise in a variety of ways to the federal agency.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q39.

I am certain I can write an innovative grant in my field.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q40. What is your tenure rank?

- ☐ Assistant Professor
- ☐ Associate Professor
- ☐ Professor
- ☐ [ ] Other

Q41. What is your department?

- O Mechanical & Aerospace Engineering
- O Electrical & Computer Engineering
- O Civil & Environmental Engineering
- O Biological Engineering
- O Engineering Education
- O Chemical Engineering
- O Other

Q42. Are you in a tenure track position?

- O Yes
- O No

Q43. What is your gender?

- O Male
- O Female
- O Non-binary
- O [ ] Other

Q44. What is your race?

- O White
- O Black or African American
- O American Indian or Alaska Native
- O Asian
- O Native Hawaiian or Pacific Islander
- O [ ] Other

Q45. What is your ethnicity?

- O Hispanic/Latino/ or of Spanish origin
- O Not Hispanic or Latino

Q46. What age group do you belong?

- O 18 - 24
- O 25 - 34
- O 35 - 44
- O 45 - 54
- O 55 - 64
- O 65 - 74
- O 75 - 84
- O 85 or older

Q47. What is your marital status?

- O Married
- O Widowed
- O Divorced
- O Separated
- O Never married

Q48. Do you have children under the age of 18 years of age?

- O Yes
- O No

APPENDIX E

SURVEY QUESTIONNAIRE MODULE 3

DATA SHARING AND DATA MANAGEMENT

Mary Lou Fulton Teachers College
Arizona State University

Deidentifier

ID. I release permission for my deidentified responses to be used for the Arizona State University doctoral dissertation by Monica Kessel. By participating in this survey you are consenting to the use of your information in the proposed research. In the survey, to protect your confidentiality, I am asking you to create a unique identifier known only to you. To create this unique code, use the first three letters of your mother's first name and the last four digits of your phone number. Thus, for example, if your mother's name was Sarah and your phone number was (435) XXX-6789, your code would be SAR6789. The unique identifier will allow us to match your post-intervention survey responses and your retrospective, pre-intervention responses when we analyze the data.

Question Block 1

Q1. I have the appropriate registrations and agency IDs to apply for a federal grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q2. I can successfully meet the required specifications for an National Science Foundation (NSF) data management plan (DMP).

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q3. I can successfully meet the required specifications an National Institutes of Health (NIH) data sharing plan.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q4.

I can write my ideas clear enough to meet NSF data management plan requirements for my directorate (e.g., CMMI, CISE, EHR).

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q5.

I can write my ideas clear enough to meet NIH data sharing plan requirements for my institute (e.g., NIAID, NCI, NEI).

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q6.

My grant will meet the priorities of the program and agency.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 2

Q7.
I can route the NSF grant including the data management plan to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q8.
I can route the NIH grant including the data sharing plan to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q9. I can conduct information gathering or reconnaissance for an NSF data management plan.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q10. I can conduct information gathering or reconnaissance for an NIH data sharing plan.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q11. The request for application or solicitation related to my NSF data management plan and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q12. The request for application or solicitation related to my NIH data sharing plan and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q13. There is alignment between my scope of work and the NSF priorities.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q14. There is alignment between my scope of work and the NIH priorities.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q15. I can develop appropriate NSF data management plan grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q16. I can develop appropriate NIH data sharing plan grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q17.
I can communicate my methodology and techniques effectively in my federal grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 3

Q18. I can talk to an NSF program officer about the new grant project.

- ○ Strongly agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q19. I can talk to an NIH program officer about the new grant project.

- ○ Strongly agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q20.
I can establish the need for the NSF data management costs and the new research.

- ○ Strongly agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q21.
I can establish the need for the NIH data sharing costs and the new research.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q22. My NSF project summary reflects my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q23. My NIH Specific Aims reflects my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q24. I can clearly articulate how my team and/or I am uniquely qualified to do the work.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q25.
I can demonstrate a connection between the data collection conducted in the research and teaching in my NSF data management.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 4

Q26.
I look forward to brainstorming new grant ideas.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q27. I value being supported by my colleagues and department when I draft my data management plan.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q28. I enjoy collaborating with other departments and/or other universities.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q29. I have a positive attitude towards writing federal grants.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q30. I appreciate the grant writing process because I feel positive, creative energy.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q31. I enjoy writing the education and training portion of a grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q32. I am confident that I can identify the right collaborator for my NSF grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q33. I am confident that I can identify the right collaborator for my NIH grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q34.
I am confident that I can write a fundable grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q35.

I am confident that I can communicate with a program officer about my data management plan.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q36.

I am confident that I can prepare my data management plan on-time and within budget.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q37.

I am confident that I can prepare my data sharing plan on-time and within budget.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q38.

I am confident that I can communicate my expertise in a variety of ways to NSF.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q39.

I am confident that I can communicate my expertise in a variety of ways to NIH.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q40.

I am certain I can write an innovative grant in my field.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q41. What is your tenure rank?

- ☐ Assistant Professor
- ☐ Associate Professor
- ☐ Professor
- ☐ _____ Other

Q42. What is your department?

- O Mechanical & Aerospace Engineering
- O Electrical & Computer Engineering
- O Civil & Environmental Engineering
- O Biological Engineering
- O Engineering Education
- O Chemical Engineering
- O Other

Q43. Are you in a tenure track position?

- O Yes
- O No

Q44. What is your gender?

- O Male
- O Female
- O Non-binary
- O [ ] Other

Q45. What is your race?

- O White
- O Black or African American
- O American Indian or Alaska Native
- O Asian
- O Native Hawaiian or Pacific Islander
- O [ ] Other

Q46. What is your ethnicity?

- O Hispanic/Latino/ or of Spanish origin
- O Not Hispanic or Latino

Q47. What age group do you belong?

- O 18 - 24
- O 25 - 34
- O 35 - 44
- O 45 - 54
- O 55 - 64
- O 65 - 74
- O 75 - 84
- O 85 or older

Q48. What is your marital status?

- O Married
- O Widowed
- O Divorced
- O Separated
- O Never married

Q49. Do you have children under the age of 18 years of age?

- O Yes
- O No

APPENDIX F

SURVEY QUESTIONNAIRE MODULE 4

ONR WHITE PAPER

Mary Lou Fulton Teachers College
Arizona State University

Deidentifier

ID. I release permission for my deidentified responses to be used for the Arizona State University doctoral dissertation by Monica Kessel. By participating in this survey you are consenting to the use of your information in the proposed research. In the survey, to protect your confidentiality, I am asking you to create a unique identifier known only to you. To create this unique code, use the first three letters of your mother's first name and the last four digits of your phone number. Thus, for example, if your mother's name was Sarah and your phone number was (435) XXX-6789, your code would be SAR6789. The unique identifier will allow us to match your post-intervention survey responses and your retrospective, pre-intervention responses when we analyze the data.

Question Block 1

Q1. I have the appropriate registrations and agency IDs to apply for an Office of Naval Research (ONR) white paper.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q2. I can successfully meet the ONR white paper required specifications.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q3.

I can write my ideas well enough to meet ONR white paper requirements.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q4.
My ONR white paper will meet the priorities of the program and agency.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 2

Q5.
I can route the ONR white paper to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q6. I can conduct information gathering or reconnaissance for an ONR white paper.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q7. The request for application or solicitation related to my ONR white paper and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q8. There is alignment between my scope of work and the ONR technical priorities.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q9. I can develop appropriate ONR grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q10.

I can communicate my methodology and techniques effectively in my ONR grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 3

Q11. I can talk to an ONR program officer about the new grant project.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q12.
I can establish the need or naval relevance for the ONR white paper topic.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q13. My ONR abstract reflects my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q14. I can clearly articulate how my team and/or I am uniquely qualified to do the work.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q15.
I can demonstrate a connection between the research and teaching in my ONR white paper.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 4

Q16.
I look forward to brainstorming new grant ideas.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q17. I value being supported by my colleagues and department when I draft my ONR white paper.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q18. I enjoy collaborating with other departments and/or other universities.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q19. I have a positive attitude towards writing federal grants.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q20. I appreciate the grant writing process because I feel positive, creative energy.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q21. I enjoy writing the education and training portion of a grant.
Q22. I am confident that I can identify the right collaborator for my ONR white paper.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q23.
I am confident that I can write a fundable grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q24.
I am confident that I can communicate with a program officer about my ONR research topic.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q25.
I am confident that I can prepare my ONR grant on-time and within budget.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q26.
I am confident that I can communicate my expertise in a variety of ways to ONR.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q27.
I am certain I can write an innovative grant in my field.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q28. What is your tenure rank?

- ☐ Assistant Professor
- ☐ Associate Professor
- ☐ Professor
- ☐ [ ] Other

Q29. What is your department?

- ○ Mechanical & Aerospace Engineering
- ○ Electrical & Computer Engineering
- ○ Civil & Environmental Engineering
- ○ Biological Engineering
- ○ Engineering Education
- ○ Chemical Engineering
- ○ Other

Q30. Are you in a tenure track position?

- ○ Yes
- ○ No

Q31. What is your gender?

- ○ Male
- ○ Female
- ○ Non-binary
- ○ [ ] Other

Q32. What is your race?

- ○ White
- ○ Black or African American
- ○ American Indian or Alaska Native
- ○ Asian
- ○ Native Hawaiian or Pacific Islander
- ○ [ ] Other

Q33. What is your ethnicity?

- O Hispanic/Latino/ or of Spanish origin
- O Not Hispanic or Latino

Q34. What age group do you belong?

- O 18 - 24
- O 25 - 34
- O 35 - 44
- O 45 - 54
- O 55 - 64
- O 65 - 74
- O 75 - 84
- O 85 or older

Q35. What is your marital status?

- O Married
- O Widowed
- O Divorced
- O Separated
- O Never married

Q36. Do you have children under the age of 18 years of age?

- O Yes
- O No

APPENDIX G

SURVEY QUESTIONNAIRE MODULE 5

SPECIAL STATUSES

Mary Lou Fulton Teachers College
Arizona State University

Deidentifier

ID. I release permission for my deidentified responses to be used for the Arizona State University doctoral dissertation by Monica Kessel. By participating in this survey you are consenting to the use of your information in the proposed research. In the survey, to protect your confidentiality, I am asking you to create a unique identifier known only to you. To create this unique code, use the first three letters of your mother's first name and the last four digits of your phone number. Thus, for example, if your mother's name was Sarah and your phone number was (435) XXX-6789, your code would be SAR6789. The unique identifier will allow us to match your post-intervention survey responses and your retrospective, pre-intervention responses when we analyze the data.

Question Block 1

Q1. I can successfully meet the required specifications for documenting a special designation (e.g. EPSCoR, MSI, HSI) in my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q2.
I can write my ideas well enough to meet special designation requirements.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q3.
My NSF grant will meet the priorities of the program and agency if special designations are required.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q4.
My DOE grant will meet the priorities of the program and agency if special designations are required.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 2

Q5.
I can route the NSF grant to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q6.
I can route the DOE grant to the Office of Sponsored Programs in exactly three business days prior to submission.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q7. I can conduct information gathering or reconnaissance for documenting a special designation.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q8. The request for application or solicitation related to my special designation and my project idea align.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q9. There is alignment between my scope of work, the NSF priorities, and the special designation selected.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q10. There is alignment between my scope of work, the DOE priorities, and the special designation selected.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q11. I can develop appropriate NSF grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q12. I can develop appropriate DOE grant documents under tight deadlines.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q13.
I can communicate my methodology and techniques effectively in my NSF grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q14.
I can communicate my methodology and techniques effectively in my DOE grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither disagree nor agree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Question Block 3

Q15. I can talk to an NSF program officer about the new grant project.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q16.
I can establish the need for the use of the special designation in the NSF grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q17.

I can establish the need for the use of the special designation in the DOE grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q18. My NSF project summary reflects my grant.

- O Strongly agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q19. My DOE public abstract reflects my grant.

- Strongly agree
- Agree
- Slightly agree
- Neither agree nor disagree
- Slightly disagree
- Disagree
- Strongly disagree

Q20. I can clearly articulate how my team and/or I am uniquely qualified to do the work.

- Strongly agree
- Agree
- Slightly agree
- Neither disagree nor agree
- Slightly disagree
- Disagree
- Strongly disagree

Q21.
I can demonstrate a connection between the research and teaching in my grant.

- Strongly agree
- Agree
- Slightly agree
- Neither agree nor disagree
- Slightly disagree
- Disagree
- Strongly disagree

Question Block 4

Q22.
I look forward to brainstorming new grant ideas.

- Strongly Agree
- Agree
- Slightly agree
- Neither agree nor disagree
- Slightly disagree
- Disagree
- Strongly disagree

Q23. I value being supported by my colleagues and department when I identify potential special designation collaborators.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q24. I enjoy collaborating with other departments and/or other universities.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q25. I have a positive attitude towards writing federal grants.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q26. I appreciate the grant writing process because I feel positive, creative energy.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q28. I am confident that I can identify the right collaborator for my grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q29.
I am confident that I can write a fundable grant.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q30.
I am confident that I can communicate with a program officer about my special designation questions.

- O Strongly Agree
- O Agree
- O Slightly agree
- O Neither agree nor disagree
- O Slightly disagree
- O Disagree
- O Strongly disagree

Q32.
I am confident that I can communicate my expertise in a variety of ways to NSF.

- ○ Strongly Agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q33.
I am confident that I can communicate my expertise in a variety of ways to DOE.

- ○ Strongly Agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q34.
I am certain I can write an innovative grant in my field.

- ○ Strongly Agree
- ○ Agree
- ○ Slightly agree
- ○ Neither agree nor disagree
- ○ Slightly disagree
- ○ Disagree
- ○ Strongly disagree

Q35. What is your tenure rank?

- ☐ Assistant Professor
- ☐ Associate Professor
- ☐ Professor
- ☐ [ ] Other

Q36. What is your department?

- ○ Mechanical & Aerospace Engineering
- ○ Electrical & Computer Engineering
- ○ Civil & Environmental Engineering
- ○ Biological Engineering
- ○ Engineering Education
- ○ Chemical Engineering
- ○ Other

Q37. Are you in a tenure track position?

- ○ Yes
- ○ No

Q38. What is your gender?

- ○ Male
- ○ Female
- ○ Non-binary
- ○ [ ] Other

Q39. What is your race?

- ○ White
- ○ Black or African American
- ○ American Indian or Alaska Native
- ○ Asian
- ○ Native Hawaiian or Pacific Islander
- ○ [ ] Other

Q40. What is your ethnicity?

- O Hispanic/Latino/ or of Spanish origin
- O Not Hispanic or Latino

Q41. What age group do you belong?

- O 18 - 24
- O 25 - 34
- O 35 - 44
- O 45 - 54
- O 55 - 64
- O 65 - 74
- O 75 - 84
- O 85 or older

Q42. What is your marital status?

- O Married
- O Widowed
- O Divorced
- O Separated
- O Never married

Q43. Do you have children under the age of 18 years of age?

- O Yes
- O No

APPENDIX H

INTERVIEW PROTOCOL

1. How would you describe your grant writing process?

2. From your perspective, describe three skills a successful researcher possessed by someone who wins grants.

3. In your opinion, what federal agency best aligns with your research? Why?

4. How would you describe your understanding of federal agency requirements for grant submission?

5. Describe three tools that you use to support your grant writing.

6. How can you improve your grant requirement familiarity with the agency you identified as best for your research?

7. Describe how the on-demand, online grant modules provided access to grantsmanship training you needed.

8. Describe three potential topics that could be added to the on-demand, online grant modules to support PIs.

9. Besides early-career engineering faculty, what other academic personnel might benefitfrom the on-demand, online grant modules?

10. How certain are you that you have the necessary information to write a funded grant?

11. In what ways would you or would you not use the resources (found under the resources tab) in the modules?

12. How often do you think you might access the information in various modules after the initial viewing?

13. Which do you think you might revisit? Why?

14. Where would you like additional grant writing support?

15. Tell me about your attitude toward grant writing. After viewing the on-demand online modules, how has your attitude toward grant writing changed?

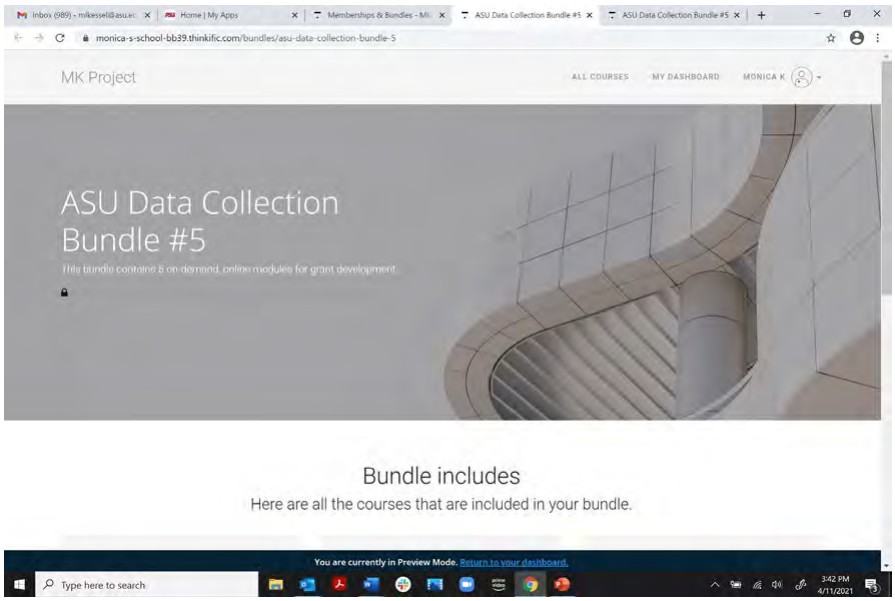
16. Tell me about your skills in grant writing. What skills do you need to improve?

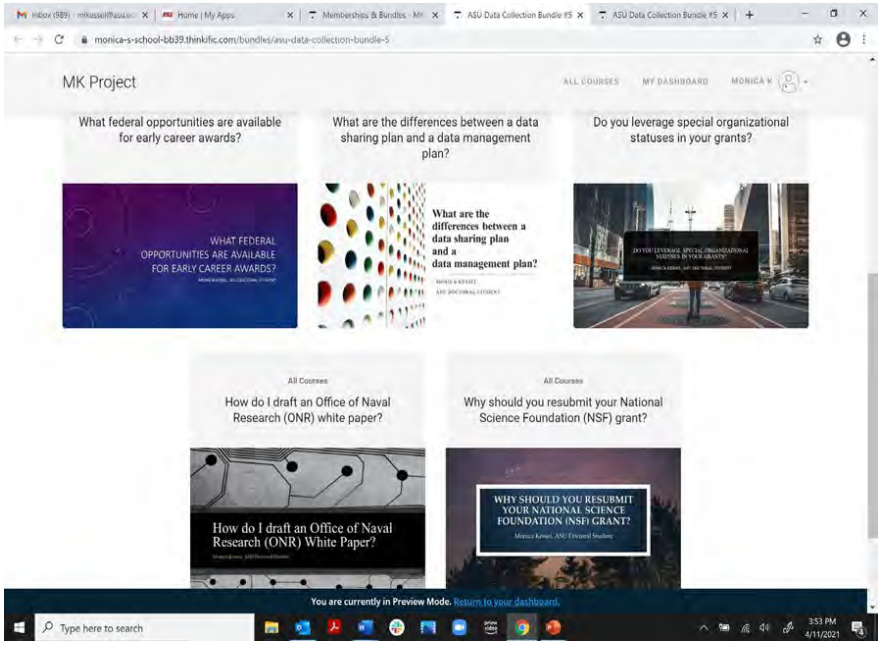
17. Describe how and if, grant writing and promotion and tenure are connected at the university.

18. What is your next research goal?

APPENDIX I

MODULE ACCESS PAGES


monica-s-school-bb39.thinkific.com/bundles/asu-data-collection-bundle-5
MK Project
ALL COURSES
MY DASHBOARD
MONICA K
ASU Data Collection Bundle #5
This bundle contains 8 on-demand, online modules for grant development.
Bundle includes
Here are all the courses that are included in your bundle.
You are currently in Preview Mode. Return to your dashboard.
Type here to search
3:42 PM
4/11/2021


monica-s-school-bb39.thinkific.com/bundles/asu-data-collection-bundle-5
MK Project
ALL COURSES
MY DASHBOARD
MONICA K
What federal opportunities are available for early career awards?
WHAT FEDERAL OPPORTUNITIES ARE AVAILABLE FOR EARLY CAREER AWARDS?
What are the differences between a data sharing plan and a data management plan?
What are the differences between a data sharing plan and a data management plan?
Do you leverage special organizational statuses in your grants?
All Courses
How do I draft an Office of Naval Research (ONR) white paper?
How do I draft an Office of Naval Research (ONR) White Paper?
All Courses
Why should you resubmit your National Science Foundation (NSF) grant?
WHY SHOULD YOU RESUBMIT YOUR NATIONAL SCIENCE FOUNDATION (NSF) GRANT?
You are currently in Preview Mode. Return to your dashboard.
Type here to search
3:53 PM
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