Seed Grants of Change: Building Thriving Networks among Female Geotechnical Faculty Members

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Abstract: The Geotechnical Women Faculty (GTWF) project has aimed since its inception in 2016 to promote gender parity among faculty within the subfield of geotechnical engineering and to increase the quality and number of connections among current faculty. This paper is a case study of one element of the GTWF project that offered seed grants to gender-diverse faculty groups to foster networking, collaborative, and mentoring relationships. Seed grants were evaluated through participants' final reports and interviews conducted by GTWF project researchers. Content analysis was performed on the interview data using two different coding methods, manual and quantitative descriptive analysis (QDA) Miner, which were used together to identify key themes. The effectiveness of this project's seed grants were judged through qualitative assessment, a novel approach among the existing literature on seed grant programs. The study's findings demonstrate the effectiveness of small grant funding in promoting collaboration and mentoring among junior faculty and leading to greater reported levels of confidence and self-efficacy. Seed grant recipients experienced financial success, with approximately 50% of seed grant projects obtaining additional grant funding. **DOI: 10.1061/(ASCE)EI.2643-9115.0000039.**

Introduction

While gains have been made in gender diversity among engineering faculty, parity with the wider population is sorely lacking, and despite the fact that women make up approximately half of the general population and account for well over half of all university students, engineering programs remain overwhelmingly male-dominated.

As demonstrated in Fig. 1, in 2015 female students made up only 22.7% of all engineering graduates at any level, receiving 23.1% of Ph.D.s in engineering, while accounting for a meager 15.7% of engineering faculty (Yoder 2015). By 2018, by contrast, the number of female engineering graduates at any level had increased to 24.1%, with 23.6% of engineering Ph.D.s going to female students and faculty representation reaching 17.4% of engineering faculty (Roy 2019). The share of female graduates in the subfield of civil engineering education has, at the same time, gone from 25.3% to 27.6%, with female faculty increasing from 17.7% to 21.7% (Yoder 2015; Roy 2019).

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Within the civil engineering subfield of geotechnical engineering, gender parity for faculty is below average. In 2016, of 385 tenured or tenure-track geotechnical faculty in the United States, 61 (15.8%) were female. In 2018, that share had increased to 82 of 491 total geotechnical faculty, or 16.7% (GTWF Project Data 2016 2018). Approximately 20% of the new hires over that 2-year span were women, reflecting a nominal effort at attracting women to the field that portends slow change. This paper will focus on programs that aim to achieve gender parity among US geotechnical faculty.

The reasons for the continued shortage of female faculty are many and multifaceted, but while each institution is unique, the systemic barriers are too prevalent to ignore: the low numbers and geographical dispersion of female faculty leading to professional isolation, gendered perceptions of engineering as a masculine pursuit, department climates heavily male-normed and geared to maintaining the status quo, and an anemic rate of hiring of women that results in low or no growth in the percentage of women in faculty positions (Howe 2010). This tendency for gender stereotypes to reinforce themselves in institutional practice and settings is documented and explained by what van Dijk and Engen (2019) call the fly wheel effect, a tripartite mechanism that reinforces gender-role expectations and continues material discrepancies. In the context of engineering faculty, this framework functions as follows: (1) the lack of engineering female faculty (2) leads students (and industry, university administrators, and everyone else) to perceive engineering as being male-oriented and unwelcoming to women, which (3) discourages women from pursuing engineering (faculty) careers, thereby reinforcing and perpetuating the cycle. Steps to increase gender (or other underrepresentation status) parity can be introduced at any point along the flywheel process, but successful structural change must address all three, changing both perceptions and positions.

Background

To increase the proportion of women in science, technology, engineering, and mathematics (STEM)-related fields, efforts should be made to not only support the gender parity of students in the pipeline but also increase visibility and connection among faculty

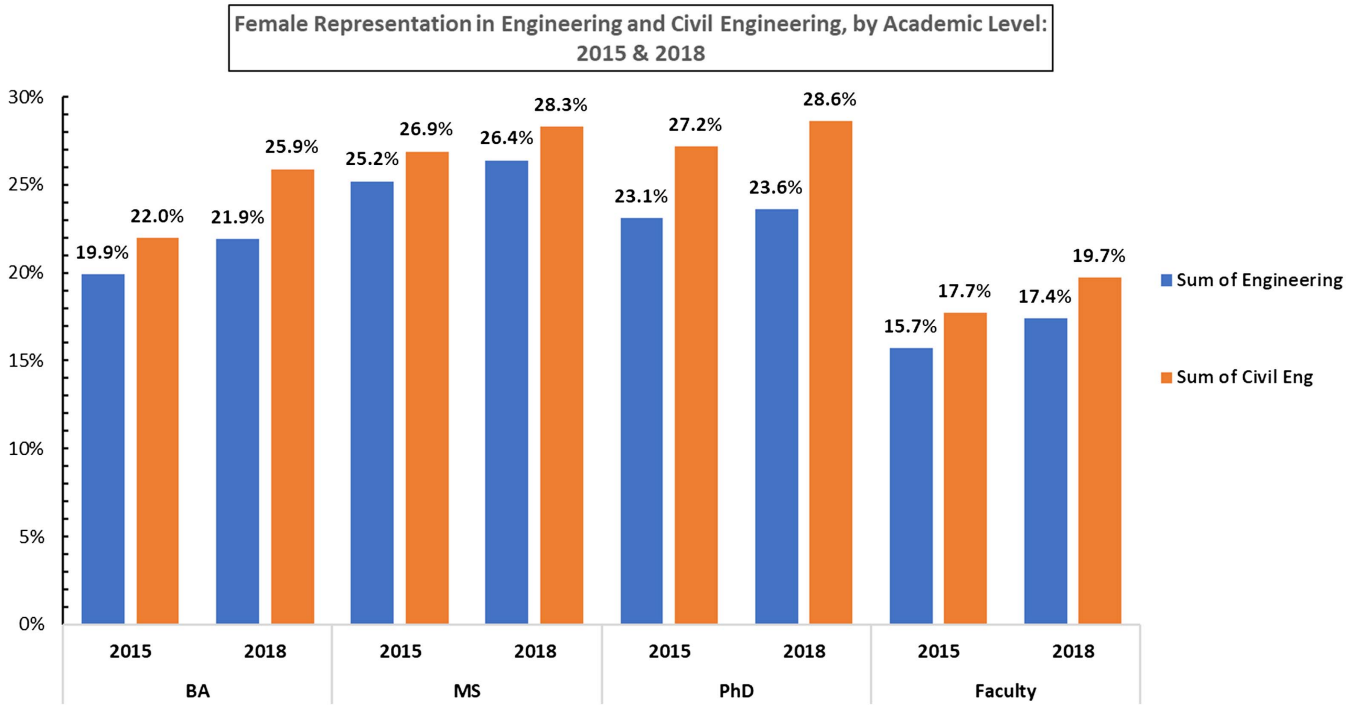

Fig. 1. Comparison of female representation in graduation rates between all engineering disciplines and civil engineering subdiscipline. (Data from Roy 2019.)

and practitioners. As Fleming (2008, quoted in Leonard and Nicholls 2013) wrote: "[the] diversity of the engineering workforce begins with addressing the diversification issues in the education of engineers." To date, a wide range of programs have been implemented since Congress mandated the National Science Foundation (NSF) to report on the status of women and other underrepresented minority (URM) faculty and students in the sciences (Leonard and Nicholls 2013). Programs have included federally funded initiatives to hire more female faculty, a proliferation of horizontal associations within the engineering field and subfields, such as the Earth Science Women's Network (ESWN), and STEM summer camps for female students like ISISHAWAII as detailed by Fujioka et al. (2007). The dearth of female faculty in engineering subdisciplines has spurred the NSF to make repeated attempts to increase and sustain diversity within the subfields, as described by Alestalo et al. (2015). In 2001, the NSF initiated the ADVANCE program, which to date has invested over $270 million "to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce" (NSF.gov 2020). ADVANCE grants are made at the university level, with customized goals and approaches to suit recipient contexts. Other initiatives to improve parity likewise tend to focus on building peer and mentoring networks and are well documented (i.e., Riegle 2006; Leonard and Nicholls 2013; Hartman et al. 2019).

Since 1989, female faculty in geotechnical engineering in particular have engaged the NSF to both support and promote female faculty. The first workshop was held in Washington, DC, in 1989 (Bhatia 1989; Gallagher et al. 2018), and the second was held in 2003, adjacent to the United States Universities Consortium on Geotechnical Education and Research (USUCGER) workshop (Alestalo et al. 2015). In 2012, a collaborative venture involving female geotechnical faculty spearheaded a project, supported by a NSF ADVANCE grant at the University of Michigan, that aimed to connect geotechnical female faculty through the creation of a *networked hub* website, GeoWorld, alongside yearly so-called e-conferences. The project experienced short-term success, but ultimately the network ties were not strong enough to overcome the weight of quotidian demands for time, and the hub fell into disuse. Gallagher et al. (2018), in reviewing the results of the project, concluded that "the many time-constraints that women experience trumped the short-term investment in setting up online networking and thus the long-term value went unrealized."

Similar attempts have been made in sister subfields within engineering to increase faculty retention and gender parity. In the geosciences, the Earth Science Women's Network (ESWN), "a grassroots, member-driven organization, dedicated to moving the geosciences forward," was started in 2002, creating a personal and professional network of women in the geosciences. The project supports undergraduates up through senior faculty, and in 2017 it received a NSF grant to launch the ADVANCEGeo program to combat sexual harassment and exclusionary behavior in the geosciences through bystander training.

These and other attempts have found ample sponsorship and support from national organizations such as the NSF, university administrations, and, of course, from women themselves in STEM-fields. Gender parity in engineering education as a whole and its subfields has lagged well behind rates in the biological sciences and in particular in the humanities and social sciences. One of the issues facing female faculty in many STEM subfields is professional isolation (Bhatia 1989; Alestalo et al. 2015; Gallagher et al. 2017, 2019). Already pressed for time, female faculty find it difficult to maintain professional and personal support when siloed and separated by vast distances. Making networks and connections that are resilient enough to overcome this issue of propinquity is a difficult task. While conferences and initiatives continue to be greeted with great fanfare, sustained and quality engagement remains elusive. It is difficult to generate ties strong enough to endure the busy academic year between annual conferences, no matter how well attended the workshops are. Faculty return to their institutions and continue

the school year but do not keep in contact with peers they met at workshops, i.e., professional isolation. This lack of sustained ties to the wider geotechnical community is one of the major barriers facing female faculty: access to not only peer mentors but to the geotechnical field more generally is difficult to arrange when the average institution has one geotechnical specialist and the next one is hundreds of miles away. To develop a sustainable and self-maintaining network of faculty, stronger and integrated peer connections within the subfield must be created.

In seeking to generate lasting "horizontal" connections between faculty, numerous programs, including the GTWF project, have built on an approach that incorporates peer mentoring. Peer mentorship, sometimes also called mutual mentorship, is a framework whereby minority individuals encounter and support one another and provide mutual support (Yun et al. 2016). The process works on the assumption that increased visibility of minoritarian members leads to greater engagement from others in that minority. This effect has been studied and found to be successful not only in the context of faculty gender composition, but also—as described by a team led by Ford et al. (2017)—with regard to women's participation in online software engineering forums (e.g., StackExchange).

Lateral relationships for many women in the engineering field, particularly in the small and geographically dispersed geotechnical field, can be difficult (Leonard and Nicholls 2013). Separated by vast distances in an already small field only exacerbates the oft-lamented *silo effect* of academia. If improving network connections within the population remains critical, it could be beneficial to make such ties dual-purpose, that is, collaborations and peer-mentoring connections that also accomplish a research task, secure a grant, or assist in achieving tenure. Such connections would supplement those that already exist among female faculty both with local colleagues and relationships with other geotechnical specialists across the country. It also supports the integration of networking strategies into daily obligations and responsibilities for faculty members.

GTWF Project

The NSF project Connecting Geotechnical Engineering Women Faculty: Networked and Thriving (GTWF) was built on efforts of the past 30 years to identify, understand, and address widespread gender inequity in the geotechnical field. Therefore, it is important to highlight the historical context that led to the GTWF project.

During the two earlier NSF sponsored events in 1989 and 2003, female geotechnical faculty articulated the barriers they faced to equitable access to professional opportunities. This information contributed to an initiative that, in 2012, funded a project to encourage female geotechnical engineers to connect with each other using GeoWorld, an online networking platform designed for the geotechnical community. GeoWorld as a site averages 8,046 unique monthly users, and roughly 20,115 unique page views, 20,735 of which are affiliated with the geotechnical field (Athanasopoulos-Zekkos, personal communication, 2020). The female geotechnical engineers who participated in this online network provided positive feedback about their experiences, but while they noted their connections to a wider community of female geotechnical professionals, barriers to equitable participation persisted in these digital spaces, echoing the challenges female geotechnical faculty were facing in the physical spaces (Gallagher et al 2019).

Building on these previous efforts, in 2016 three geotechnical faculty—principal investigator (PI) Dr. Shobha Bhatia from Syracuse University and co-PIs Dr. Adda Athanasopoulos-Zekkos from the University of Michigan/UC Berkeley and Dr. Patricia Gallagher from Drexel University—along with Dr. Sucheta Soundarajan, a network science expert from Syracuse, proposed a model to augment geotechnical faculty's information about and opportunities for creating and maintaining their professional networks through interventions to encourage both in-person and online network connections. Having identified challenges common to female geotechnical faculty, this project focused on implementing possible solutions. The overall goal of the GTWF project was to create an enduring network for geotechnical engineering faculty that fosters career success and resilience for female faculty in the field through active network building and connectivity.

A series of surveys and conferences were held starting in the fall of 2016 with a social network survey that surveyed female geotechnical faculty about their use of social media and their network connections with other geotechnical faculty. The results of the survey were used in planning breakout sessions and scheduling keynote speakers at the first conference in April 2017—a 2-day workshop in Washington, DC, that was attended by only women. Widely well received, the first workshop was followed up a year later by a second workshop in March 2018 that took place in Orlando, Florida, and was open to both male and female faculty. Fig. 2 illustrates the chronology of the GTWF project and its components.

GTWF Logic Model

The aims of the GTWF project were as follows:

1. Increase understanding by participants of how social networks impact career success, collaboration, and productivity.
2. Increase participant network building skills to enhance career outcomes and research productivity.
3. Increase the use of virtual and other long-distance strategies to maintain network connectivity.
4. Increase the number, quality, and frequency of connectivity of ties among GTWF.
5. Enhance understanding of how to create effective programs that build a productive, sustainable network for a subdiscipline that is both geographically disparate and busy.

The two key activities that supported this goal included (1) the use of facilitative learning experiences to improve faculty's networking and collaboration experiences; and (2) the use of a social network and surveys on long-distance networking practices to improve understanding of existing networks and network building and maintenance practices.

An intervention model of small grants, based on social networking theory and expressed demand from female faculty, was created to provide opportunities for connections with colleagues (male and female) across the nation and equip participants with a network for finding peers, collaborators, and mentors. The first GTWF seed grants were offered to foster the initiation and development of network ties that would promote mentoring as "transformative relationships" that would allow junior faculty to enhance their career, in the model described by Yip and Kram (2017). Small grant opportunities and other incentives were offered to motivate and provide seed funding for new collaborations or mentoring activities.

GTWF Seed Grants

Seed grants, also known as startup grants, are a common and effective method for academic institutions to encourage the pursuit and establishment of larger, more intensive projects (Costa 1999; Douglas and Hartley 2011; Zuiches 2013). Most commonly, seed grants have as their goal the obtainment of an additional, larger, grant, or funding to continue a project past the proposal phase to completion. As a result, a majority of the literature on seed grant efficacy focuses on return on investment (ROI) and simple

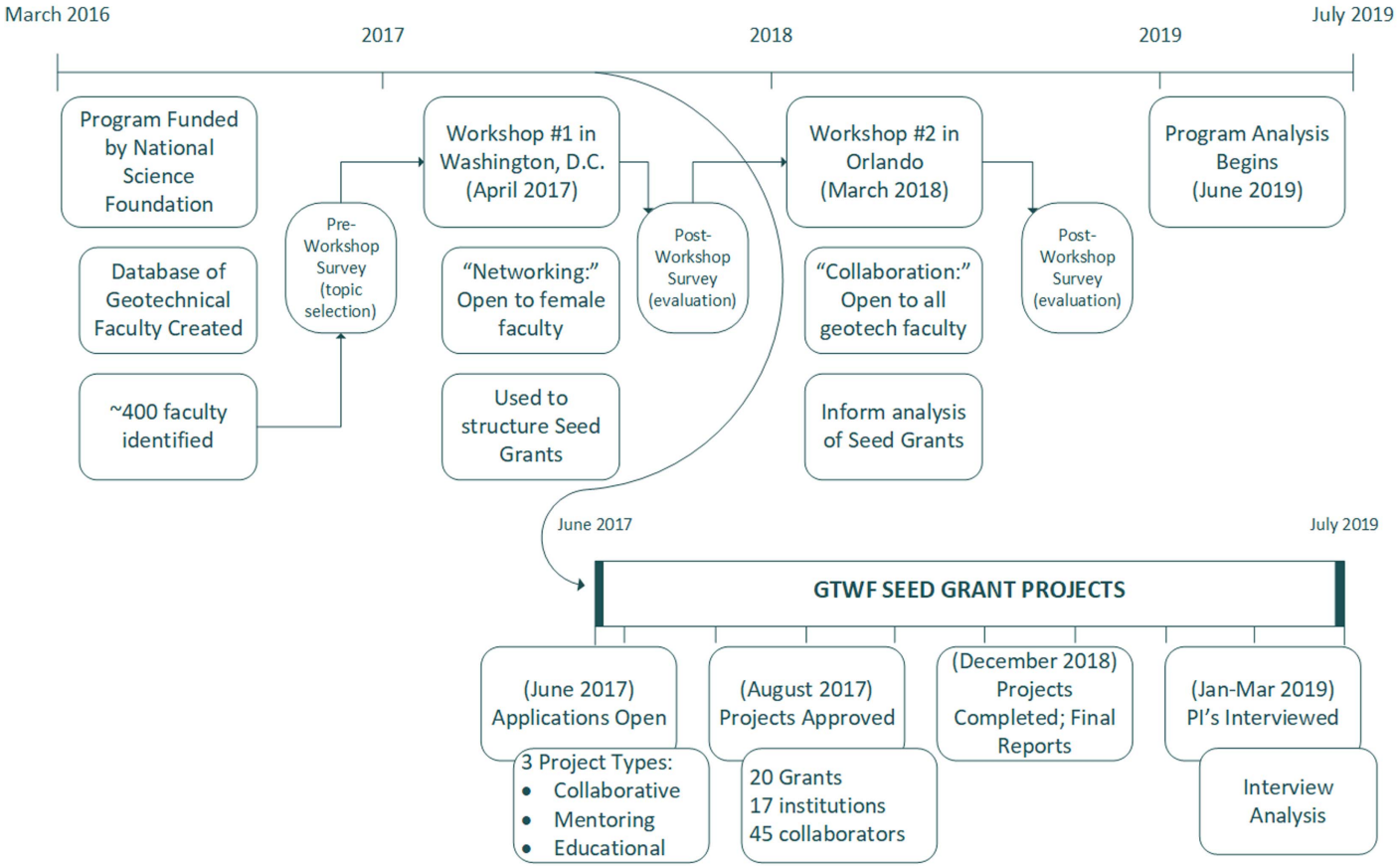

Fig. 2. Timeline of GTWF project, from workshops through analysis. Note that the seed grant project runs parallel to the second workshop in Orlando, Florida.

econometric measurements of success, or lack thereof (e.g., Costa 1999; Ayoub et al. 2017).

The literature on seed grant efficacy measured by qualitative means is extremely thin. Because the vast majority of seed grant projects aim only to secure additional funding, their criteria for success remain stubbornly econometric. One of the major appeals of seed grant funding, for the granting party at least, is the lower cost—and lower risk—required up front, as awardees seek external funding or are funded in stages. Awardees also enjoy support for startup costs, as with applying for a larger grant; additionally, applicants may find greater support for projects whose success is not guaranteed and, thus, are free to propose less so-called traditional projects than under a traditional, full-project grant (Douglas and Hartley 2011). Seed grants in the academy generally provide funding in search of a deliverable, either external funding or a research project with definable results (Costa 1999; Zuiches 2013; Ayoub et al. 2017).

The Geotechnical Women Faculty (GTWF) project offered small—$5,000 maximum—seed grants to a defined cohort of 150 geotechnical faculty, both women and men, in order to spur the creation of a *networked and thriving* community of geotechnical faculty nationwide. Such a network would serve to enhance the career prospects and sense of belonging among female faculty, who consistently point to lack of (same-gender) mentors and coworkers as one of the barriers facing women in the field (Abadi et al. 2006). The seed grants were created to support collaborative projects among geotechnical faculty nationwide. The focus was to decrease the cost for participants of investing time in networking and network building and to foster career-long relationships.

Nature and Evaluation of Seed Grants

Recipients of GTWF project funding initiated a variety of projects, which were divided into three classifications: (1) Research Collaboration: 14 teams; (2) Teaching Collaboration: 2 teams; and (3) Mentoring and Networking: 4 teams (Gallagher et al. 2019).

All 20 PIs were geotechnical faculty at a US institution: 15 female (75%) and 5 male (25%). A majority of PIs (65%) were assistant professors, 15% were associate professors, and 20% were professors. Proposals were evaluated by two reviewers who suggested changes to PIs for modification or clarification before approval. Proposals were submitted by 20 teams and went through several rounds of revisions, with all 20 receiving funding from the GTWF project. Grants were made to PIs from 17 institutions in the US, with 3 institutions receiving 2 grants each. The 20 administered seed grants involved 45 faculty working across 27 universities. Primary awardees collaborated with an additional 10 universities across the country (Fig. 3), including one overseas (Indian Institute of Technology Mumbai). Of all collaborators, 27 were female and 18 were male.

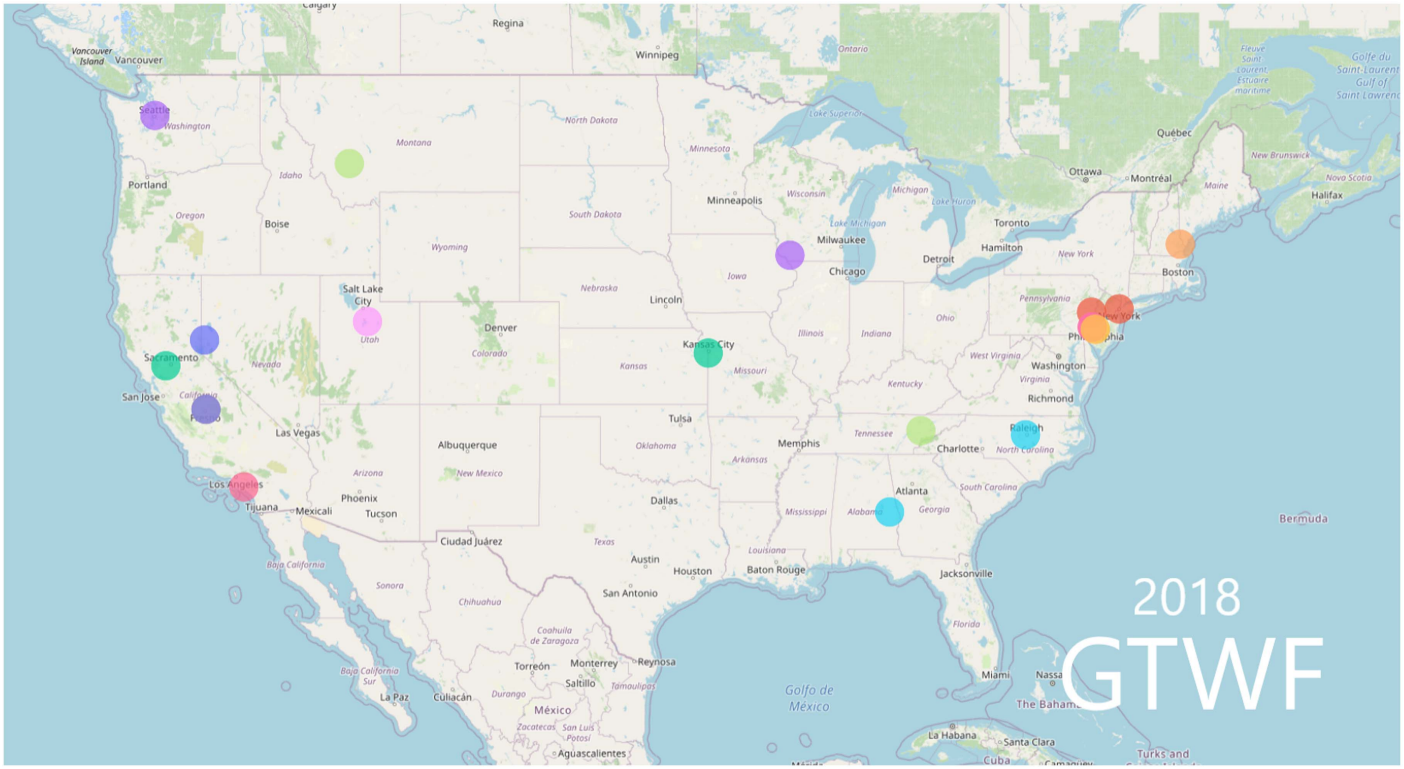

Fig. 3. Geographic locations of PI institutions that received GTWF funds in 2018. Note that the high concentration of recipients in the Philadelphia region results in some not displaying fully. [Map credit: © OpenStreetMap contributors, under Creative Commons-BY-SA-2.0 license (https://creativecommons.org/licenses/by-sa/2.0/).]

Upon completion, each seed grant PI submitted written final reports, and the grant recipients were interviewed about their experiences. Transcriptions were produced from these interviews and subsequently analyzed. Interview questions were drafted with input from social science researchers at Syracuse University to maximize later interoperability. Questions were asked about PI attitudes toward networking, collaboration, and mentorship both before and after participation in the GTWF seed grant program. The interview questions are attached in Appendix I.

While it is relatively simple to assess the efficacy of most seed grants, with a simple ratio of funds spent to new funds secured, the GTWF program was more interested in the quality *of the seed grant projects themselves*, rather than a funding- or publication-based outcome. As such, the program cannot be judged from a financial standpoint or as one focused on deliverables. This raises significant issues when reviewing the literature on seed grant programs because the vast majority are designed to spur further funding, with issuing bodies thus concerned more with results than process.

Results

Quantitative Results

Seed grants are typically evaluated quantitatively (numbers spent, numbers in), and while our focus was not quantitative, we have collated metrics from PI final reports and interview transcripts that may be of interest to the reader. Results are from 3 to 18 months after completion of the GTWF seed grants in June 2018. A full 50% of all projects resulted in an additional grant project, and 55% of projects produced a deliverable for publication. One group of two PIs in particular enjoyed a high degree of economic success: one grant for nearly $400,000 in funding, and an additional second grant of $100,000 (Table 1).

Table 1. Seed grant deliverables quick look, $N = 20$

Outcome	Count
Additional grants applied to	10
Papers or presentations prepared for publication	11
New collaborations started	28
PI trips made[a]	>26

[a]Some reports were indeterminate: we have included only known, mentioned travel.

While the results from our interviews with PIs were qualitative in nature, we were able to create some quantitative analyses of common themes that appeared in interviews. In addition to traditional coding analysis, transcripts were analyzed using a word-frequency analysis. Four major clear themes emerge based on a content analysis of the interview transcripts: (1) collaboration, (2) networking, (3) mentoring, and (4) overall benefit. The figures in Table 2 demonstrate the four themes, their subthemes, and the prevalence of each subtheme in participants' responses to our interview questions.

Qualitative Results

Interview Participants

Participation in all seed grant assessments was a requirement of receiving the award, which resulted in a high response rate. Equally significant, the 20 PIs do not constitute a representative sample of

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Table 2. Theme and subtheme prevalence in interview responses

Theme	Explanation	Prevalence (%)
1. Collaboration		
Shared or diverse interests	Collaborators are chosen based on overlapping or complementary interests	70
Prior connection	Collaborators chosen because of prior connection (had already met or worked together)	40
Preferred traits	Collaborators chosen because of professional or personal compatibility (i.e., similar working styles or mutual goals)	40
2. Networking		
Personal connections	Respondents felt personal connections were important in developing professional relationships; these included discussions about family, visits to peers homes, and sharing meals	90
Professional connections	Professional considerations drive networking (i.e., mutually beneficial arrangements, career prospects); potentially connected to peer mentoring	45
3. Mentorship (of female faculty/students)		
Being mindful/encouraging	Half of respondents reported approaching interactions with female students or coworkers while mindful of structural bias or other gender-based issues	50
Universal mentoring	Respondents felt that everyone, regardless of gender, should be mentored or treated similarly	20
Lack of Experience	Some respondents felt too junior to be mentors, as they were still at an early career stage	15
4. Overall benefits		
Valuable learning	Was the overall experience beneficial or productive?	70
Gaining experience	PIs expressed gaining new skills or becoming more confident as a result	15
Promotion	Completing tasks that were either required for or beneficial to receiving tenure	20

the national population of geotechnical faculty in terms of either (1) gender—15 PIs interviewed were female, while only 5 were male—or (2) rank—16 PIs are junior faculty and only 4 are senior faculty.

Interviews

Intercoder reliability, according to the SAGE Encyclopedia of Survey Research Methods (2008), "refers to the extent to which two or more independent coders agree on the coding of the content of interest with an application of the same coding scheme" (Cho 2008). This is one way that researchers can maintain more objectivity and validity when using research methods like content analysis that require subjective interpretations of data. This not only ensured easy reproducibility of the process, but it also provided a schema into which data could be organized. Interview questions were coded based on the five outcomes listed in the GTWF Logic Model, with a color for each of the five outcomes. Two researchers separately color-coded the interview questions and then compared their results. Almost 90% of the questions were coded similarly on first comparison, suggesting a shared understanding of the relation between project goals, interview questions, and outcomes. A common conclusion was reached regarding the categorization of the remaining 10% of questions.

Data Analysis

Content analysis is a research method that involves studying and interpreting a variety of textual artifacts, most often by coding data and deducing patterns and themes from them. Content analysis can be either quantitative (word frequencies, text length) or qualitative (meanings and implications of words within a text and of the text as a whole) in nature. Using both coding software and traditional coding/analysis methods, an analytic process was designed that relied on both qualitative and quantitative content analysis and began with a hybrid top-down (deductive) and bottom-up (inductive) approach to ensuring the reliability and reproducibility of our processes (Braun and Clarke 2006).

To ensure that our data analysis adhered to the specific objectives of the GTWF study, we first deductively aligned our coding procedures to five outcomes listed in the GTWF Logic Model. This task also provided a measurable assessment tool for the two coders performing the data analysis.

Limitations

Qualitative research in general relies on interpretation by human researchers, which can often lead to questions of reliability and validity. The researchers involved in this study made every effort to ensure interrater reliability (Belotto 2018). In addition to using multiple methods of data analysis (coding both by hand and with software), the researchers also met to informally and formally discuss interim results from their data analysis with each other and with their supervisor and provided both quantitative and qualitative results so that the numerical statistics could validate the narrative interpretation of data.

Analysis of Results: Breakdown

In the assessment stage, the impact that seed grant awards for collaborative research projects have on geotechnical (GT) faculty was examined by interviewing and analyzing the 20 geotechnical faculty who served as PIs on project proposals funded through this award. Analysis identified four major themes in participants' interviews: (1) identifying collaboration and collaborators, (2) connecting through networking or relationships, (3) mentoring colleagues and students, and (4) overall benefits.

Theme 1: Collaboration. Contemporary academia, and the so-called knowledge economy more broadly, emphasizes and requires collaborative achievement more than individual merit-based work (Leibowitz et al. 2017; Misra et al. 2017). Two main subthemes related to collaboration were identified through interviews: (1) Purpose and meaning of collaboration; and (2) rationale for selecting collaborators.

Responding to the question "What does collaboration mean to you," P11 replied: "It's about finding somebody that you can work with . . . that has I would say a complementary skillset or set of resources." The two subthemes are therefore related; collaboration is paired work with a goal, and collaborators are selected with that goal in mind.

Content analysis of PI interviews identified three major strands associated with the selection process and positive collaboration: (1) shared or diverse interests, (2) prior connection, and (3) preferred traits. It was reported by 70% of PIs that collaborative partners—including those outside the GTWF program—were selected on the basis of shared or diverse interests, often with an eye toward complementary skills for a given project. That is, a PI who specializes in Field A and is exploring an experiment in

Subfield AB would be more likely to seek out a collaboration with an expert in Field B, rather than Field C. This sort of matchmaking, so to speak, is geared toward goal completion, or picking the right person for the job, as opposed to selecting collaborators based on more personal criteria.

Participants additionally explained that they selected collaborators because of their prior connection and comfort level, and they selected mentors by reputation (i.e., publications, research history) and shared interests. While only 40% of PIs identified prior *personal connection* as a core consideration when planning a new collaboration, they recognized that finding collaborators was an active engagement process. As P14 stated: "I think that that's definitely a useful thing, because it is something that you really have to be very intentional about." Obviously, relying on prior connections to select collaborators requires prior connections: a network of peers and potential partners must first be built up in order to be utilized.

To most PIs, the functions of collaboration and networking were deeply interconnected:

"I think professional network by my definition would be establishing new and continuing existing collaborations" (P8).

The distinction most often came down to concrete versus abstract interaction—discussed at the first GTWF conference as well—that networking is more nebulous, with a goal of *knowing* a person, whereas collaboration entails a specific, actionable, and shared goal.

Theme 2: Networking. Almost all participants expressed a preference for connecting with colleagues via in-person, face-to-face methods, particularly for key meetings. All were also comfortable with electronic communication, and a large plurality maintained some form of professional digital presence (e.g., LinkedIn, or a departmental website).

In addition, PIs who were junior faculty indicated that the GTWF project coincided with beginning their job and was important in developing their professional network and understanding the tenure process. For example, some participants reported that the GTWF seed grant was their first exposure to grant writing. Participants talked about being brand new faculty getting to know their colleagues both at their home institutions and in the broader field. Multiple participants felt that a long-term outcome of their seed grant was an ongoing relationship with a mentor, sponsor, or collaborator. It should be noted that these connections between non-home-institution peers would not exist without a conscious effort to network with other geotechnical faculty.

Participants indicated that the GTWF seed grant helped them feel more confident in pursuit of new collaborations, due in part to a positive experience with the project. One participant reported that as a result of her project, she became more comfortable as an instructor at a teaching university and felt able to compete with R1 faculty (e.g., with respect to grant funding from national orgs): "I'm way more confident in myself. I think that it's way easier to have people trust you and you are more confident in yourself. And it's easier to give the impression that you are [confident] when you've had something successful. So I feel like [the project] has built not only my self-esteem, you know what I mean, but also it has increased my reputation" (P13).

Even relatively simple interventions, such as workshops detailing simple *networking how-to* methods, can lead to substantial changes in how individuals perceive their professional efficacy. Destigmatizing networking can be accomplished by pursuing a more personal focus, with a majority of PIs (90%) positively associating personal connection with professional compatibility. Rather than adopting a utilitarian approach, where networking is pursued for narrow careerist pursuits, our interviews suggest that taking a more holistic approach to networking can help overcome internal barriers and reluctance to reach out. Offering external reasons, such as a collaborative project incentive, also seems to positively impact PIs self-reported comfort level with cold calling.

Theme 3: Mentorship. Approximately 50% of participants in their interview mentioned the importance of being mindful of and encouraging about mentoring, specifically when addressing female students or—where applicable—junior female faculty. These participants explained that mentoring female colleagues and female students is something they take very seriously and understand as complex, and they believe that personal connections are beneficial for trusting and comfortable professional relationships.

Participants highlighted specific actions they took and ideas they had about mentoring female colleagues and students. For example, they said that mentoring can be (1) sharing personal experiences about being female in a male-dominated field, (2) providing specific expectations, and (3) giving recognition to colleagues or students for whatever work they did on a project.

Several PIs expressed doubt that they could serve as mentors, owing to their junior status, but expressed gratefulness that they themselves were able to get to where they were due to assistance and mentorship in the past. All participants agreed mentoring was important for both students and faculty, even if approaches to serving as a mentor varied.

One PI she felt teaching was reaffirmed as her primary objective: "I always find myself torn because I'm like, but this [mentoring faculty and students] is important . . . I feel like if I do not do that, I might as well be a researcher in an R&D department in some national laboratory or in a company . . . " (P4).

Theme 4: Overall Benefit. A majority of the participants (70%) reported that GTWF interventions (Workshops 1 and 2 and seed grants) helped them realize that they needed to be proactive about reaching out to colleagues, and indeed that they had colleagues to reach out to—beyond the silo.

PIs reported feeling that being a part of the GTWF project added value in more than one way: they spoke about reinvigorating their research, having the opportunity to meet and learn from the experts in their field, and that they felt more confident or motivated as a result of participation in the GTWF project. Junior faculty consistently mentioned feeling more confident as a result of participation and growing their so-called portfolio to become a more accomplished professor and competitive candidate for tenure.

While the need for more mentoring in the tenure process speaks to tenure issues that extend far beyond the scope of the seed grant project, participants also discussed the connection between seed grants and tenure in terms of gaining more access to research opportunities. For example, participants planned to continue working with seed grant collaborators to get additional grants for research or writing proposals and articles, for example. They indicated that since receiving this seed grant award (or as a result of collaborating/networking in general), they have sought out, and encouraged their students to seek out, other grant funding, or they came to realize that grants do not have to be large amounts of money to create an impact or start a new project or idea. Participants described one of the ways they have interacted with colleagues more since their seed grant is in providing and receiving feedback about research proposals, career proposals, and so forth and provide feedback to students.

In addition to having an interest in pursuing another seed grant, a high percentage of participants felt that their seed grant project added value to their career and research goals. Again, 90% of participants responded affirmatively when asked about the value these seed grants added to their overall career plans and research agendas. In their responses, participants were often surprised at how much they were able to achieve with a small amount of funding:

"I was a little bit skeptical as to, okay, how far can $3000 take you? So yeah, that's not a lot of money, but then you can get creative and try to think . . . strategically as to what you can do, I think it is very valuable, and I only have positive things to say about the seed grant and how it has significantly helped me in building my program: which was the main, overarching goal of the Seed Grant to begin with" (P1).

Conclusions

The original purpose of providing seed grant funding was to support collaborative and networking projects among junior female faculty. Although funding was provided directly for projects, the aim of the grant was the indirect support of the networking that would result as a necessary part of the project. As the main goal of the study was secondary from the point of view of the PI, we conducted interviews to gather qualitative data that were relevant to our assessment of whether PIs were able to use the provided grants to become *networked and thriving* faculty members. Where possible, PIs were asked for feedback about their experience that was directly relevant to the stated aims of the larger GTWF project.

Analysis of our PI interviews suggests that even small funding opportunities, like the GTWF seed grants, not only connect GT faculty through new or deeper network ties, but they also put GT faculty in a position to think about what those connections mean for their career advancement. While this was initially intended as a way to assess the seed grants, it became more of an important discussion about what GT faculty need and want professionally, how they understand the GT community and their place in it, and what they would like to see in the future of academia for faculty in geotechnical engineering and more broadly.

Measuring Success

Whereas typical surveys of seed grants are a simple, so to speak, money in, money out measure of success, our analysis focuses on the qualitative experience of seed grants, demonstrating the effectiveness of such targeted funding in support of faculty networking, collaboration, and mentorship. While several of our PIs went on to successfully obtain additional funding—whether from the NSF, their institution, or other—the purpose of our project was to focus more on the *process* than the *product*. Measuring participant satisfaction is notoriously difficult to accomplish, and a quantitative approach was deemed too narrow. We have also not explicitly linked each subaward's numerical and qualitative data because the varied nature of the supported projects would not be amenable to statistical analysis. Some PIs aimed to create a sustainable project and were indeed successful in going on to receive additional funding. Other projects had goals far less measurable; for example, one PI created a workshop to promote engineering to high-school-aged female students, with no component for ongoing funding or longitudinal study.

As P2 pointed out in her interview, judging a project's success, or even potential, can be rather difficult: "I think everyone is just so busy, and the collaboration cycle . . . is naturally very slow . . . I think it's hard to distinguish between, let's say, failure, where I'll never hear from someone again, and [success]" (P2).

Because the majority of GTWF participants are junior faculty, we argue that smaller interventions have a larger proportional effect on their career trajectory: publishing two papers is more impactful for new faculty than for established, tenured faculty. We have demonstrated the effectiveness of small-scale grants in targeting specific networking-oriented projects for junior faculty. Although $N = 20$ is not a statistically significant sample, collection and analysis of qualitative data allows for richer descriptions of the outcomes of the project, beyond mere statistical analysis. Providing a shared goal—in this case a small project designed to promote collaboration or mentoring—is a robust way to develop collaborative and supportive networks among minoritarian faculty and allies.

Interview feedback suggests that even small funding opportunities, like seed grants, not only connect faculty through new or deeper network ties, they also put faculty in a position to think about what those connections mean for their career advancement, something they rarely found time to do when implementing *just* networking strategies per previous intervention projects. The time spent on the seed grant had added value above and beyond strict networking at a conference, for example. This assessment process proved to be a valuable tool supporting reflection about what GT faculty want and expect from their career as well as understanding the GT community and their place within it. Given the small number of female faculty, these reflections about community and the future of GT engineering education have the potential to make a significant impact.

Qualitative data collection via interviews and subsequent analysis reveals that small-scale targeted funds can be successfully deployed to assist junior faculty—particularly female faculty—in creating professional and collaborative networks crucial to their career success. An overwhelming majority of 19 PIs (95%) reported feeling mostly or very positive toward the project overall, with only a single PI (5%) reporting feeling neutral. Feedback generated from interviews of Round 1 participants was incorporated into changes for the second round (offered in 2019–2021): (1) PIs were provided with program definitions of terms before beginning their projects, to avoid confusion over what was considered networking versus collaboration; and (2) interview questions were revised to be more streamlined and targeted, with the hope that responses will better address target areas.

Looking at the second goal of the seed grant project, strong and resilient network, we conclude that participation in a GTWF seed grant was successful in creating a network that has indeed endured. When compared to virtual networks, or even in-person expressions of interest at conferences, the dual purpose was able to generate several deliverables and collaborative projects, whose professional ties have persisted even after the formal end of the seed grant.

Several participants addressed challenges faced as a working parent and the way that pregnancy, childcare, or taking care of family members impacted their relationships with colleagues or students, their opportunities for advancement or research, and their expectations of collaborations, for example. Participants describe valuing colleagues who were able to be flexible to and understanding of their home life commitments (specifically early motherhood), which included planning ahead instead of doing things last minute and being comfortable with meetings that happen during daycare pick-up or remotely while at home with sick children.

Further Study

Whether this sort of program has long-term support potential has not been addressed—a potential future check-in with GTWF participants from both cohorts at a 5-year date could provide valuable insight into the lasting effects of early-career support of female faculty designed specifically to build their networks for collaboration and mentoring. While not at present set up as a controlled trial, it would be possible to design a survey for a future checkpoint that could, by following GTWF participants in their postproject years, shed light on the role such seed grant funding can have.

The authors feel confident in asserting that this project could be successfully replicated and are currently in the process of supporting a second round (although the Covid-19 pandemic has resulted in significant delays). The second round will be finished in 2021, with analysis and results ideally available for fall publication.

Appendix I. Interview Questions

Introductory Questions

- Can you talk a little bit about the purpose of the seed grant project for which you were the PI? Follow up with: Do you feel you achieved those goals?

Questions about Networks

- Have you increased your online presence since participating in this project (e.g., LinkedIn, Twitter, professional website/blog, GeoWorld)? Follow up with: If so, please elaborate on how you have done so, OR, if not, what might be the top three reasons why not?
- How did your understanding of your professional network develop as a result of participating in this seed grant project/these seed grant projects? Follow-up: Please elaborate on how you have done so, OR, what might be the top three reasons why not?
- Do you think seed grant opportunities like this are valuable ways to expand your professional networks? Follow-up: Can you give at least three reasons why/why not?
- If you attended Workshop 1 on social network development, how did you use the tools and strategies you learned in the first workshop to support your network through your seed grant project?

Questions about Collaboration

- What does collaboration mean to you?
- In what ways do you plan to continue collaborating with the academic and professional colleagues you worked with on this seed grant project?
- Did students participate in your seed grant? In what ways might you continue collaborating with the students you worked with on this seed grant project?
- What were some of the challenges of collaborating as you worked on this seed grant project?
- Do you think you are better positioned to look for collaborators as a result of this experience?
- What do you think the long-term outcomes will be of collaborations established through the seed grant?
- If you attended Workshop 2 on collaboration, how did you use the tools and strategies you learned in the second workshop to support your network through your seed grant project?

Questions about Working with Colleagues and Students

- How did you select the professional colleagues you worked with on this seed grant project?
- If applicable, how did you select the undergraduate or graduate students you worked with on this seed grant project?
- Based on your experience with these seed grants, how has your understanding of collaborating with female colleagues changed?
- Follow-up: Similarly, how has your understanding of collaborating with female students changed?
- Based on your experience with these seed grants, how has your understanding of mentoring female colleagues changed?
- Similarly, how has your understanding of mentoring female students changed?
- On a scale of 1–5 (with 1 being very little and 5 being substantial), how much did you think about your role as a mentor, collaborator, or sponsor to female colleagues and students before this seed grant?
- Using the same 1–5 scale, with 1 being very little and 5 being substantial, how much has that changed after your experience with this seed grant? Follow-up: Can you give one to three examples of the type of changes you have made?

Concluding Questions

A sponsor is defined as someone with influence who actively ushers a mentee through advancement opportunities, calls attention to the mentee's talents, or otherwise facilitates access to opportunities for exposure to other people of influence or promising assignments

- Did this seed grant help you acquire or access sponsorship? Follow-up: Please elaborate on how you have acquired sponsorship, OR please share at least two reasons why you feel that sponsorship opportunities were not generated.
- Did this seed grant help your collaborators acquire or access sponsorship?
- Follow-up: Please elaborate on how your collaborators acquired sponsorship OR please share at least two reasons why you feel that sponsorship opportunities were not generated.
- If you had access to another small seed grant, what project might you pursue? Follow-up: If yes, how might it be similar to or different from this seed grant project?
- Have your thoughts changed about the value small seed grants have for your career and research as a result of this experience? Follow-up: If yes, in what ways have they changed?

Data Availability Statement

Some or all data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request.

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