

Virtual Communities of Practice: Social Capital's Influence on Faculty Development

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Introduction

In this paper, we describe the benefits of a virtual community of practice (VCoP) for engineering education research (EER) faculty development. While we know that sustained engagement of engineering faculty in EER creates synergies between EER and engineering education in practice, which can support improved teaching in engineering [1], engineering faculty rarely receive formal training in EER. In an effort to assist research in the professional formation of engineers (PFE), the National Science Foundation (NSF) has invested in the PFE: Research Initiation in Engineering Formation (RIEF) program since 2016 (previous awards were made through the Research Initiation Grants in Engineering Education program, abbreviated RIGEE). The RIEF program funds engineering faculty who have little or no experience conducting social science research. The NSF considers support of engineering faculty in EER a major initiative because it increases and diversifies the community of engineering education researchers. These new engineering education researchers work collaboratively on a two-year project with experienced research mentors in pairs or in larger groups. Despite the NSF's significant investment, there is no overarching structure to support awardees' completion of successful projects and facilitate their continued engagement in the EER community after completion of the RIEF grant. To that end, our ongoing project (NSF-2029446 and NSF-2029410) has developed a series of virtual workshops within a VCoP to support engineering education faculty who are developing skills in EER. Our project aims to answer how participation in a RIEF VCoP cohort influences the engagement of RIEF project investigators in the EER community. This project addresses this gap in structure and research by providing training and structured support through a VCoP and mentorship for RIEF awardees. RIEF awardees developing skills in EER are considered the "mentees" while their co-investigators who have experience in EER are considered the "mentors" in the VCoP. Therefore, the RIEF VCoP is addressing a significant need by promoting sustained engagement of RIEF mentees in EER through the development of research-related social capital.

A recent study of RIEF participants identified needs for resources and training in methods, networking, and community supports [2]. Our VCoP workshops have focused on creating and delivering virtual sessions tailored to the topics identified by the RIEF community. These workshops support the success of RIEF projects by helping RIEF mentees fully integrate into the EER community and providing RIEF mentors access to EER resources to support their mentoring.

Background

Communities of practice are groups of people who interact on a regular basis and focus on a particular topic, creating an informal learning group. Wenger [3] describes communities of practice as "living curriculum" because the communities facilitate learning and sharing of information and resources within a group [4]. For engineering and engineering education faculty, communities of practice have been specifically developed to support early career engineering education research faculty [1] or share instructional practices [5]. A virtual community of

practice allows support and sharing of resources by bringing members together without a limitation to geography or institution; therefore, the VCoP can be highly inclusive.

Theoretical Framework

For this work, we rely on Lin's network theory of social capital [6], which examines social capital at the level of the individual person. Lin defines social capital as "resources embedded in a social structure which are accessed or mobilized in purposive actions" [7]. We use the social capital theory to understand how professional ties and a resource-rich EER network enhances RIEF mentees' capacity for and success in conducting EER. Lin's definition encompasses three essential elements of social capital: availability, accessibility, and activation [6]. While a large social network is beneficial because of the presumed abundant availability of resources, network size alone does not ensure that there is a large "volume" of social capital. It is also important for an individual to have sufficient access to people in their network who can link them to the needed resources, and those resources must be purposefully activated—that is, the individual must put them to work to achieve a goal [8]. We have provided definitions of these elements of social capital along with examples of how they might apply to the RIEF participant network in Table 1. The network theory of social capital further describes four mechanisms of social capital: (1) enhancing the flow of information, (2) influencing individuals (3) offering desirable credentials, and (4) reinforcing identity and recognition in the group [6]. Table 2 provides examples of how the four social capital functions will enrich the EER capacity of RIEF mentees.

Table 1. Elements of social capital in the RIEF participant network.

Element	Definition from SC Theory	Example applied to RIEF network
Availability	Pool of resources available in one's social network (includes strong and weak ties)	RIEF mentee knowing American Society for Engineering Education (ASEE) Education Research and Methods (ERM) members, faculty who work in Engineering Education departments/programs
Accessibility	Ease of access to resources; depends on quality of relationships and frequency of interactions (termed "strength of ties")	RIEF mentor introducing RIEF mentee to a journal editor at EER networking event
Activation	Purposive use of resources	RIEF mentee attending ASEE ERM Annual Community Celebration and Awards Reception to meet researchers with particular methodological skills related to RIEF project

Our project is building participants' professional networks in EER by increasing availability and accessibility of past and present RIEF mentees and mentors, EER content experts, people in leadership positions in the field (e.g., journal editors, ASEE division chairs), potential future collaborators, and others positioned to support or promote the work of RIEF mentees, such as research seminar organizers. The development of RIEF mentees' strong and weak ties [9-10] are being accelerated through development of their professional networks in EER. This project is facilitating RIEF mentees purposive use of embedded resources (social capital activation) to help them accomplish their EER goals during the two-year RIEF project cycle and beyond.

Table 2. Lin's Four Mechanisms of Social Capital in the RIEF participant network.

Mechanism	Example applied to RIEF network
Enhances the flow of information	RIEF mentees learn about opportunities to moderate conference sessions, apply for leadership positions in ASEE, or volunteer for NSF review panels
May influence individuals with decision-making power (e.g., "putting in a good word")	RIEF mentees are invited to give seminars or collaborate on other projects on basis of their mentor's recommendation
May offer necessary or desirable social credentials	RIEF mentees are seen as legitimate members of the EER community when they accompany mentors to events
Reinforces an individual's identity and recognition with a given social group	RIEF mentees develop an identity as engineering education researchers through their RIEF project

Project Strategy

To help participants accomplish their EER goals in the RIEF VCoP, we have focused on two specific aims in this project:

- 1) Create community support for new RIEF mentees and mentors, thereby maximizing success and impact of their NSF-funded project and their future EER projects;
- 2) Create, curate, and distribute resources for learning EER that are accessible to engineering faculty and consequently lower barriers to participate in EER and apply for RIEF grants.

We used the NSF Award Search website to identify potential VCoP participants from RIEF projects funded during the 2020 and 2021 fiscal years. We invited the first cohort of participants to join the RIEF VCoP in September 2020 and the second cohort in September 2021. We encouraged participants to share the invitation with all their relevant team members on their RIEF projects, including graduate students.

We designed the RIEF VCoP to facilitate future collaborations and provide opportunities for RIEF mentees to participate in the EER community long after the RIEF projects are completed. We hold all VCoP meetings on Zoom because it offers accessible virtual meetings that do not require any created accounts or downloaded software and has capabilities to create smaller breakout rooms to facilitate small group or paired discussions. The virtual nature of the sessions makes the VCoP accessible to participants during the ongoing COVID-19 pandemic. The frequent activities of short duration support participants' social capital development because virtual meetings are easily accessible regardless of geographic area, available monetary resources, and child or eldercare commitments. We designed the topics to provide support throughout all phases of a project and beyond.

We selected meeting topics using data collected from current and past RIEF program participants indicating what resources and community assistance they felt would best support their projects and future work in EER. In addition to the scheduled virtual meetings, we set up a Slack channel, website, and held "office hours" sessions. We archived session recordings and other resources in a Box folder for asynchronous use.

We partnered with an existing NSF-funded effort (NSF-1914735 and NSF-1914647) that hosts networking events with all past and current RIEF community members in conjunction with EER conferences. These in-person meetings at conferences further provide opportunities for RIEF mentees to expand their EER networks and build social connections at the EER conferences they attend.

We surveyed VCoP participants after each session to evaluate the efficacy of each session. The surveys serve as a method to collect feedback on topics that participants would like to see addressed in future sessions, and we use the response to make improvements to future sessions. In addition to the session feedback surveys, we have implemented an engagement survey, a social network survey, and semi-structured interviews that will be reported on in future work.

Although not in our initial plans, we used participant feedback to develop asynchronous content delivery via a series of short, downloadable information sheets on a variety of topics related to navigating proposal and grant management processes and the ASEE conference. Called Practices in Engineering Education Research (PEER) Guides, these short documents provide advice about NSF proposal and grant management processes and tips for navigating the EER research community. They can be downloaded from the [EER Mentor Network site](https://sites.google.com/view/eermentornetwork) (<https://sites.google.com/view/eermentornetwork>).

Preliminary Results

The VCoP has begun to address the two aims mentioned above: develop a RIEF community and create resources. The RIEF awards from fiscal year 2020 included 14 mentees and 12 mentors. Thirteen of the 14 mentees and 7 of 12 mentors from that RIEF cohort participated in the VCoP 2020 cohort. The current 2021 RIEF awardees cohort consists of 12 mentees and 13 mentors. We focus the preliminary findings section on the 2020 VCoP cohort.

At the time of final paper submission, we have facilitated 11 VCoP sessions and have plans for an in-person session at the ASEE conference; these are shown in Table 3.

We sent workshop feedback surveys to the 2020 cohort's 13 mentees after each session. We sent an overall feedback survey at the end of all sessions at the end of the academic year. Our preliminary survey results show that participants believe the VCoP positively benefits their EER work.

The end-of-year survey posed the question, "How useful were the presentations in learning about resources, opportunities, and other information in engineering education?" Answer options were "Excellent," "Good," "Poor," and "Terrible." Seven of 11 responses reported the level of usefulness as "Good." The other four participants reported the usefulness as "Excellent." This was encouraging to see because the participants saw a benefit to participating in the VCoP. One participant explained:

The presentation portions were helpful in providing general information... [Google Jamboards] paired with the breakout rooms were excellent resources providing valuable information.

Table 3. Virtual meeting topics for cohorts.

Date	Topics
Oct. 2020	Kickoff meeting, Program overview, Introductions
Dec. 2020	Lessons Learned: Panel of Current and Former RIEF Participants*
Jan. 2021	Mentoring Strategies*
Feb. 2021	All about Methods: Quantitative, Qualitative & Mixed Methods*
Apr. 2021	Office Hours
June 2021	Networking Event
Sept. 2021	Kickoff meeting, Program overview, Introductions
Dec. 2021	Venues for Publishing EER Studies
Feb. 2022	Office Hours
Apr. 2022	Next Steps: Funding Opportunities Beyond the RIEF Program*
May 2022	Networking Event
June 2022	Networking Event at ASEE 2022 (in-person)

Note: Asterisk (*) indicated that sessions were recorded and saved for use by subsequent cohorts.

Another participant also explained their response and why it was specifically a “Good” rather than “Excellent”:

There were a lot of great "nuggets" shared about the RIEF program, NSF, research, etc. I don't think there were presentations aimed at this, however, so I didn't give it an "excellent"

When asked about their favorite session, nine participants responded. Of the nine participants that responded, seven reported the Networking Social as their favorite session. This was not surprising because the Networking Social event occurred toward the latter half of workshop sessions. The latter half of sessions in the VCoP offered participants a chance to identify potential questions they would want to answer through future workshops/sessions. By the time of the Networking Social session, participants were also more engaged in their projects and could speak to a lot more about their experiences so far, as stated by one participant:

At this point, I had finally gotten to know a few people in the group and I felt more comfortable asking questions or just chatting. It was also great to have a few mentors there that could provide guidance and feedback and resources. It was just fun overall.

The most telling question from the survey asked, “Do you feel participation in the 2020 VCoP has helped you with your RIEF project?”. Of the eight participants who responded to this question, four felt that “Yes” it did help them while the other four indicated that participation “Somewhat” helped them. It was encouraging to note that most participants found their participation in the VCoP as positive. The suggestions for improvement have shed some light on this split of responses. For example, one participant has suggested diving deeper with very specific workshops:

More frequent meetings with deeper dives into more specific topics-like a crash course on building a questionnaire.

Although we planned shorter session with the idea that it would easier for VCoP members to participate, this quote illustrates the potential need for some longer sessions in the future.

We used feedback from the surveys to decide on the topics for the [PEER Guides](#). Creating these guides supported our aim of resource development and supported participants’ desire to access content asynchronously (and in perpetuity). We designed these resources to be used by VCoP members and other members of the EER community. To date, we have developed the following guides (click on hyperlinks to download):

- [Budgets and Budget Justifications](#)
- [Mentoring Plans for NSF RIEF Proposals](#)
- [NSF No-Cost Extensions](#)
- [NSF Supplements](#)
- [Making the Most of the ASEE Annual Conference and Exhibition](#)

Discussion

We aligned the VCoP sessions and PEER Guides with several mechanisms of social capital. They have enhanced the flow of information between VCoP members and former RIEF mentors and mentees (“Lessons Learned: Panel of Current and Former RIEF Participants”), among VCoP members who are RIEF mentors and other mentoring experts (“Mentoring Strategies”), through discussions of research methods with VCoP participants and methodological experts (“All about Methods: Quantitative, Qualitative, Mixed Methods”), through “Office Hours” sessions with VCoP participants and project leaders (Karin is a former RIEF mentee and current mentor and Julie is a current RIEF mentor and former NSF program officer), and between VCoP members and members of EER journal editorial boards (“Venues for Publishing EER Studies”). The networking sessions have served to help reinforce identity and recognition as engineering education researchers. The PEER Guides focused on NSF processes align with the mechanism of enhancing the flow of information. The PEER Guide focused on navigating the ASEE conference is designed to reinforce identity and recognition, enhance the flow of information, offer credentials, and influence individuals with decision-making power.

Overall, the responses have signaled positive experiences and increased engagement with EER while participating in the RIEF VCoP. The VCoP has been an external support structure for mentees to learn about common EER practices within a community of other engineering education researchers while developing relational resources.

The virtual format allowed for flexibility and accessibility, but it was a challenge for us scheduling a time when all or most participants could join the sessions. One major factor that may have negatively influenced participation in the VCoP was the additional time demands on faculty in their personal and professional lives due to the COVID-19 pandemic. For example, participants with young children were (and still are) dealing with disrupted childcare and schooling. The same is true for participants with eldercare responsibilities. We found that scheduling meetings according to the availability of our speakers was much more feasible than attempting to find a time when most participants were available.

Although the online aspect of a VCoP is more accessible and inclusive, participants expressed that they were experiencing “Zoom fatigue”—that is, the additional mental strain of constant videoconferencing meeting in lieu of activities that would normally be held in person. In response to this feedback, we scheduled synchronous times for networking and discussion sessions while making presentations available asynchronously. Scheduling both synchronous and asynchronous meetings was a very feasible way to address the scheduling challenges and (to some extent) the videoconferencing fatigue expressed by our participants.

One additional tip for sustaining or increasing participation is communicating requests via multiple forms of media. For example, we placed QR codes for end-of-session survey links in presentation slides during the session and sent emails out after the sessions. We did not see a direct correlation between increased communication and increased participation over time.

Future Work

We hope that our experiences might be useful to others wishing to develop virtual communities of practice within the engineering education community or in other fields. To this end, we plan to generate a set of lessons learned in facilitating our VCoP that can be downloaded and used to replicate successful VCoPs in other contexts.

We are undertaking additional assessment and research related to our VCoP. We have developed a social network survey to investigate how VCoP participants grow their EER-related networks over time. We will also use surveys to track participants’ engagement in the EER community over time by measuring their participation activities such as attending relevant conferences, publishing papers in the field, submitting EER proposals, and serving in service capacities for related journals and organizations.

Conclusions

This paper described the formation of a VCoP to support mentors and mentees in the NSF RIEF program. The VCoP included synchronous and asynchronous presentations and discussions on topics identified by former RIEF participants, as well as created documentation resources for participants to use during their RIEF projects. By creating supports for engineering faculty mentees to develop skills and networks in EER. Further, our project supports RIEF mentors through providing mentoring resources and networks. The purposeful development of social networks in the EER community for RIEF mentees supports their sustained engagement in the EER field beyond the initial two-year RIEF project. By expanding knowledge on successful and

sustained engagement of engineering faculty in EER, the project will further inform strategies to increase synergies between engineering practitioners and engineering education researchers, which will ultimately increase the impact of EER on engineering teaching practices and facilitate bridging the gap between engineering education practice and research.

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References

- [1] A. L. Pawley, A. R. Carberry, M. E. Cardella, M.-I. Carnasciali, S. R. Daly, J. L. Gorlewicz, G. L. Herman, M. M. Hynes, S. S. Jordan and N. N. Kellam, "The PEER Collaborative: Supporting engineering education research faculty with near-peer mentoring unconference workshops," presented at the *121st American Society for Engineering Education Annual Conference and Exposition, ASEE 2014, Indianapolis, IN, USA, June 15-18*.
- [2] M. Ko, J. F. Mirabelli, A. J. Barlow, K. J. Jensen, & K. J. Cross, "Faculty motivations and barriers for engineering education research," presented at *American Society for Engineering Education Virtual Annual Conference, ASEE 2021, July 26-29*.
- [3] E. Wenger, "Communities of practice: A brief introduction," STEP Leadership Workshop, University of Oregon, 2011.
- [4] J. Lave and E. Wenger, *Situated learning: Legitimate peripheral participation*, Cambridge, MA: Cambridge University Press, 1991.
- [5] G.L. Herman, L. Hahn and M. West, "Coordinating college-wide instructional change through faculty communities," in *proceedings of American Society of Mechanical Engineers International Mechanical Engineering Congress and Exposition, IMECE 2015, Houston, TX, USA, November 13-15*.
- [6] N. Lin, *Social capital: A theory of social structure and action*, Cambridge, MA: Cambridge University Press, 2011.
- [7] N. Lin, "Building a network theory of social capital," *Connections*, vol. 22, no.1, pp. 28-51.
- [8] N. Lin, "A network theory of social capital." *The handbook of social capital*, vol. 50, no. 1, pp. 69, 2008.
- [9] M. S. Granovetter, "The strength of weak ties," *American Journal of Sociology*, vol. 78, no. 6, pp. 1360-1380, 1973.
- [10] R. S. Burt, "A note on social capital and network content," *Social networks*, vol. 19, no. 4, pp. 355-373, 1997.