Impacts of the ProQual Institute: Building communities of technical STEM faculty for long-term engagement in educational research

In this paper, we report on the impacts of the ProQual Institute—a $1M award via the NSF ECR-EHR Core Research program in 2019—as it nears the end of its funding period. The ProQual Institute's goal is to build national capacity for STEM education research by engaging technical STEM from across the U.S. in cohorts that participate in an 8-week course on qualitative and mixed methods educational research techniques, followed by engagement in several communities of practice to continue supporting participant research projects and building participants' confidence as educational researchers. This project was funded based on impact rather than knowledge generation; thus, this paper will report on the impacts of the ProQual Institute in terms of participants served and evaluated outcomes and project team observations. The key evaluation questions we answered were:

1. To what extent did the project design and implement a high-quality and culturally responsive training program?
2. What knowledge and skills did participants gain because of participation in the ProQual Institute?
3. How could the ProQual Institute be built upon to improve participant outcomes?

Background & Conceptual Framework

The target audiences for the ProQual Institute were STEM instructional and technical tenure-track faculty (natural scientists). Historically, integrating these two groups into STEM education research communities has been both challenging and essential to the health of the field. Instructors from various disciplinary backgrounds, have contributed significantly to the development of educational research networks and communities [1, 2]. Many educational research programs also draw on these communities to recruit future scholars [3, 4]. These dynamics are evident in engineering education research, a field that initially developed from public exchanges between [5-7] and explicit efforts of, passionate engineering educators [8, 9].

Other disciplinary contexts have explored the value of, and challenges associated with, more deeply involving educators in educational scholarship [10-12]. A number of scholars have explored an epistemological facet of teachers' participation in two distinct but related worlds through the tensions between the applied focus of educational practice and the orientation of educational research toward generating abstract knowledge claims in the sense of a "pure" science [2, 13, 14]. In examining these goal differences, Joram [14] described the challenge for educators as anchored in perceptions that, "research is divorced from the real world of teaching, and … research is inaccessible to them because of the overly technical format in which it is presented" (p. 124). The ProQual Institute aimed to bridge this gap by teaching educational research design not as a series of technical skills and hurdles to overcome independently but as an exploratory and curiosity-driven process conducted as part of a supportive community of practice.

A review of the literature concerning natural scientists engaging in educational research reveals a complex interplay of challenges around assumptions of ontology, epistemology and, ultimately, the nature and purpose of research. More specifically, literature highlights the ontological and

epistemological tensions that can arise from the differences between the often implicit assumptions of objectivism and materialism in the sciences and understandings informed by social constructivism and interpretivism that underpin many forms of educational research [13, 15]. Some of these issues have been previously explored in engineering education as "conceptual difficulties" experienced by trained engineers learning educational research methods [16]. For example, in a discussion of the difficulties of preparing educational researchers in the broader STEM education context, Labaree [17] described scientists as "building scholarly skyscrapers on the apparently durable base of hard-pure research" (p. 14), who are then faced with the quite unfamiliar "marshy epistemological terrain" (p. 14) of educational inquiries. Put another way, Berliner [18] described this tension as a contrast between the pursuit of universal laws in the sciences and the crafting of contextual, transferable findings in educational research. The ProQual Institute aimed to help resolve this tension by providing a means to systemically identify and scope a social reality to investigate, borrowing from a pragmatist perspective to help participants understand the value of qualitative research as a means to understand facets of lived experiences that quantitative approaches cannot fully capture.

Conceptual Framework

To introduce qualitative research accessibly to both STEM instructors and natural scientists, we selected a framework that helped participants realize how to integrate high-quality research practices into all aspects of the research design process, in a way that is intuitive, equitable, and mapped to the intellectual curiosity of the researcher. The framework upon with project activities were built is the Qualifying Qualitative Research Quality (Q3) framework pioneered by Walther, et al. [19]. This framework presents qualitative research quality as an essential and context-sensitive consideration in every aspect of a study's design, rather than as a series of specific strategies that can be added to a research design to increase quality [19, 20]. The framework divides research quality into six kinds of validation that must be considered in both the making and handling of qualitative data. Table 1 defines these dimensions in greater detail.

Table 1: An overview of the Q3 framework for qualitative research quality

Form of Validation	**Key Concern in Making Data**	**Key Concern in Handling Data**
Theoretical Validation	Does the research process wholly capture everything the researchers want to learn about the social reality under investigation?	Do researchers' interpretations fully reflect the coherence and complexity of the social reality under investigation?
Procedural Validation	Do the research procedures afford the researchers an authentic view of the social reality under investigation?	What processes are in place to mitigate the risks of the researchers misinterpreting the participants' lived experiences?
Communicative Validation	How is meaning co-constructed with participants to ensure that data represent participants' social realities on their own terms?	How is data co-constructed with research communities to build upon existing work while remaining authentic to research participants?

Pragmatic Validation	Is the selected theoretical framework a good fit for the social reality under investigation?	How meaningful are the study's results to the social reality under investigation (and other similar social realities?)
Ethical Validation	Is the study conducted reflexively, responsibility, and in the best interests of social reality under investigation?	Do the findings do justice to the social reality under investigation, and positively impact the people that comprise it (and other similar social realities?)
Process Reliability	How can random influences on the research process be mitigated, and how can the social reality under investigation be dependably captured or recorded?	How can the researchers demonstrate and document the dependability of their data collection and analysis approaches?

The premise of the ProQual Institute is that training faculty how to conduct high-quality qualitative research should begin not with an overview of approaches, theories, and methods. Rather, it should begin by helping participants identify and answer the right questions to design their studies from the ground up to maximize the studies' alignment with each of the six forms of validation. We call this approach a "**methodologically unencumbered**" introduction to qualitative research. Drafting a properly scoped investigation of a well-defined social reality of interest is the most critical first step, and the other decisions involved in the conduct of qualitative research flow more easily from there, with the Q3 framework as a constant guide.

Project Implementation & Evaluation Methods

The name "ProQual Institute" alludes to the two defining features of our approach to helping STEM faculty develop as educational researchers. First, the institute was **problem-led**: Participants came to the institute with a specific educational research idea in mind, and the skills they learned during the institute helped them develop that particular idea. Second, the institute focused on **research quality**: Participants learned to integrate the Q3 framework into their research design from the very first activity they were asked to do, and the framework served as a consistent guidepost for every decision, including problem definition, framework selection, methodological design, and communication planning.

Project Activities

The project incorporated multiple activities to help the STEM faculty participants develop skills, confidence, and community around educational research. First, all faculty participated in the **institute** proper, a structured course conducted over Zoom with eight modules (one module per week), ultimately building toward a complete research design for the participants' projects. The institute included homework to be done between sessions in which participants took the ideas from the Zoom classes and applied them to their own projects; this homework was framed as an essential but optional part of the experience, recognizing that faculty are busy and sometimes unable to devote hours of attention each week to the institute. Table 2 shows the full institute curriculum. A total of three institutes were held—in spring 2021, fall 2021, and spring 2022.

Table 2: Curriculum of the project's institute

Week	Topic(s) Covered
1	Community formation, social realities under investigation, pictorial systems mapping
2	Pictorial systems map refinement, scoping the social reality to investigate
3	Identifying appropriate theories, analyzing published qualitative research
4	Deep dive into the Q3 framework, aligning study design with forms of validation
5	Applying the Q3 framework to participant projects (small working group format)
6	Using methodologies, overview of common qualitative methodologies
7	Qualitative data analysis, analysis software, and coding practice
8	Wrap up – Putting everything together and seeing a full example study in action

Second, concurrently with the institute, project leadership held weekly **community hours**, which functioned similarly to traditional office hours. These were Zoom meetings where any and all participants were welcome to ask questions about institute content or how to apply that content to their projects, and receive help from project leadership and fellow participants alike. These community hours were framed as optional in the first cohort, but feedback about their usefulness prompted the project team to more strongly encourage participation in later cohorts.

After each cohort of participants "graduated" from the institute, project leadership held follow-up **research incubators**—one in fall 2021 (for the first cohort), two in spring 2022 (for the second cohort) and two in fall 2022 (for the last cohort.) These incubators were held every 1-2 weeks and provided a forum for institute graduates to continue developing their research ideas in the context of a supportive cohort. Participation in these incubators was optional but incentivized via a $3,000 stipend. The incubators served two major purposes. First, they helped participants maintain self-accountability for continued engagement in their educational research projects. Second, they were intended to help participants build a sense of expertise and authority as educational researchers. Unlike with the community hours, the project leadership was careful to intervene only when necessary, letting the participants lead the processes of presenting their ideas and providing feedback to their peers.

Finally, at the prompting of participants, we supported the continuation of the incubators beyond the first semester and the creation of **participant-led communities of practice** around particular topics of interest. Project leadership provided interested individuals with an additional $3,000 stipend to lead and recruit for both the incubators and communities of practice, and otherwise took an entirely hands-off approach to these ongoing activities; they were entirely participant-run. As an example, one institute graduate hosted a community of practice for studying graduate student cultures, which enjoyed more than ten participants in an average meeting. Two ongoing incubators and three communities of practice have been hosted so far.

The participants

Across the three institute cohorts, the ProQual Institute has enjoyed the participation of 48 STEM faculty, averaging 16 participants per cohort. Recruitment for the institutes focused on minority-serving institutions in the southeast United States, but we also amplified recruitment at the national level through ASEE listservs, NSF contacts, and word-of-mouth advertising from early participants. Participants were overwhelmingly women (n=37, 77%), included many faculty of color (n=21, 44%), and spanned 19 states and two other countries (Canada and Oman.)

In terms of methods experience, 19 (40%) reported being new to research, 19 (40%) reported having experience with quantitative and qualitative research methods, and the remainder (n=10, 21%) reported being familiar with one kind of method but not the other. Of the 48 incubator participants, 28 (58%) participated in the incubators and other post-institute activities.

Evaluation methods

An external evaluation team conducted semi-structured interviews during summer 2022 to understand participants' experiences in the program (particularly, the institute and, for those to whom it applied, the incubators) and to determine the effectiveness and possible improvements for the project moving forward. Interviews were designed for participants to reflect and share experiences of their participation, engagement, learning process, and the overall impact of the institute. The evaluation team interviewed a total of 23 volunteer participants via Zoom. Interviews ranged from 30 to 45 minutes. The interviews were audio-recorded and transcribed using Otter.ai, an artificial intelligence transcription service.

The evaluation team designed and used a semi-structured interview protocol to allow for a set of standardized questioning across respondents, as well as understand personalized perspectives. Evaluators developed interview questions using the broader evaluation questions to gain insight into the quality of the institute, its impact on participants' learning and behavior, the results of engaging in the institute, and the replicability of the training structure and curriculum. Questions were also designed to consider the mission, vision, and goals of the ProQual Institute.

The interviews were analyzed using content analysis [21] and thematic coding [22, 23] in ATLAS.ti qualitative data analysis software. This method of data analysis allowed the evaluation team to systematically categorize and summarize common or frequent areas addressed across all interviews. The data analysis of interviews employed an inductive approach as categories emerged throughout the coding process. Initially, four interviews were perused and analyzed to create a preliminary coding scheme, and then all 23 interviews were coded using the coding system developed. In coding all interviews, new categories emerged and were further analyzed by identifying common patterns and negative cases within each category.

From this point forward, we use the term "**participants**" to refer to participants in the evaluation process. Participants in the project overall will be referred to as "**graduates**."

Evaluation Results

Participants positively evaluated their experience in the institute and provided constructive feedback along five emergent themes. Table 3 shows these themes along with a summary of results. The remainder of this section will take a deep dive into each theme, leveraging participant quotes to elaborate further.

Table 3: Summary of evaluation results along each of the five emergent themes

Theme	Positive Feedback	Constructive Feedback
Program design and structure	The design and structure of the 8-week course was well-received by participants, who especially praised its focus on individualized	The time requirements for the course, while reasonable for many participants, were a significant barrier for many others. Participants reported

	project development and orientation toward community learning.	time as the number one barrier for continued engagement.
Motivation, engagement, & support	Participants reported diverse reasons for participating in ProQual, including a highly engaging and supportive system to participants during and after their training.	Participants with little to no experience in qualitative research reported struggling more than their peers. Several participants also struggled to understand the organization of the project team's document management system.
Increased knowledge & skills	Most participants expressed a more thorough understanding of interpretive research methods because of their participation in the course and have adapted their own approaches to research accordingly. They also reported an increase in critical analytical skills, confidence levels, and awareness of ethical considerations in educational research, among other areas.	Participants requested more practice in hands-on components of qualitative research, particularly coding.
Perceptions of interpretive research before and after the institute	Participants reported more positive perceptions of qualitative research resulting from participation, particularly in terms of its usefulness in answering diverse research questions and its accessibility.	Participants indicated a desire for a printed book containing the Q3 research design approach and resources that they could continue to reference as they conduct interpretive research in the future.
Diversity, inclusion, & cultural sensitivity	Participants expressed ProQual's training provided a profound approach to diversity, inclusion and culturally sensitive research as ProQual's training approach to education had built a diverse and inclusive environment where individuals with different races, cultures, perspectives, previous knowledge and backgrounds came to learn together in a collaboratively way.	Evaluators suggested including more explicit, modular discussions of diversity, inclusion, and culturally sensitive approaches to improve participant recall of these topics.

Theme 1: Program design and structure

Participants reported feeling highly satisfied with the organization and structure of the training. For example, some of the areas they considered a strength of the training design were the organization, quality of materials, the lesson times followed by open office hours; the virtual sessions; the community hours; and having time in between each of the sessions, so they could "digest" everything they had learned. As one participant said:

> I thought it was great. I really liked the way it was structured, having the work ahead of time I didn't feel was too much to get that weekly work done. I thought the actual meetings were very well organized in terms of time. […] I thought the other participants were really engaged, which was nice. I thought the overall structure of the way they presented the material was really good. I liked the way they had kind of thought about the whole process and how they led us through from drawing a picture at the beginning to putting all those pieces together.

Other components of the training that were considered effective were the webinars, the readings, the worksheets, the shared Google Drive, and the slides. Participants enjoyed how the institute's curriculum built upon itself to arrive at a complete research design. One participant commented,

“I really liked how it was structured, and each week built on the next, but it had its own sort of focus.”

Participants also indicated that they were pleased to:

1. Develop a research project from the start of the course.
2. Learn about different research methods, approaches, techniques, and strategies.
3. Have the flexibility to expand on specific knowledge and skill areas.

They commented that they had especially enjoyed sharing ideas with others and receiving feedback in an ongoing manner. In addition, the multiple spaces provided to get to know other participants and to learn from one another were highly appreciated. Participants who engaged with the research incubators described the incubators as particularly important for helping them feel like a legitimate part of a larger research community. As one participant put it:

> I really enjoyed the second semester where they did a research incubator and [we got] to share ideas with each other and get feedback on ideas. It really helped me to build confidence and [learn] what does a good project look like and how can I look at my own project with a critical eye and look at other people's projects to develop strength in their projects. [It] was a cool experience to get to have those conversations and talk to different people with different perspectives on what could be done for that specific project area. I really, really enjoyed that.

Constructively, participants noted that the time requirements to engage with the optional facets of the ProQual Institute required to get the most out of it—the community hours, homework, incubators, communities of practice, etc.—were a large barrier to continued commitment to the project. Time was the number one barrier to continuing participation, which is perhaps unsurprising given that many participants were instructional faculty with minimal research time built into their jobs. One participant’s statement was particularly telling in this regard:

> I was a teaching faculty with no previous training in social science trying to do this work. And I was teaching 120 students, three capstone design courses—21 teams of senior students. I was drained, completely drained, and I couldn't keep up, I wish I could read more, I wish I could do more, but I was mostly doing the bare minimum that I could do. Anyways, I [gained] amazing experience, [and] I have the resources I could go back [to] whenever I need to, but that was the biggest challenge, the time for me to invest outside the time of the workshops.

Theme 2: Motivation, engagement, & support

The vast majority of participants pointed out high levels of support as a strength of the ProQual Institute. They frequently noted the support from the community of learners and the leading team as contributing to their positive experiences. Several individuals who participated in the interviews expressed high satisfaction with the collaborative network that the ProQual Institute had nurtured since the beginning of the training. They expressed not feeling alone, having a group of colleagues from different disciplines and universities who were always willing to provide feedback and share resources while developing and conducting their research. This group of people they can reach out to whenever they need was considered a way to get out of

their comfort zones and expand their understanding of qualitative research. This community was particularly impactful for participants without educational research contacts at their institutions, as one participant succinctly described:

> I'm the only one who has tenure track in my department, so I don't have that like community of scholars in my department that I can kind of bounce qualitative methods off and say, “Hey, have you ever done this?” Or, “I'm thinking about this, can you try that?” Or, “I'd like to try that.” So, recognizing that now I have this network of people that I can reach out to through the ProQual Institute and not being shy about just like, posting on Slack or wherever, if I'm interested in something like, “Hey, has anybody ever done this method?” Someone will speak up.

Also, the project team and facilitators were all highly praised. Participants of the ProQual Institute commented that the project team had been highly responsive and welcoming and that they cared about participants’ learning. Readings, slides, and worksheets further supported the training program experience. Participants also reflected that all questions were answered in a kind, open, and friendly manner. As one participant expressed:

> I really appreciated the opportunity and [especially] the leadership of [members of the leadership team], and just the fact that they are such advocates for practitioners. I feel like it's really hard sometimes being [in this position], I feel very alone because I see education research from all of these different disciplines, but all of them have their own way of doing [research]. [So] it was nice to talk to reasonable people that were talking about a method that could be not just applicable in STEM, but I think across a lot of disciplines.

Constructively, several participants noted that the institute’s pacing was not perfect for all participants, particularly those with less research experience coming into the institute. As one of the participants indicated, “I was at the lower end of the knowledge spectrum, and so to me, it felt a little tougher for me to get, I think, the real insights.” Another respondent shared that there were kings of “emergent experts” in the workshops and other participants slowly picking things up, highlighting the importance of better acknowledging incoming skill levels and teaching equitably to this segment of the audience.

Another common piece of constructive feedback was that the systems we used to organize files (*Google Shared Drives*) and facilitate asynchronous conversations (*Slack*) could have been designed more thoughtfully to allow participants to find the support they needed more easily. One participant highlighted that the variety of systems used at different institutions may necessitate more direct training in educational technology being used for inter-institutional training initiatives like the ProQual Institute:

> Organizationally, the Google [Shared] Drive was sort of a confusing document management system; a lot of the documents were difficult to find. […] Slack has been hit or miss. I think it depends on whether people are Slack users or not. I am a Slack user so I'm very comfortable posing questions or engaging with others, not just with [the project leaders], but when someone posts a question and I feel like I have a contribution to make, I can respond to them. I think others maybe are less familiar with Slack [and] saw it as a

> way of direct messaging [the project leaders] and weren't interested in communicating with others.

Theme 3: Increased knowledge & skills

Participants shared with the evaluation team that they now use technical language and terminologies better, allowing them to evaluate research literature, develop skills to become a reviewer, and help others by evaluating their work. Several participants also indicated that they have intentionally shared the analytical skills and qualitative foundation that they have gained from the ProQual Institute with colleagues because, as one participant shared, “peer review is not just when we put in journal articles, but peer review can start when we are thinking of ideas, forming our research and supporting a community of researchers.” The interviewees frequently spoke of an increase in their confidence as qualitative researchers. They commented that thanks to ProQual Institute they felt more confident in engaging in qualitative or mixed methods research.

Some participants also indicated that after participating in the ProQual Institute, they now have increased awareness about how the researchers’ ontology, axiology, and epistemology frame their chosen research methods and research questions. These participants shared that the ProQual Institute has heightened their awareness of the impact of qualitative research, how to conduct research sensitively, and the impact of context. As a result, they understood that the qualitative researcher needs to seek validity and trustworthiness by accurately portraying individuals' perceptions and experiences. As one respondent highlighted, “we spent a fair amount of time talking about things that interviewers should or should not do, and ways to phrase questions so that they were inclusive and had potentially minimal impact on the interviewee.”

Finally, participants indicated that participating in the ProQual Institute resulted in acquiring a better skillset for research. Some of them commented that they have developed a better understanding of the coding process, how to generate data, what data to collect to answer research questions, how to conduct interviews, how to analyze data, how to do a thematic and discourse analysis, the employment of the Q3 Framework, understanding the technical language, understanding the different processes, drawing a pictogram, doing a literature review, how to use theories to support research, limitations, thinking and planning for the worst case scenarios, and the use of some analytical software such as NVivo. In addition to these hard skills, some participants also referred to soft skills they had gained during their training. Some examples they provided were related to working with others in a team and communication skills. For instance, one participant reported:

> I feel like I'm better at communicating things. Almost like I have a better vocabulary. I have better communication skills because of the institute. I'm trying to think of like specific things, having the social reality was really nice, being able to show that to my students, being able up to get them to kind of wrap their head around what that looks like and what that means for our work.

Constructively, though, some participants newer to qualitative research expressed a desire to spend more time practicing key hands-on skills, such as coding data, analyzing others’ research methods, and how to find and identify appropriate theories. This feedback again highlights the

importance of finding ways to teach equitably to an audience with a diverse array of prior qualitative research experience.

Theme 4: Perceptions of interpretive research before and after the institute

All interview participants agreed that participating in the institute changed how they perceived qualitative research. There were three types of responses regarding the amount of prior knowledge and experience working with qualitative/mixed methods research. Many commented that before the training, they had a fundamental understanding of qualitative and mixed methods research. Some indicated they had no knowledge, experience, or formal training in developing this type of research. Finally, a smaller group of individuals expressed that they already had solid qualitative and mixed methods foundations before beginning the institute.

Overall, many participants reported having more experience and knowledge working with quantitative approaches to research. In addition, they commented that before engaging in the institute training, their perceptions were that qualitative research was nebulous, less systematic, complex, extraordinarily time intensive, scary, complicated, and confusing. A few of them shared that before their training, they considered qualitative data, not real data, because "you cannot quantify it." Nevertheless, many saw great value in it even though they had no previous knowledge. They considered that qualitative research "is really good when you have to get in-depth, or when you're looking at a topic that has not been studied a lot."

After the institute training, interviewees also noticed a change in their perceptions about qualitative research and mixed methods. They feel more confident speaking about qualitative research and how it can be approached with quality. Some considered it especially useful to look at research problems that cannot be easily understood and approached using a quantitative method. A few participants highlighted the usefulness of mixed methods for reinforcing qualitative and quantitative data and finding disparities or differences among both. Overall, qualitative research was described more after the training in terms of being "useful, positive, and accessible."

Theme 5: Diversity, inclusion, & cultural sensitivity

Participants reported that ProQual Institute's training approach to education had built a diverse and inclusive environment where individuals with different races, cultures, perspectives, previous knowledge, and backgrounds came to learn together collaboratively. These individuals commented that the environment was always encouraging, welcoming, and inclusive. A few of them also shared with the evaluation team that they had never felt discriminated against due to gender or race. One participant commented:

> I think this training was much more inclusive of people that didn't come from a traditional education background, you know, but were practitioners. And that's something that I think is really important to incorporate into the field. And that was really highlighted and appreciated through the training, which I think is really unique compared to a lot of other courses I've taken through kind of more traditional educational paths.

Even though a few of the participants indicated that they had never explicitly seen elements of culturally responsive pedagogy, critical consciousness, or something similar, most of them

pointed out that the facilitators highlighted the relevance of aspects such as context and representation, in terms of diversity and inclusion, in research on several occasions. For example, one participant commented that this was evident, "especially when we talked about ethics and how to administer things like surveys and focus groups and interviews, there was attention paid to being inclusive and culturally sensitive." As they shared, this resulted in a deeper awareness of the relevance of incorporating participants as partners in a meaningful way. Another participant stated this insight explicitly:

> It's really given me a much deeper mentality, but also skills to really think more deeply, more thoughtfully, more considerably about issues of diversity and inclusion. I want to grow as someone who's incorporating participants as partners, more than just being researched upon […] I mean, just observing at this professional development program, and seeing how the leaders acted with sensitivity, with knowledge, it just gives me a really good role model […] it's something that I could try to emulate.

Constructively, some participants stated they had no recollection of issues of diversity and inclusion being explicitly discussed during the institute. As a result, the evaluation team recommended including a module on these issues as part of future curriculum.

Discussion (Lessons Learned)

The evaluation results shed light on the impacts of the ProQual Institute and revealed several lessons for the successful training of instructional and technical STEM faculty for educational research. First, we designed the project under the research-informed assumption that a cohort- and community-based approach would be essential in helping participants build confidence and expertise as educational researchers. The evaluation results thoroughly confirmed this assumption to be correct. The development of an ongoing educational research community of practice that includes both project participants and leadership was repeatedly cited by evaluation participants as essential to their experience. This observation aligns with work around the efficacy of propagation approaches for educational change, demonstrating that sustained support to help learners translate new skills to their own contexts is essential for sustained change in academic environments [24].

On the other hand, long-term commitment to participate in communities of practice requires time, which participants reported being in short supply. Faculty time limitations are well-documented as constant constraints in all facets of faculty development work [25-27]. There is no "silver bullet" solution to this problem. It is our belief that faculty should be free to dictate their own professional development engagement based on their availability to do so. We viewed our responsibility as reducing other barriers to entry into the educational research space (intimidation to engage, epistemological tensions, etc.) to make engagement easier once time allows. Furthermore, we heard anecdotally from several participants who engaged in the follow-up research incubators that regular meetings as part of a cohort helped with their time management, providing a measure of accountability to stop their intellectual curiosity from falling to the wayside amidst more pressing responsibilities. For these reasons, we believe a community-based approach to educational research training was a productive approach despite the time commitment required.

One piece of constructive feedback we did not anticipate was that many participants struggled to adapt to the educational technology we elected to use. We used Google Shared Drives to organize our files for participants and Slack as a communication tool between participants. We sent an email to project participants at the start of each institute explaining how we organized each system and how we anticipated everyone using the systems. We assumed this would be enough to acclimate participants, but evaluation responses indicated that participants who were less familiar with Google Drive and Slack needed more preparation to use these tools effectively. In running any future cross-institutional training activities, one of our first priorities would be to offer more in-depth support and training in the use of the technology being used for organization and communication.

Conclusion

Engaging technical and instructional STEM faculty in educational research is an important avenue to better understand diverse student experiences and improve STEM education systems. The ProQual Institute has demonstrably achieved an effective process for training STEM faculty in educational research using a methodologically unencumbered approach rooted in communities of practice and a propagation model of change. Our results indicated that the presence of continuous support from both project leaders and community peers, coupled with an approachable way of thinking about research design, were critical in helping participants develop skills and confidence as educational researchers. Moving forward, we believe our project demonstrated the efficacy of contextually sensitive propagation approaches (as opposed to dissemination approaches) to change, and that the development of cross-disciplinary communities of practice is essential to the continued engagement of STEM faculty in educational research and practice.

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