

Impacts of the ProQual Institute: Summative evaluation of participant skills, perceptions, confidence, and research products from a qualitative research institute

In this paper, we report on the final evaluation of the impacts of the ProQual Institute (PQI)—a \$1M award via the NSF ECR-EHR Core Research program in 2019—as it nears the end of its funding period. The results of this evaluation build upon the previously reported findings of interviews in a prior ASEE conference paper [1]. The PQI’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 and other opportunities to continue supporting participant research projects and building participants’ confidence as educational researchers. This project was funded based on impact rather than research or knowledge generation; thus, this paper will report on the impacts of the PQI in terms of participants served, evaluated outcomes, and project team observations. We answered seven evaluation questions, grouped into two categories:

Category 1: Efficacy of the PQI curriculum and activities

1. To what extent did participants find PQI activities worthwhile for their development?
2. To what extent did participants believe PQI activities are helpful and accessible for STEM faculty more broadly?

Category 2: Participant outcomes beyond PQI activities

3. To what extent did the PQI improve participants’ knowledge and comfort level around using qualitative and mixed methods?
4. To what extent did the PQI increase research productivity among participants?
5. In what ways did the PQI affect participants’ perceptions of qualitative research?
6. In what ways did participants apply the new knowledge and skills gained via the PQI?
7. To what extent are participants using qualitative and mixed methods in new research projects since “graduating” from the PQI?

Background & Conceptual Framework

As similarly stated in our publication of prior evaluation results [1], the target audiences for the PQI 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 [2, 3]. Many educational research programs also draw on these communities to recruit future scholars [4, 5]. These dynamics are evident in engineering education research, a field that initially developed from public exchanges between [6-8] and explicit efforts of passionate engineering educators [9, 10].

Other disciplinary contexts have explored the value of, and challenges associated with, more deeply involving educators in educational scholarship [11-13]. Several 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 [3, 14, 15]. In examining these goal differences, Joram [15] 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 PQI 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 the nature and purpose of research. More specifically, the 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 [14, 16]. Some of these issues have been previously explored in engineering education as "conceptual difficulties" experienced by trained engineers learning educational research methods [17]. For example, in a discussion of the difficulties of preparing educational researchers in the broader STEM education context, Labaree [18] 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 [19] 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 PQI 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 which project activities were built is the Qualifying Qualitative Research Quality (Q3) framework pioneered by Walther, et al. [20]. 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 [20, 21]. 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 Concerns in Handling Data
Theoretical Validation	Does the research process wholly capture everything the	Do researchers' interpretations fully reflect the coherence and complexity

	researchers want to learn about the social reality under investigation?	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 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, responsibly, and in the best interests of the 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 PQI is that training faculty on 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. This process is summarized in the form of a flowchart in Figure 1 (revised and updated from a similar flowchart in a prior publication, [22]).

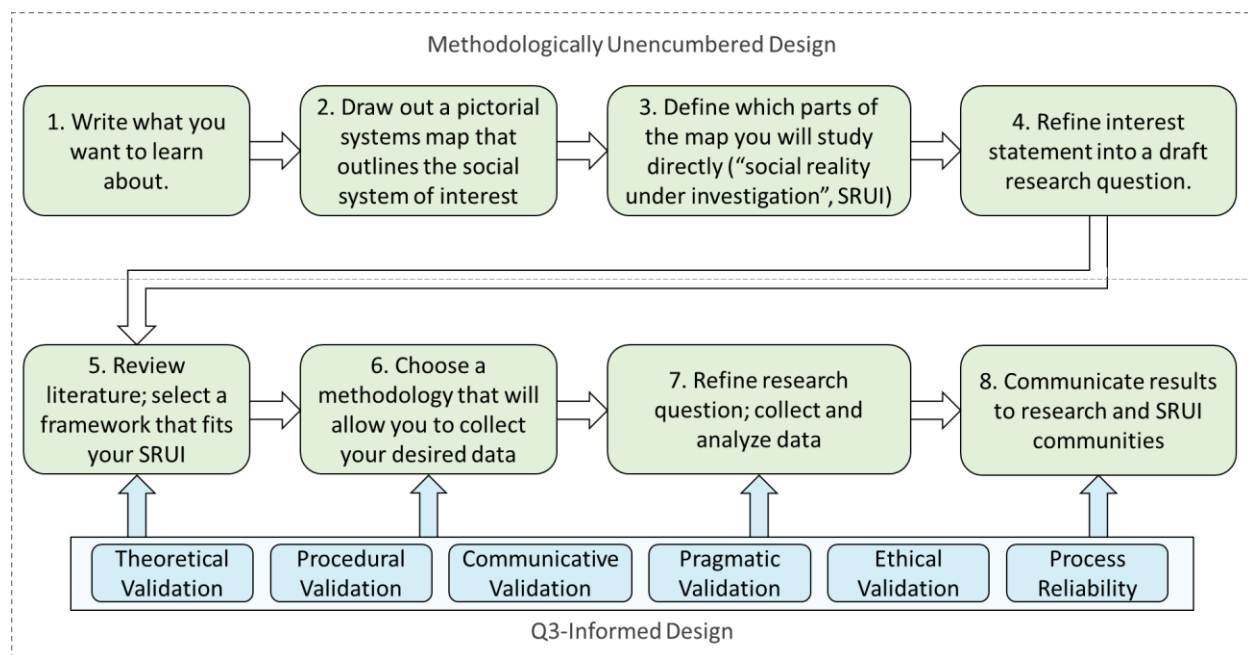


Figure 1: A visual representation of the ProQual Approach to research design, which served as the basis for PQI curricula and activities. Revised and updated from a similar flowchart in a prior publication [22].

Project Implementation & Evaluation Methods

The name “ProQual” alludes to the two defining features of our approach to helping STEM faculty develop as educational researchers. First, the institute was **problem-led** (“Pro”): 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** (“Qual”): 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 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 ProQual 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 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 encourage participation more strongly 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 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 the community hours, the project leadership was careful to intervene only when necessary, allowing PQI graduates to lead the processes of presenting their ideas and providing feedback to their peers.

Furthermore, 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 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 PQI graduate hosted a community of practice for studying graduate student cultures, which enjoyed more than ten participants in an average meeting. We supported a total of two participant-led incubators and five communities of practice.

We also provided PQI graduates with an opportunity to work with project personnel one-on-one to receive coaching in the development and strengthening of grant proposals for their projects. A total of 11 participants engaged with this opportunity. Table 3 illustrates four examples of proposed projects whose development the ProQual project team has supported.

Table 3: Examples of grant proposals ProQual has helped develop through coaching

Research topic	Scope of social reality under investigation	Methodology employed	Funding pursued
Extracurricular STEM mentorship for racially minoritized K-12 students	Mentorship experiences of racially minoritized youth and mentors in a community youth program in a large U.S. city with a high poverty rate.	Action research, interviews	NSF AISL
Centering the engineering identity of black men to enhance degree completion and representation	Experiences of Black men in engineering, especially at HBCUs and HSIs	Interpretive Phenomenological Analysis and photovoice, interviews	NSF CAREER
Understanding the barriers that contribute to the gender gap in higher education computing disciplines	Decision-making factors that influence the choice of high-achieving women to stay or exit the computer science pathway	Narrative analysis, interviews	NSF BCSER
Identifying intervention targets to increase mental health help-seeking in undergraduate engineers	Help-seeking beliefs of diverse students	Mixed methods approach to improve and refine the Engineering Mental Health Help-seeking Instrument (EMHHI)	NSF EEC

Finally, we provided participants with an opportunity to become trainers in the ProQual Approach by coordinating workshops led by PQI graduates at engineering education conferences. At the time of writing, we have coordinated one such workshop opportunity [22], with another workshop proposal under consideration. The high participation rate in these workshops reinforces a continuing desire for professional development in qualitative research approaches within the engineering education community.

The participants

Across the three institute cohorts, the PQI 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 methodological expertise, 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 employed a comprehensive survey methodology encompassing various item types, including demographics, Likert scale, select all that apply, and multiple-choice items. The survey aimed to gauge participants' engagement with PQI activities; their knowledge, perceptions of, and comfort with qualitative and mixed methods; assessment of training outcomes and curriculum; the influence of PQI training on research dissemination; and self-reported behavioral changes before and after training. Questions were also designed to consider the mission, vision, and goals of the PQI.

The recruitment process involved reaching out to all participants from the PQI, emphasizing voluntary participation without any incentives. The evaluation team administered the survey through a secure online platform (Qualtrics) to safeguard participant confidentiality. Before taking the survey, participants were presented with an informed consent statement, assuring them of the survey's purpose, confidentiality, and voluntary nature. The response rate was 67% (32/48), though not all participants answered all questions. The results of this evaluation are shared in aggregate to maintain individual privacy. This paper reports on findings and recommendations for the training program offered by the PQI, which continues operating outside the scope of the grant via an organization established by the original Principal Investigators of the ProQual project.

The collected data underwent descriptive statistical analysis for Likert scale items using SPSS and thematic coding for open-ended responses using Atlas.ti software. Ethical considerations were paramount, ensuring confidentiality, responsible data usage, and participant privacy. These data analysis methods allowed the PQI evaluation team to systematically categorize and summarize common or frequent areas addressed across all open-ended responses and synthesize the quantitative results from the multiple-choice and Likert scale items. The data analysis of open-ended responses employed an inductive approach as categories emerged throughout the coding process.

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 “**PQI graduates**.”

Evaluation Results: Efficacy of the PQI curriculum and activities

A primary concerns of the project team were the value that the PQI offered from participants' perspectives and the accessibility of the PQI for teaching qualitative and mixed methods to technical STEM faculty. The first two sections of the survey addressed these outcomes. The number of participants responding to each survey section is specified.

1. Value of PQI activities for participants' development (Likert scale, n=25)

The majority of survey respondents expressed a positive experience with the direct outcomes of ProQual training, as summarized in Figure 2. Ninety-two percent (n=23) of survey respondents reported that investing their time in ProQual activities was worthwhile, making it the highest-rated item (M=4.92, SD=0.27). There was an overall positive perception regarding how participation in ProQual had benefited participants in their academic pursuits (M=4.80, SD=0.49), how engagement in the ProQual-supported community had impacted their research

($M=4.40$, $SD=0.69$), how their communication skills had improved as a result of ProQual's training ($M=4.08$, $SD=0.89$), and how it had boosted their confidence in pursuing various external funding opportunities ($M=4.04$, $SD=0.92$).

Two items received slightly lower ratings: 'I think ProQual offers enough learning opportunities to keep my knowledge and skills up to date' ($M=3.92$, $SD=0.93$), and 'I have been actively engaged in the community supported by ProQual' ($M=3.80$, $SD=0.89$).

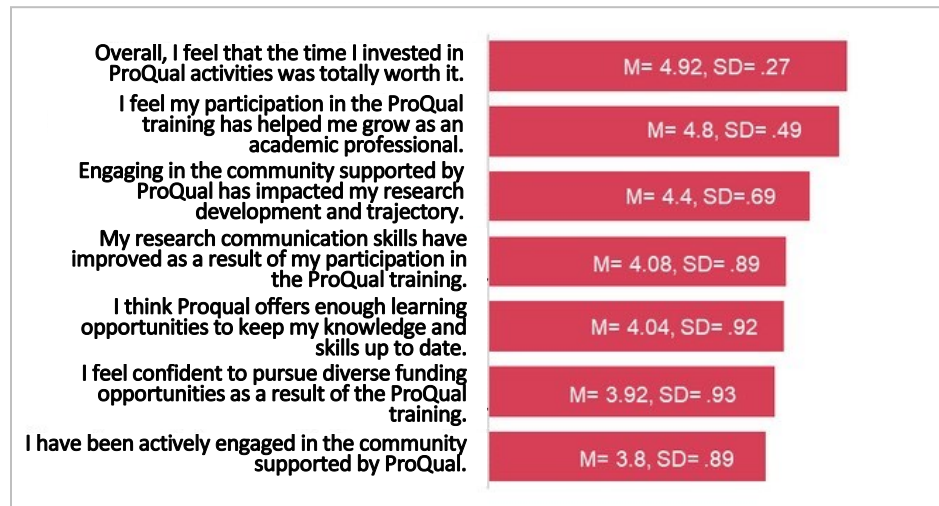


Figure 2: ProQual training direct outcomes
(1- Strongly disagree to 5 - Strongly Agree; $n=25$)

2. Helpfulness and accessibility of PQI activities for STEM faculty (Likert scale, $n=25$)

Survey participants reported that although the ProQual curriculum is valuable for helping educational researchers initiate the use of qualitative and/or mixed research methods, only a minority of them have utilized ProQual training materials to conduct training sessions and workshops. These results are summarized in Figure 3.

All participants either agreed or strongly agreed that the ProQual curriculum had been beneficial for educational researchers looking to initiate the use of qualitative and/or mixed research methods ($M=4.84$, $SD=0.37$). Furthermore, the majority also believed that the ProQual course is accessible to faculty interested in acquiring knowledge about qualitative and/or mixed research methods ($M=4.56$, $SD=0.64$).

However, fewer than 25% ($n=6$) of survey respondents strongly agreed to using ProQual training materials to facilitate training sessions and workshops on qualitative and/or mixed methods for other faculty at their institutions ($M=3.20$, $SD=1.47$).

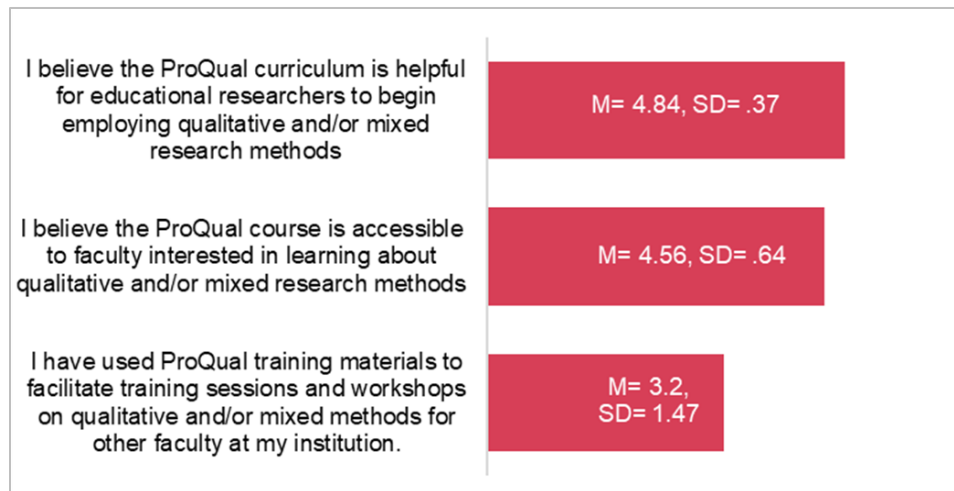


Figure 3: Helpfulness & accessibility of the PQI
(1- Strongly disagree to 5 - Strongly Agree; n=25)

Evaluation Results: Participant outcomes beyond PQI activities

The intended impacts of the project extend beyond the scope of direct PQI outcomes and include how PQI graduates perceive and apply qualitative and mixed methods after graduating. This section summarized findings across four survey sections related to these post-PQI outcomes. The number of participants responding to each survey section is specified. All percentages are in reference to the total number of responses across all options of the survey section.

3. Knowledge and comfort level with qualitative and mixed methods (Likert scale, n=25)

As a result of participating in the ProQual Institute, survey respondents reported improvement in multiple areas, as Figure 4 exhibits. The areas of highest improvement were knowledge of qualitative research methods, comfort level in using qualitative research methods, and applying qualitative research. All of these changes were attributed to participation in the ProQual training.

More than 75% (n=19) of survey respondents reported experiencing a significant improvement in their knowledge of qualitative research methods after participating in the ProQual Institute (M=4.76, SD=0.43). Additionally, participants strongly concurred that two other aspects of the ProQual Institute had notably improved since their training: their comfort level in using qualitative research methods (M=4.52, SD=0.57) and the frequency of their application of qualitative research (M=4.28, SD=0.78).

The survey revealed that the items with the lowest reported knowledge and comfort levels were related to mixed methods research. Only 16% (n=4) of participants reported an increase in their understanding of mixed methods (M=3.84, SD=0.73), their comfort level in utilizing mixed methods (M=3.80, SD=0.80), and the frequency of their application of mixed methods (M=3.36, SD=0.84).

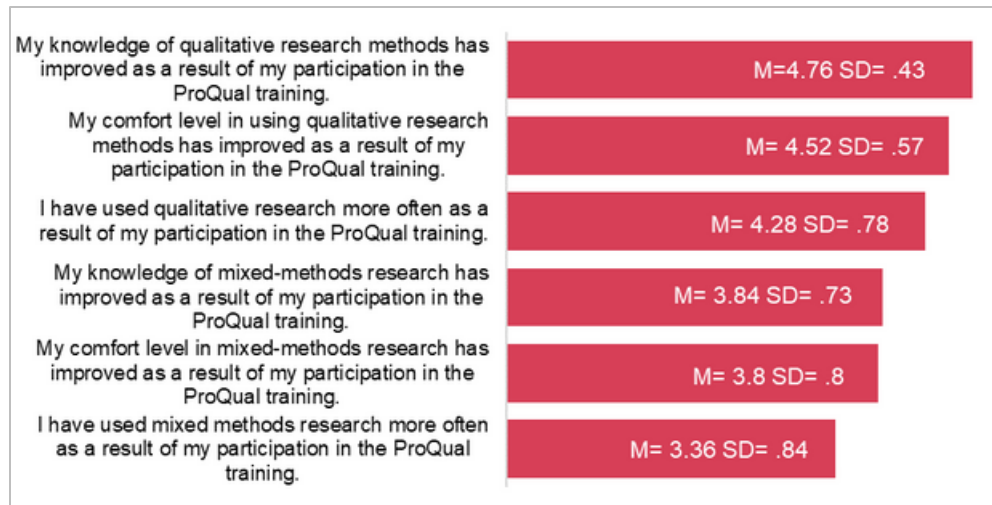


Figure 4: Knowledge and comfort level in employing qualitative and mixed methods research (1- Strongly disagree to 5 - Strongly Agree; n=25)

4. Impact on PQI training on research collaboration (select all that apply, n=25)

Survey respondents noted that ProQual Institute training has assisted them in the productivity of their research, particularly by leading to an increase in collaborations, grant submissions, and publications (submissions and/or acceptances). Figure 5 summarizes these results.

Sixteen participants, when asked how PQI training has aided them in their research productivity, reported an increase in their research collaborations. The second and third reported impacts of the ProQual Institute regarding research productivity, as reported by participants, were an increase in grant submissions (11 participants) and an increase in publications (9 participants).

Fewer participants noted an impact on increasing conference presentations (7 participants) and in other areas (3 participants). These included activities such as project planning, oral communication, improving the quality of publications, gaining confidence in reviews, and enhancing their ability to write qualitative work, even if not yet published.

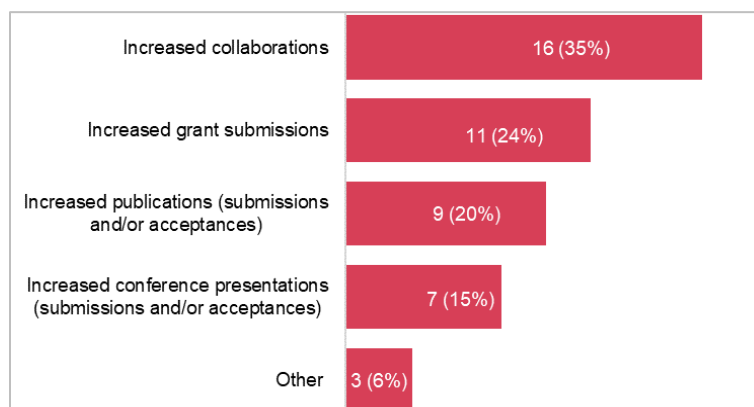


Figure 5: PQI impact on research productivity (Number of participants who selected option; n=25)

5. Impacts of PQI on participant perceptions of qualitative research (free response, n=16)

In response to an open question about how their thoughts on qualitative research changed due to ProQual training, several participants provided insightful feedback. One respondent noted, “Qualitative research is much more structured than I originally thought.” This observation underscores a shift in perception regarding the level of organization and planning involved in qualitative research, highlighting the importance of structure in the process.

Another participant expressed newfound motivation and enthusiasm, saying, “Once I get a position, I think I’ll give it a chance and try stepping into education research. ProQual training gave me the motivation and encouragement for it.” This individual’s testimony underscores the training’s motivational impact, even on those outside the education field, emphasizing its potential to inspire a diverse range of researchers.

Several participants emphasized increased confidence in their qualitative research methods. One respondent stated, “I have gained significant confidence in my qualitative research methods through participation in ProQual.” This confidence boost was attributed not only to the curriculum but also to the collaborative interactions within the community, where participants workshopped their projects, fostering a sense of empowerment and self-assuredness.

Furthermore, the training had a substantial impact on participants’ understanding of theoretical frameworks and research problem formulation. One participant remarked that they had “gained a lot of insight on how to use theoretical frameworks in qualitative research” and another stated that they were “better able to grasp and navigate bigger aspects, like theoretical frameworks, social reality, developing a research question, appropriate methodologies, etc.”

Overall, participants reported that the PQI training not only demystified qualitative research but also provided the participants with newfound structure, motivation, confidence, and the ability to navigate complex research aspects, making qualitative research more accessible and valuable to a diverse range of researchers. It effectively equipped them with the skills and mindset to engage meaningfully in this field.

6. Application of new knowledge and skills (free response, n=19)

As a result of participating in the PQI, survey participants reported engaging in more qualitative research, collaboration, and professional development activities. Participants have been able to utilize various types of qualitative data collection and data analysis on new projects. Some participants are also engaging in proposal writing, primarily using qualitative research design.

Survey respondents primarily reported engaging in more qualitative research experiences, professional development activities, and collaborative research since participating in the PQI. For example, one participant described their transition from primarily quantitative work to incorporating more qualitative methods:

I think I have gained significant comfort and confidence in conducting qualitative research and understanding key quality metrics to apply when designing my research studies. While I do have quantitative research methods in my research group, a lot more of my work has focused on qualitative methods, which was unexpected.

Seven respondents specifically mentioned engaging in qualitative research such as conducting focus groups, performing qualitative data analysis, and developing qualitative designs for research projects and grant proposals.

Other participants mentioned starting new collaborations, engaging in proposal writing and review, and presenting at national and international conferences. One survey participant also shared that they have inspired their graduate students to engage in more qualitative research.

On average, survey respondents have engaged in 2-3 new research projects since they participated in ProQual. Three respondents mentioned not engaging in new projects due to transitioning to new roles, still being in proposal development, and having limited time as faculty. However, these respondents also expressed interest and motivation to begin new research projects soon. One participant summarized this sentiment well: “I was previously a postdoc researcher, and now a teaching-focused faculty. I hope to engage in more education research in the future.”

7. Types of methods employed in new projects (select all that apply, n=22)

As shown in Figure 6, all participants who reported new research projects since participating in the PQI (22 participants) reported using qualitative methods such as observations, focus groups, and interviews. Other qualitative methods mentioned included the following:

- Focus groups, open-ended questions, photovoice, metacognitive reflections.
- Autoethnography, critical reflection, thematic analysis
- Interviews, FGDs, observations, Delphi technique, narrative analysis

The second highest reported methods were quantitative methods (11 participants), which primarily included surveys. In line with the findings related to knowledge and comfort level, comparatively few participants reported deploying mixed methods in new projects (5 participants).

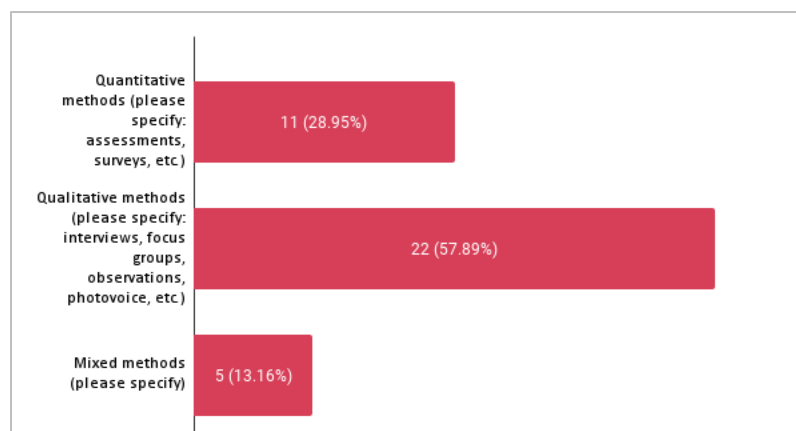


Figure 6: Types of methods employed in new projects
(Number of participants who selected option, n=22)

Discussion (Lessons Learned)

The evaluation results shed light on the impacts of the PQI and revealed several lessons for the successful training of instructional and technical STEM faculty for educational research. First, participant responses revealed that training in the ProQual Approach via the PQI was wholly worthwhile, and achieved many of the most important impacts the project team sought to achieve. Most participants reported an increase in research productivity, particularly in terms of increased collaborations and grant submissions. The latter increase was likely bolstered by the opportunity offered to PQI graduates for free grant proposal development choices during the past 12 months—an opportunity 11 graduates utilized. Graduates who reported engaging in new research projects overwhelmingly chose qualitative methods for their studies—the focus of the PQI—which highlights the readiness of graduates to leverage these methods in research outside of the formal training environment.

Survey results also revealed two gaps in project outcomes that we seek to remedy in the final year of the project, 2024. First, participants reported making limited use of project materials in working with other faculty for training, teaching, or workshops. In recent discussions with PQI graduates, the reason for this finding became clear: There was confusion around which institute materials can be shared publicly versus those which should be kept within the institute. This confusion manifested from a communication by the project team during PQI Training that the materials provided to participants are still working drafts, and should only be shared with the permission of the project team. In the final year of the project, we are focusing the remaining project resources on the development and publication of a textbook on the ProQual approach, which amalgamates and builds upon all the materials used for training during the PQI. The public availability of this textbook will address the expressed desire of both PQI graduates and participants of workshops on the ProQual Approach to have a set of resources both for personal reference and for sharing the ProQual Approach with colleagues.

Second, participants expressed few conference publications on the qualitative research they were doing, and a desire to attend educational conferences. We have begun responding to this concern by providing opportunities for PQI graduates to serve as leaders for workshops on the ProQual Approach at engineering education conferences. Successful graduates applying to these opportunities received full funding from the project to attend these conferences, allowing them to not only practice teaching the ProQual Approach to others but also to connect with myriad new colleagues with a shared passion for educational research.

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 PQI 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 participants found their participation in the PQI a wholly worthwhile experience, and revealed demonstrable impacts in terms of the confidence of PQI graduates in using qualitative research methods, and their productivity in terms of developing new research projects that include these methods. The results also highlight a need for research training in a new approach to be accompanied by easily

digestible and shareable reference materials, which helped the project team focus our planned activities for the final year of the project.

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant No. 1937741. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

- [1] J. R. Morelock *et al.*, "Impacts of the ProQual Institute for Research Methods: Building communities of technical STEM faculty for long-term engagement in educational research," in *2023 ASEE Annual Conference*, Baltimore, MD, 2023.
- [2] G. L. Anderson, K. Herr, and A. S. Nighlen, "Studying your own school. An educator's guide to qualitative practitioner research.," 1994.
- [3] R. Deem and L. Lucas, "Learning about research: Exploring the learning and teaching/research relationship amongst educational practitioners studying in higher education," *Teaching in higher education*, vol. 11, pp. 1-18, 2006.
- [4] National Science Foundation. (2019). *PFE: Research Initiation in Engineering Formation (PFE: RIEF)*. Available: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503603
- [5] National Science Foundation. (2019). *EHR Core Research (ECR): Building Capacity in STEM Education Research (ECR: BCSER)*. Available: <https://www.nsf.gov/pubs/2019/nsf19565/nsf19565.htm>
- [6] R. A. Streveler and K. A. Smith, "Guest Editorial: Conducting Rigorous Research in Engineering Education," *Journal of Engineering Education*, vol. 95, no. 2, 2006.
- [7] M. Borrego, "Development of Engineering Education as a Rigorous Discipline: A Study of the Publication Patterns of Four Coalitions," *Journal of Engineering Education*, vol. 96, no. 1, pp. 5-18, Jan 2007.
- [8] J. R. Lohmann, "Refining our Focus," *Journal of Engineering Education*, vol. 97, no. 1, p. 1, Jan 2008.
- [9] C. Allendoerfer, K. Yasuhara, J. A. Turns, and C. J. Atman, "Making an Impact on Engineering Education Communities: Learning from the Past and Looking Forward," in *ASEE Annual Conference and Exposition*, New Orleans, LA, 2016.
- [10] N. M. Trellinger, B. Sattler, and J. Turns, "'I realized that I myself am on the path to being a pioneer': Characterizing the experiences of graduate students in an innovative interviewing experience.," in *2015 American Society for Engineering Education Conference & Exposition*, Seattle, WA., 2015.
- [11] L. Stone, "Kuhnian science and education research: Analytics of practice and training," in *Educational Research: Why 'What Works' Doesn't Work*: Springer, 2006, pp. 127-142.
- [12] C. Henderson, A. Beach, and N. Finkelstein, "Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature," *Journal of research in science teaching*, vol. 48, no. 8, pp. 952-984, 2011.
- [13] I. Buoro, "One way or return? The journey from practitioner to researcher," *International Journal of Training Research*, Article vol. 13, no. 2, pp. 145-158, 2015.

- [14] J. Hattie and H. W. Marsh, "The relationship between research and teaching: A meta-analysis," *Review of educational research*, vol. 66, pp. 507-542, 1996.
- [15] E. Joram, "Clashing epistemologies: Aspiring teachers', practicing teachers', and professors' beliefs about knowledge and research in education," *Teaching and Teacher Education*, vol. 23, pp. 123-135, 2007.
- [16] J. Feuer, L. Towne, and R. J. Shavelson, "Scientific Culture and Educational Research," *Educational Researcher*, vol. 31, pp. 4-14, 2002.
- [17] M. Borrego, "Conceptual Difficulties Experienced by Trained Engineers Learning Educational Research Methods," *Journal of Engineering Education*, vol. 96, no. 2, pp. 91-102, Apr 2007.
- [18] D. Labaree, "The peculiar problems of preparing educational researchers," *Education Researcher*, vol. 32, pp. 13-22, 2003.
- [19] D. C. Berliner, "Comment: Educational research: The hardest science of all," *Educational researcher*, vol. 31, no. 8, pp. 18-20, 2002.
- [20] J. Walther, N. W. Sochacka, and N. N. Kellam, "Quality in Interpretive Engineering Education Research: Reflections on an Example Study," *Journal of Engineering Education*, vol. 102, no. 4, pp. 626-659, 2013.
- [21] J. Walther and N. W. Sochacka, "Qualifying qualitative research quality (The Q3 project): An interactive discourse around research quality in interpretive approaches to engineering education research," in *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, 2014, pp. 1-4.
- [22] J. R. Morelock *et al.*, "Learn How to Design High-Quality Qualitative Educational Research! – A Workshop for Disciplinary STEM Faculty by Disciplinary STEM Faculty," in *2023 IEEE Frontiers in Education Conference*, College Station, TX, 2023.