Designing a Streamlined Workshop for STEM-H Faculty Engaged in the Scholarship of Teaching and Learning

Ms. Jody Zhong, University of Louisville

Ms. Zhong is a fourth-year doctoral student in the College of Education and Human Development at the University of Louisville. Ms. Zhong's interests lie in researching identity, diversity, and professional development/thriving within the academy.

Dr. Patricia A Ralston, University of Louisville

Dr. Patricia A. S. Ralston is Professor and Chair of the Department of Engineering Fundamentals at the University of Louisville. She received her B.S., MEng, and PhD degrees in chemical engineering from the University of Louisville. Dr. Ralston teaches undergraduate engineering mathematics and is currently involved in educational research on the effective use of technology in engineering education, the incorporation of critical thinking in undergraduate engineering education, and retention of engineering students. She leads a research group whose goal is to foster active interdisciplinary research which investigates learning and motivation and whose findings will inform the development of evidence-based interventions to promote retention and student success in engineering. Her fields of technical expertise include process modeling, simulation, and process control.

Ms. Teresa Lee Tinnell, University of Louisville

Terri Tinnell is a STEM Education Curriculum and Instruction PhD Candidate and Graduate Research Assistant at the University of Louisville. Research interests include: interdisciplinary faculty development, first-year engineering student retention, STEM teacher education, and collaborative, team-based learning experiences.

Dr. Thomas Tretter,

Thomas Tretter is professor of science education and director of the Gheens Science Hall & Rauch Planetarium at the University of Louisville. His scholarship includes collaborative efforts with science and engineering faculty targeting retention of STEM majors in entry-level STEM courses.

Dr. Marie Brown

Designing a Streamlined Workshop for STEM-H Faculty Engaged in the Scholarship of Teaching and Learning

Introduction

Across the disciplines encompassed by STEM and Health Sciences (STEM-H), there has been growing interest among these disciplinary faculty towards learning more about how to conduct education research within their disciplines. In a recent national effort, NSF has called for "Building Capacity for Science, Technology, Engineering, Mathematics (STEM) Education Research" via its program solicitation 20-521. Projects are supported that build STEM-H faculty capacity to carry out high quality STEM education research that will enhance the nation's STEM education enterprise and broaden the pool of researchers that can conduct fundamental research into STEM learning and learning environments. This is motivated in part by the recognition that improved STEM education will benefit from qualitative and quantitative research [1], and for the need to evaluate the effectiveness of various initiatives that are being explored [2]. Recent NSF awards have focused mostly on graduate students seeking to become STEM researchers including studies that established: 1) an Institute in Critical Quantitative, Computational, and Mixed Methods Training for Underrepresented Scholars [3], 2) a Meta-Analysis Research Institute (MMARI) to improve the quality of meta-analyses conducted in STEM education by providing training to graduate students and early career scholars to broaden their expertise and skills to conduct rigorous research on STEM [4], and 3) a research institute with year-long training of two cohorts of 20 Quantitative Research Methods (QRM) Scholars [5]; these scholars were PhD students with research foci on issues of access and equity of underrepresented populations in STEM within either K-12 or postsecondary settings.

In response to faculty interest expressed on our campus for how to best conduct STEM-H education research, we developed a brief, focused introductory workshop series designed for STEM-H faculty and professionals. These disciplinary STEM-H researchers sought not only to better understand and evaluate their teaching practices to benefit students, but for their own professional development they wish to document and share what they learned. The workshop series introduced participant to basic concepts and key components for conducting well-designed education research, starting with a description of the education research landscape within which participants would likely find themselves at different places in terms of purpose. The goal of the workshop was to help interested participants crystallize their knowledge of what issues and challenges to be cognizant of and to develop next-step plans for themselves toward meeting personal goals that align with their professional research endeavors. This paper outlines the design decisions along with rationale to develop that workshop, simultaneously satisfying a suite of constraints that are at times in tension with each other.

Related Literature

Professional development

Our workshop development borrowed from the conceptual frameworks of both Caffarella and Zinn [6] and Desimone [7]. Desimone [7] presents the case that there is research consensus to support five key framework features of effective professional development: (1) content focus, (2)

active learning, (3) coherence, (4) duration, and (5) collective participation. While that research was primarily focusing on K-12 teachers, we believe these key features are also critical to the design of this workshop for university STEM-H faculty and professionals.

Focused entirely on higher education faculty, with a different but complementary view, Caffarella and Zinn [6] describe a framework within the context of what factors enhance or impede professional development. They discuss the four domains within which factors that support or create barriers are clustered: (1) people and interpersonal relationships, (2) institutional structures, (3) personal considerations and commitments, and (4) intellectual and psychosocial characteristics. Their work describes the interplay of the many factors affecting university faculty and professionals and how that can influence their professional development activities. As we designed this workshop, we were particularly sensitive to the time requirement, recognizing that if too much time and effort were required it would become a barrier, but too little time would deprive participants of adequate content focus as recommended by Desimone [7]. We envisioned this workshop to serve as an effective introduction to the complex endeavor of conducting high-quality education research, enabling participants to identify and decide to act upon whatever next steps might be most appropriate for their situation. We and the participants all recognize that this introductory workshop series could not address each complex topic in detail, but rather was intended as an introduction to highlight key features of high-quality education research.

As suggested in Brinthaupt et al. [8], this workshop leveraged the expertise of two university unit centers – an engineering-based center for teaching and learning engineering and an education-based center for research in STEM learning – as well as the university's professional development center for faculty. Separately, none of the centers could have made this workshop possible. The framework presented by Brinthaupt et al. [8] was considered as we planned the follow up assessment of the workshop. They propose three dimensions (impact, value, and range) and six linked levels (reciprocity, saturation, strategic role, return on investment, direction and locus). Their framework examines effects of leveraging on both the participants and the centers.

While there are many studies about faculty professional development to improve STEM teaching, we could only find one study specifically targeting STEM faculty development to conduct educational research. Dr. Louis Nadelson created a "STEM Education Research Scholars Group," a faculty community of practice (COP) designed to increase STEM faculty expertise in STEM education research [9]. Nadelson reports on the effectiveness of the COP based on four cohorts of faculty, finding that the COP was an effective way to enhance STEM faculty understanding of and engagement in educational research. Our workshop was planned to respond to growing interest, both on our campus and nationally, to support STEM-H faculty and disciplinary researchers' development of educational research skills.

The educational research landscape: Scholarship of Teaching and Learning (SoTL), Discipline-Based Educational Research (DBER) and Educational Research (ER)

To discuss the education research landscape, we proposed to characterize the landscape as research communities spanning from SoTL to DBER to ER, with the understanding that there is

much debate over what constitutes membership in one community or another. Within STEM-H disciplines, scholars have largely distinguished between the Scholarship of Teaching and Learning (SoTL) and Education Research (ER) by characterizing SoTL as mainly concerned with assessment of teaching and having limited generalizability, while ER has been viewed as more engaged with basic questions of "why" and "how" students learn [10], [11]. ER has also been viewed by some as more rigorous than SoTL [12], [13], though others have argued that there is value to every position in the landscape [10], [14], [15]. In addition to characterizing the educational research landscape with these two nodes, others use the label Discipline-Based Education Research (DBER) to capture efforts of STEM-H disciplinary faculty who engage in structured research about the teaching and learning in their particular discipline. Although characterizations of the relationships between these communities vary, of interest for this research study is the range of educational research perspectives that disciplinary faculty may hold, including the purpose and audience for any particular scholarship they choose to engage in. It is convenient to view them in a landscape including SoTL, DBER, and ER, with the awareness that various descriptions and research initiatives overlap, often represented by Venn diagrams. Recognition of degrees of overlap can be found in the literature with zero to complete overlap, depending on the researcher's perspective [12], [16], [17], [18], [19].

Brief history and emergence of the three communities

Emerging first, ER as a field dates back to the 1830s, when school supervision and planning were first influenced by systematic data collection. These data collection efforts, according to Travers [20], involved "an examination of the ideas on which education was based, … and the development of a literature on education that attempted to make available to teachers and educators important new ideas related to education that had emerged in various countries" (p. 7). Today, education research is defined by the American Educational Research Association as the

> "scientific field of study that examines education and learning processes and the human attributes, interactions, organizations, and institutions that shape educational outcomes. Scholarship in the field seeks to describe, understand, and explain how learning takes place and how formal and informal contexts of education affect all forms of learning. Educational research embraces the full spectrum of rigorous methods appropriate to the questions being asked and also drives the development of new tools and methods" [21].

Historically, DBER emerged between 1970-1990, although concern about the teaching of science started in the late 1800s and became more high-profile with the advent of the space program starting in late 1950s. DBER combines expert knowledge of a science or engineering discipline with the challenges of learning and teaching in that discipline, and the science of learning and teaching generally to address discipline-specific problems and challenges. A widely recognized definition of DBER comes from the National Research Council [15], "DBER is grounded in the science and engineering disciplines and addresses questions of teaching and learning within those disciplines… DBER investigates learning and teaching in a discipline from a perspective that reflects the discipline's priorities, worldview, knowledge, and practices. DBER is informed by and complementary to general [educational] research on human learning and cognition." Bodner [22] defines DBER in terms of three elements: (1) a well-articulated set of

guiding research questions, (2) an explicit choice of theoretical framework on which to base the study, and (3) a choice of methodology appropriate for probing the research question. These views frame DBER as a subset within ER.

SoTL developed in parallel with DBER, and it emerged as a result of Boyer's work [23], which emphasized the need for classroom research and sparked conversations about teaching among colleagues at the university level. According to McKinney [11], SoTL "involves the systematic study of teaching and/or learning and the public sharing and review of such work. 'Study' is broadly defined given disciplinary differences in epistemology and the need for interdisciplinary SoTL…SoTL focuses on teaching and learning at the college level, and is primarily classroom based. Ideally, SoTL also involves application and use" (p. 10). With these ideas, Felten [25] identifies five principles for good practice to assess and critique SoTL work: (1) inquiry focused on student learning, (2) grounded in context, (3) methodologically sound, (4) conducted in partnership with students, (5) appropriately public.

Community overlap and tensions

While most acknowledge that these three research communities have common focus of research on teaching and learning, tension exists between the communities. The tension is primarily around the problems that can arise when faculty members with no experience or training in social science or educational research attempt to conduct educational research within their disciplines, with many ER researchers appalled by what is often a lack of attention to existing educational literature and the need for a theoretical framework [12], [13], [18].

Even within DBER communities there can be friction. According to Felder and Hadgraft [26], the engineering education community has two separate and "sometimes antagonistic groups: the theoreticians, who seek to understand the learning process at a fundamental level; and the practitioners, who continue to focus their research on improving teaching structures and methods" (p. 1). They note that the demand for a framework tied to learning or social theory to justify "rigorous" engineering education research (proposed by the National Science Foundation-funded project, Conducting Rigorous Research in Engineering Education: Creating a Community of Practice, commonly known as the RREE project) has diminished the importance of applied research, relegating it to "assessment" – a type of SoTL. Streveler et al. [27] summarize the RREE levels of rigor for inquiry about teaching and learning. Felder and Hadgraft [26] note that the RREE levels fail to acknowledge "grounded theory" and other approaches that social scientists commonly employ.

Larsson et al. [18] conducted an empirical study of 10 researchers from the ER and SoTL communities to better understand the attributes of each. They found that the SoTL community was viewed as more inclusive with an overall goal to change practice with immediate effect on student learning, whereas the ER community seemed more exclusive and focused on extending the research knowledge base without immediate effect on practice. Some researchers view DBER and ER completely distinct from SoTL [17] stating "In contrast (to SoTL), DBER pursues research questions and hypotheses about teaching, learning, and ways of thinking in a discipline that extend beyond single classrooms and programs in order to yield original, generalizable, and mechanistic insights into educational processes and their effects." However, Miller-Young and

Yeo [28] articulate a two-dimensional framework for conceptualizing SoTL which attempts to delineate the learning theories and methodologies appropriate to studying teaching and learning. They argue that SoTL is not inherently different from ER, but that SoTL researchers would benefit from a better understanding of the range of lenses and methodologies used in ER.

The need for collaboration

While there has been much written about the challenges of teaching educational research methodologies to STEM faculty [10], [29], [30], [31] and the challenges associated with analyzing the impact of much SoTL work [32], there is a clear need to assist interested disciplinary STEM-H faculty in strengthening their abilities for conducting appropriate education research that fits within their purposes and their selected place in the landscape [33], [34]. Collaborative research efforts across communities are not common in general, neither in the form of collaborations involving DBER scholars in different science departments nor in the form of teams comprised of DBER scholars and ER researchers [35]. The literature shows that social scientists are often not involved in DBER research [36], and many authors note that for DBER fields to grow, there is a great need for collaboration between DBER, SoTL and ER researchers [19], [36], [37].

Purpose

With this landscape and associated tensions and challenges in mind, combined with the prior collaborative experience the three university centers shared, planning for our workshop commenced. Based on prior collaborations between the centers, our team (the two faculty leaders (center directors), supported by graduate students and two university professional developers), determined the audience and focus for the workshop. We felt the discrepancies between STEM-H discipline research and education research (e.g. natural laws vs. conceptual frameworks, feasibility and ethicality of controlled studies in education), would be the main source of initial confusion for participants. We hypothesized that the participants would benefit from an introduction to foundational education research ideas, and we addressed these discrepancies that lead to tensions due to differing views and values of research among the discipline-based communities. We sought to unpack and diffuse tensions by emphasizing that anywhere on the landscape, valuable research means appropriately designed research for meaningful outcomes. We specifically avoided the term “rigorous” because we felt that designation has led to value judgements and hierarchical tensions that are not helpful in promoting STEM-H educational initiatives.

The intellectual endeavor of designing this type of workshop has many parallels to the engineering design process, which might serve as a useful analogy. Just as the engineering design process itself is complex and multifaceted independent of the outcome product that results, the workshop design process engages similar complex design thinking independent of how the outcome product is evaluation. Thus, this paper targets the workshop design process and presents the outcome of that design process; however, how well the participants learned or reacted is a future direction this team will be pursuing. So the purpose of this paper is not to share the efficacy of the final solution (i.e. the impact of the workshop on participants) but rather

to unpack and articulate the design process which is a nontrivial exercise, and then share the outcomes of the design process (i.e. the planned workshop).

Research question

Given the complexity of the education research landscape and the attendant range of decisions and expertise needed for STEM-H disciplinary faculty to meaningfully engage in this important work, we created a professional development opportunity to offer interested participants. Cognizant of Caffarella and Zinn's [6] framework articulating potential barriers for faculty professional development as discussed earlier, this paper addresses the following research question, which guides our effort:

What are the features of a time-efficient educational research workshop for STEM-H faculty and professionals that results in participants developing a customized guide for their next desired steps?

In planning for this workshop, we first identified the need to minimize potential institutional barriers such as limited time availability of participants, while recognizing the need for adequate duration and coherence [7] for effectiveness. During planning, tensions also arose between limited time for incorporating an adequate range and depth of content focus while simultaneously not trivializing complex research tasks. Ultimately, the research team collectively and consensually developed the features of the workshop to include: (a) the topics to address; (b) how to most effectively sequence the topics; (c) what pedagogical approaches to employ to actively and meaningfully engage the participants. We also identified that a useful end product for participants in the workshop would be a self-customized guide for their desired next steps in educational research, where the workshop experiences would facilitate and support informed development of this customized guide. The results of this effort in terms of workshop design are presented below.

Recruitment

Staff from the University's center for faculty development advertised the workshop on their website as well as by emailing faculty and professional listservs across the University's various schools, specifically targeting departments such as medicine, public health, physics, biology, chemistry, as well as engineering departments. Study PIs also extended invitations to faculty in these departments with whom they were personally acquainted and/or had previously collaborated with. In addition, faculty from the school of education and social sciences departments such as experimental psychology were invited to attend in order to gain a sense of the interest areas and challenges related to educational research that STEM-H faculty reported. Finally, while recruitment efforts mainly targeted faculty members, several participants who did not hold faculty positions but were involved in faculty development or educational research support were welcomed, as their professional roles aligned with the goals of the workshop (e.g. a medical researcher studying education/training of medical residents). This multidisciplinary prospective audience was targeted with the hopes of facilitating an exchange of perspectives on conducting research as well as cultivating cross-discipline collaboration. The resulting participants in the workshop are shown in Table 1.

Table 1. Description of STEM-H Participants in Workshop (*N* = 15)

Departments	Positions	Gender
Astronomy	Tenured (*n* = 8)	7 women
Chemical Engineering	Pre-tenure (*n* = 1)	8 men
Engineering Fundamentals	Term (*n* = 3)	
Experimental Psychology	Faculty developer (*n* = 2)	
Industrial Engineering	Research manager (*n* = 1)	
Medical Education		
Nursing		
Pediatrics		
Physics		
Physiology		
Public Health		

Workshop Design Results

The crafting of the workshop centered around Desimone's [7] five essential pedagogical components to faculty development initiatives, including content focus, active learning, coherence, duration, and collective participation. Study PIs designed a workshop series comprised of four one-hour sessions spaced over a month, with each session focusing on a different topic area. While facilitators recognized that this brief format was below the 20 hours recommended by Desimone to create an impactful workshop [7], a shorter timeframe was deemed necessary in order to not impede participation with the barrier of a heavy time commitment, with the goal of making this introductory workshop accessible to the broadest possible audience of interested participants.

Given the workshop's brief format, identifying a feasible outcome product for participants was a critical area of discussion amongst study PIs. Facilitators aimed to provide a targeted, useful orientation to key topic areas in educational research while not trivializing the complexity of the educational research process. Content was adjusted accordingly to provide a broad overview of SoTL and education research rather than a deep exploration of these topics. Facilitators emphasized the goal of the workshop functioning as a starting point for participants to use in identifying next steps in their own research projects and growth journeys as educational researchers. To facilitate this, study PIs designed a document (an "idea organizer") that participants could use to record their research planning throughout the workshop and created a repository of resources (e.g. references, handouts, and referrals to on-campus supports such as the faculty professional development center) for participants to access during and after the workshop. Facilitators also built in time during workshop sessions for participants to receive feedback from each other and the facilitators on their ideas for research questions and studies. The ultimate goal of all of these measures was to assist participants in deciding where to go next and feeling supported in their continuing exploration of educational research.

Workshop topics content and sequencing

Facilitators brainstormed general topics they hypothesized to be most important or helpful for the audience given the facilitators' previous experience collaborating with STEM-H faculty. Topics such as the SoTL/ER/DBER distinction, balancing rigor with flexibility in research design, statistical analyses, selecting a conceptual framework, and venues for dissemination were quickly raised as areas that some faculty had expressed interest in or that facilitators predicted would need clarifying given cross-discipline (STEM-H to education) differences. Considerable discussion focused on identifying central principles or takeaways for each topic area that could be presented within the brief timeframe.

Table 2. Planned topics for workshop over four 75-minute sessions

	Topics
Session 1	• ER Landscape • Introduce the customized guide • Research questions • Conceptual frameworks
Session 2	• Research Design Considerations • Data Collection-Surveys • Data Collection-Observation Protocols
Session 3	• Data Analysis options • Selecting an analytic technique
Session 4	• Return to the ER landscape • Craft details of customized guide and next steps

After selecting the primary topics to address in the workshop, we sequenced them (see Table 2) to be in approximate temporal order for conducting a research study. We anticipated that this sequencing would be most productive for participants to identify the status of their particular research project in terms of knowing what next steps might be most productive for them. For example, if their research questions are not yet precisely formulated or include ill-defined constructs, recognition of that may suggest that additional reading in relevant literature may be helpful to operationalize key parts of their intended research. However, we recognized, and intended to help workshop participants recognize, that strong education research includes a number of iterative loops, whereby for example emerging results from data analysis may redirect the researcher back to the literature to revisit a conceptual framework in order to best interpret the results. A brief description of the pedagogical choices planned session-by-session to facilitate the workshop follows.

Session 1. The workshop series began with a brief overview of the educational research landscape, including SoTL, DBER, and ER. The intent was to assist participants with identifying where they are within that landscape in terms of their intended education research effort, which in turn can inform the most useful next steps for themselves. Following an introduction to the graphic organizer that was presented as a structure designed to facilitate thinking and articulating actionable next steps for themselves at key points throughout the workshop series, characteristics of good education research questions were addressed. Through a series of examples, we presented the iterative development of several research question sets the facilitation team has used, to illustrate the process as well as the need for precision and clarity in terms of constructs, boundaries, and relationships between the key constructs. The final topic for Session 1 was an

introduction to conceptual frameworks, emphasizing the value of relevant frameworks to guide other aspects of the research, especially interpretation of results. Whereas in much of STEM-H disciplinary research the frameworks are well-known (e.g. grounded in natural physical laws that everyone would know), people are so complex that there are typically a multitude of potential frameworks or lenses from which one could view the learning process.

Session 2. To begin the session, participants were encouraged to draft initial research questions for themselves based on their interest, and to refine them based on ideas presented in the workshop. These participant-generated research questions then shared with peer colleagues for additional feedback and refinement. The session's first topic of education research design considerations primarily targeted options that contrast with the classic experimental design that STEM-H researchers were familiar with. Specifically addressing ways to approach design considerations given the lack of a randomized control group (e.g. perhaps a single-group design if focused on this year's students). Rather than covering an exhaustive (and exhausting) review of all possible designs, we instead focused on a few of the most common educational research design options. Examples of designs featured in our workshop included: how to use a covariate to manage potential non-equal groups or how to manage the non-blind aspect of educating people who know they are being taught. The second major topic of Session 2 was a limited overview of data collection strategies, targeting two of the most likely approaches we anticipated participants would use: surveys and observations. An overview of survey design (including validity and reliability) with a heavier focus on quantitative-like techniques (e.g. Likert scales) was at minimum expected to raise awareness of potential weaknesses to be attentive to. Similarly, a few well-developed observation protocols using well-defined scripts were shared as potentially useful tools to capture time-dependent student and/or instructor actions.

Session 3. As a continuation to Session 2's feedback exercise, Session 3 began with another brainstorming and feedback session, this one encouraging participants to reflect on methods of data collection they might use to answer their developing research questions as well as challenges with their anticipated methods. The session then flowed into an overview of data analytic strategies in educational research. Because we anticipated the majority of the STEM-H disciplinary participants would be more familiar with quantitative analyses, for this introductory workshop series we chose to restrict data analytic options to a limited spectrum of primarily quantitative analyses, with a few non-parametric options included for frequency or rank data. One tool that was introduced was a statistical analysis decision tree, wherein the participants were guided by the nature of their research question (e.g. comparing groups or identifying relationships among variables) and the nature of their data (nominal, ordinal, interval, or ratio) to follow a pathway which ultimately suggested a specific analytic approach. While this was not expected to be comprehensive, it was intended to provide participants with a sense of analytic opportunities, including use of covariates as available. The workshop experiences were intended to also provide a conceptual overview of the mathematical foundations underpinning families of analyses – intended to potentially serve as starting points for further exploration if any participants find themselves wanting to know more about specific options.

Session 4. The final session was focused on supporting refinement of participants' next-steps plans, grounded in the thinking and tasks from the prior 3 sessions. This included a revisiting of the education research landscape for each person to solidify their personal goals and

purposes for engaging in education research. Interactive segments were designed to have participants crafting customized plans and asking further questions or getting additional input from facilitators on specifics they may be particularly ready to pursue. Final outcomes from this last workshop session included participants providing reflective feedback to facilitators on the effectiveness of various components of the series, as well as participants crafting their own customized next-steps plan and voicing their preferences for future programming or resources (e.g. a second workshop, broadening or starting a collaborative relationship between researchers from the school of education and STEM-H disciplines).

Upcoming Assessment

To assess the efficacy of the workshop planned according to the guidelines and constraints delineated in this paper, study PIs submitted an IRB application to collect data from participants. The identified research questions for this upcoming assessment are:

1. How does a time-efficient, focused workshop series influence STEM-H faculty and professionals' perceptions of where they locate themselves within the SoTL/ER/DBER landscape?
2. How did the workshop help participants identify where they want to be with regards to their own education-focused research?

Future workshop assessment will be based on data collected through a series of three open-ended written surveys as well as participant workshop artifacts. In the first open-ended survey, which was administered at the beginning of the first workshop session, participants were asked to articulate their reasons for attending the workshop and personal goals they had for their participation. The second survey, administered at the end of the last workshop session, asked participants to share what content they found most helpful from the workshop as well as suggestions for future workshops. The third survey, to be administered six months post-workshop, will ask participants to update the study team on what action (if any) they have taken on their personal goals as well as additional thoughts on the workshop. Over the course of the four workshop sessions, study PIs also asked participants to electronically submit an updated "idea organizer" after every workshop session, which tracked participants' developing research interests, identified goals, and reactions. These data will hopefully provide fruitful insight into the unique challenges and considerations that come with participants' development as researchers in the SoTL/ER/DBER landscape.

Workshop Meets Original Goals

At this point, the workshop series has been delivered as planned and assessment of workshop impact is just beginning. We can only report on initial impressions from our interactions and field notes during the workshop. Initial takeaways and selected facilitator observations from the workshop proceedings included that, unsurprisingly, the Session 3 topics concerning data analysis were of great interest to attendees, as evidenced by frequent and detailed participant questions being asked regarding the finer points of analytic possibilities. Somewhat surprisingly, multiple attendees expressed feeling a sense of being overwhelmed at where to even start with researching their topic of interest. Most specifically, they found difficulty conducting fruitful

literature searches or finding the right keywords to lend to properly relevant citations. This may be sensible, however, when considered alongside the fact that the same participants reported having little prior experience engaging in educational research or collaborating with education/social science researchers. Workshop activities such as gallery walks and feedback sessions revealed that participants generally struggled to narrow their research questions and operationalize embedded constructs. Despite the challenging experience of learning about complex topics in a short time span, attendees expressed continued interest through consistent attendance across all four sessions spanning one month. Additionally, participants expressed thoughtful ideas for the next steps that they intend to take as they continue toward their personal and professional goals in educational research. Based on this feedback and participant actions, we infer that the selected workshop topics, sequencing, and depth of treatment were appropriate for reaching the goals of the workshop in helping interested STEM-H faculty and professionals crystallize their knowledge of what issues and challenges to be cognizant of, and to develop next-step plans for themselves.

References

[1] National Science Board, "Our Nation's Future Competitiveness Relies on Building a STEM-Capable U.S. Workforce: A Policy Companion Statement to Science and Engineering Indicators," National Science Foundation, Arlington, VA, 2018.

[2] National Academies of Sciences, Engineering, and Medicine, "Indicators for Monitoring Undergraduate STEM Education," The National Academies Press, Washington, DC, 2018.

[3] E. Roman-Dixon, "NSF Award #1937490 Abstract: Institute in Critical Quantitative, Computational, and Mixed Methods Training for Underrepresented Scholars," 2019. [Online]. Available: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1937490&HistoricalAwards=false. [Accessed 11 3 2020].

[4] E. Tipton, "NSF Award #1937633 Abstract: Modern Meta-Analysis Research Institute," 2019. [Online]. Available: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1937633&HistoricalAwards=false. [Accessed 11 3 2020].

[5] L. S. Istaplet and G. Hancock, "NSF Award #1937745 Abstract: Quantitative Research Methods for STEM Education Scholars Program," 2019. [Online]. Available: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1937745&HistoricalAwards=false. [Accessed 11 3 202].

[6] R. S. Caffarella and L. F. Zinn, "Professional development for faculty: A conceptual framework of barriers and supports," *Innovative Higher Education,* vol. 23, no. 4, p. 241, 1999.

[7] L. M. Desimone, "Improving impact studies of teachers' professional development: Toward better conceptualizations and measures," *Educational Researcher,* vol. 38, no. 3, pp. 181-199, 2009.

[8] T. M. Brinthaupt, L. Cruz, S. Otto and M. Pinter, "A framework for the strategic leveraging of outside resources to enhance CTL effectiveness," *To Improve the Academy,* vol. 38, no. 1, pp. 82-94, 2019.

[9] L. Nadelson, "The Influence and Outcomes of a STEM Education Research Faculty Community of Practice," *Journal of STEM Education,* vol. 17, no. 1, pp. 44-51, 2016.

[10] M. Borrego, R. A. Streveler, R. L. Miller and K. A. Smith, "A new paradigm for a new field: Communicating representations for engineering education research," *Journal of Engineering Education,* vol. 97, no. 2, pp. 147-162, 2008.

[11] K. McKinney, Enhancing Learning through the Scholarship of Teaching and Learning: The Challenges and Joys of Juggling, San Francisco, CA: Jossey-Bass, 2007.

[12] H. Kanuka, "Keeping the scholarship in the scholarship of teaching and learning," *International Journal for the Scholarship of Teaching and Learning,* vol. 5, no. 1, 2011.

[13] B. Macfarlane, "Prizes, pedagogic research and teaching professors: Lowering the status of teaching and learning through bifurcation," *Teaching in Higher Education,* vol. 16, no. 1, pp. 127-130, 2011.

[14] D. L. Carlisle and G. C. Weaver, "STEM education centers: Catalyzing the improvement of undergraduate STEM education," *International Journal of STEM Education,* vol. 5, no. 47, 2018.

[15] National Research Council, "Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering," The National Academies Press, Washington, DC, 2012.

[16] S. Clegg, "Conceptualising higher education research and/or development as 'fields': A critical analysis," *Higher Education Research & Development,* vol. 31, no. 5, pp. 667-678, 2012.

[17] E. L. Dolan, S. L. Elliott, C. Henderson, D. Curran-Everett, K. St. John and P. A. Ortiz, "Evaluating discipline-based education research for promotion and tenure," *Innovative Higher Education,* vol. 43, no. 1, pp. 31-39, 2018.

[18] M. Larsson, K. Mårtensson, L. Price and T. Roxå, "Constructive friction? Exploring patterns between Educational Research and The Scholarship of Teaching and Learning," in *The 2nd EuroSoTL Conference*, Lund, Sweden, 2017.

[19] T. F. Shipley, D. McConnell, K. S. McNeal, H. L. Petcovic and K. E. St. John, "Transdisciplinary science education research and practice: Opportunities for GER in a developing STEM Discipline-Based Education Research Alliance (DBER-A)," *Journal of Geoscience Education,* vol. 65, no. 4, pp. 354-362, 2018.

[20] R. M. W. Travers, How Research Has Changed American Schools: A History from 1840 to the Present, Kalamazoo, MI: Mythos Press, 1983.

[21] American Educational Research Association, "What is Education Research?," American Educational Research Association, 2019. [Online]. Available: https://www.aera.net/About-AERA/What-is-Education-Research. [Accessed 18 December 2019].

[22] G. M. Bodner, "Changing how data are collected can change what we learn from discipline-based educational research," in *2016 Physics Education Research Conference Proceedings*, Sacramento, CA, 2016.

[23] E. L. Boyer, Scholarship Reconsidered: Priorities of the Professoriate, New York, NY: The Carnegie Foundation for the Advancement of Teaching, 1990.

[24] P. Hutchings and L. S. Shulman, "The scholarship of teaching: New elaborations, new developments," *Change: The Magazine of Higher Learning,* vol. 31, no. 5, pp. 10-15, 1999.

[25] P. Felten, "Principles of good practice in SoTL," *Teaching & Learning Inquiry,* vol. 1, no. 1, pp. 121-125, 2013.

[26] R. M. Felder and R. G. Hadgraft, "Educational practice and educational research in engineering: Partners, antagonists, or ships passing in the night?," *Journal of Engineering Education,* vol. 102, no. 3, pp. 339-345, 2013.

[27] R. A. Streveler, M. Borrego and K. A. Smith, "Moving from the 'Scholarship of Teaching and Learning' to 'Educational Research': An example from engineering," *To Improve the Academy,* vol. 25, no. 1, pp. 139-149, 2007.

[28] J. Miller-Young and M. Yeo, "Conceptualizing and communicating SoTL: A framework for the field," *Teaching & Learning Inquiry: The ISSOTL Journal,* vol. 3, no. 2, pp. 37-53, 2015.

[29] M. Borrego, "Conceptual difficulties experienced by trained engineers learning educational research methods," *Journal of Engineering Education,* vol. 96, no. 2, pp. 91-102, 2007.

[30] A. Gardner and K. Willey, "Academic identity reconstruction: The transition of engineering academics to engineering education researchers," *Studies in Higher Education,* vol. 43, no. 2, pp. 234-250, 2018.

[31] E. R. Miller, J. S. Fairweather, L. Slakey, T. Smith and T. King, "Catalyzing institutional transformation: Insights from the AAU Stem Initiative," *Change: The Magazine of Higher Learning,* vol. 49, no. 5, pp. 36-45, 2017.

[32] G. Newton, J. Miller-Young and M. Sanago, "Characterizing SoTL across Canada," *The Canadian Journal for the Scholarship of Teaching and Learning,* vol. 20, no. 2, 2019.

[33] L. G. McBride and A. S. Kanekar, "The Scholarship of Teaching and Learning: Origin, development, and implication for Pedagogy in Health Promotion," *Perspectives on Pegagogy,* vol. 1, no. 1, pp. 8-14, 2015.

[34] A. S. Webb, "Navigating the lows to gain new heights: Constraints to SoTL engagement," *The Canadian Journal for the Scholarship of Teaching and Learning,* vol. 10, no. 2, 2019.

[35] V. Talanquer, "DBER and STEM education reform: Are we up to the challenge?," *Journal of Research in Science Teaching,* vol. 51, no. 6, pp. 809-819, 2014.

[36] S. M. Lo, G. E. Gardner, J. Reid, V. Napoleon-Fanis, P. Carroll, E. Smith and B. K. Sato, "Prevailing questions and methodologies in biology education research: A longitudinal analysis of research in CBE--Life Sciences Education and at the Society for the Advancement of Biology Education Research," *CBE--Life Sciences Education,* vol. 18, no. 9, pp. 1-10, 2019.

[37] L. A. Arthurs, "Undergraduate geoscience education research: Evolution of an emerging field of discipline-based education research," *Journal of Research in Science Teaching,* vol. 56, no. 2, pp. 118-140, 2019.