AC 2011-1562: SHORT TERM IMPACT OF AN ENGINEERING EDUCATION RESEARCH WORKSHOP ON PARTICIPANT'S RESEARCH INTERESTS AND CAPABILITIES

Junaid A. Siddiqui, Purdue University, West Lafayette

Junaid Siddiqui is a doctoral student at the School of Engineering Education, Purdue University. Before joining the doctoral program he worked for nine years at the faculty development office of King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. In this role he was involved in several faculty development activities, particularly working with the faculty members for exploring the use of web-based technologies in the support of classroom teaching. He received his MS in Civil Engineering from KFUPM while he has also earned an MPBL degree from Aalborg University, Denmark. His research focus during his doctoral studies is on institutional and faculty development in engineering education.

Robin S. Adams, Purdue University, West Lafayette

Robin S. Adams is an Assistant Professor in the School of Engineering Education at Purdue University. She led the Institute for Scholarship on Engineering Education (ISEE) as part of the Center for the Advancement of Engineering Education (CAEE). Dr. Adams received her PhD in Education, Leadership and Policy Studies from the University of Washington, an MS in Materials Science and Engineering from the University of Washington, and a BS in Mechanical Engineering from California Polytechnic State University, San Luis Obispo. Dr. Adams' research is concentrated in four interconnecting areas: cross-disciplinary thinking, acting, and being; design cognition and learning; views on the nature of engineering knowledge; and theories of change in linking engineering education research and practice.

Lorraine N. Fleming, Howard University

Lorraine N. Fleming is a Professor of Civil Engineering at Howard University and a Carnegie Scholar. She served as a Co-Principal Investigator of the Center for the Advancement of Engineering Education (CAEE). Dr. Fleming earned her Ph.D. in civil engineering from the University of California at Berkeley and holds a Master of Science and Bachelor of Science degree in civil engineering from George Washington University and Howard University, respectively. Dr. Fleming's research interest is concentrated on the reform of engineering education, broadening participation in engineering and the scholarship of teaching and learning.

Alison A. Dingwall, Howard University

Alison Dingwall is a Ph.D. candidate in Social Psychology at Howard University. She earned a Masters in Public Health from The George Washington University and a Master of Science in social psychology from Howard University. Her baccalaureate studies were completed at American University. Ms. Dingwall is a graduate research assistant with the Department of Civil Engineering at Howard University. Her research interests include engineering education, social rejection and program evaluation.

Short Term Impact of an Engineering Education Research Workshop on Participant's Research Interests and Capabilities

Abstract

This paper presents the results of a study that evaluates the impact of a multiday workshop that seeks to build capacity in engineering education research and enable research-informed approaches to transform engineering education. The focus of this paper is on the short-term impacts of the workshop as measured through a pre and post survey. The evaluation plan also includes long-term impacts, but this is not included in this paper. The survey included closed and open-ended questions regarding participants' familiarity, confidence and engagement in conducting engineering education research and using research to inform teaching or curriculum. An analysis of the pre-survey illustrates the considerable variability in participants' backgrounds in engineering education research; however, all participants emphasized a need for better understanding of choosing a conceptual framework for education research, using principles of rigor in education research, and developing a plan to answer a research question. The aggregate analysis of pre-post changes indicate gains in the level of familiarity for distinguishing education research from engineering research and the knowledge of principles and methods of rigorous educational research. An increase in the interest of building a community of researchers was also observed. An interesting observation is that the participants with less teaching experience, presumably in the early part of their career, demonstrated relatively more interest towards education research than those who had more experience.

Background

The interest in engineering education research has rapidly increased over the past decade. It is growing as a field of inquiry and a variety of organizations and initiatives have emerged to support a growing community of engineering education research scholars. For example, the current criteria for reviewing papers for the Educational Research and Methods (ERM) Division of ASEE are intended to promote generalized research based on empirical studies that have a broader appeal for the engineering education community[1]. The Journal of Engineering Education envisions itself to be a means of "building a community of scholars" with a mission to advance rigorous research in engineering education[2]. With this increased expectation for high quality scholarly work grounded in empirical data and explicit reasoning has emerged online forums to support sustained collaboration among engineering education researchers such as Collaboratory for Engineering Education Research (CLEERHub.org)[3], the Research in Engineering Education Network[4], and PhD Consortium in Engineering Education[5].

The National Science Foundation funded program, *Expanding and Sustaining Research Capacity in Engineering and Technology Education: Building on Successful Programs for Faculty and Graduate Students*, aligns with both these needs of expanding and sustaining research capacity in engineering education. This project builds on prior experiences of successful capacity-building projects including the Rigorous Research in Engineering Education program[6], the Institute for Scholarship in Engineering Education[7], and Bootstrapping in Computer Science Education Research[8]. The project consists of several programs that collectively focus on engineering and engineering technology faculty and graduate students to (1) increase capabilities in conducting

rigorous education research and using empirical research results to develop evidence-based curriculum, and (2) nurture and sustain a self-supporting virtual community of engineering education scholars.

This paper focuses on the short-term impact of one of the workshops that are part of the project. The background section continues with describing the purpose and process of the workshop. A brief review of literature on the development programs for engineering education research is presented. A summary of the overall evaluation plan of the project is given which is followed by the specific evaluation questions considered in this paper that appear at the end of background section. The rest of the paper describes the pre and post survey conducted for the evaluation and presents and discusses the results of the surveys.

Description of Workshop

The goal of the two and a half day engineering education research workshop is to meet a critical need in the development of engineering education research by targeting the following learning objectives for the participants: (1) describe relevant psychological models of student learning, (2) apply these models to learning engineering, (3) develop a substantive engineering education research question, and (4) develop a theory-based research plan to answer the research question. The National Research Council (NRC) report on Scientific Research in Education[9] identifies the principles of research which include questions for education research to be posed such that questions could be investigated empirically, grounding research into theory, and seeking generalization among studies. The workshop sought to promote the principles of rigorous research in engineering education and facilitate developing an understanding of these principles among the participants. The workshop was designed based on ideas that align with the theory of transformative learning[10, 11], providing participants with the opportunity to reflect and engage in a discourse with the peers and workshop facilitators.

Forty-three engineering and engineering technology faculty members from across the country and abroad with at least some prior experience in engineering education research attended the workshop. As part of the application process, participants indicated research topics in engineering education that they wanted to pursue and identified their interests for participating in the workshop. Workshop participants were selected based on a connection between their research interest and the scope of the workshop. Efforts were made to ensure diverse perspectives among workshop participants by including faculty from minority serving institutions while there was also a participant from a 2-year college.

The workshop consisted of activities to facilitate community formation among the participants and to develop engineering education research capabilities. Experts in the field, many of whom also served as facilitators, provided featured presentations on theoretical frameworks from cognition and educational psychology and from the well-known report on "How People Learn?"[12]. Presentations were also made on developing a theory-based research plan such as framing a research question, selecting a research methodology, design of research, principles of scientific inquiry, and reporting research findings. The workshop began with participants sharing their research topics to identify common themes and interests among the participants that were used to form common interest groups. These common interest groups worked together

throughout the workshop to assist one another with developing and refining their research study design. Facilitators provided opportunities for one-on-one discussions with participants. The workshop concluded with peer reviews of poster presentations of participant's research plans and an overview of CLEERHub[3], a virtual archival repository and interaction space for supporting the participants over time.

One of the main topics discussed in the workshop was the theoretical frameworks for learning and how a framework can be selected to design education research. This topic was discussed based on the report "How People Learn?"[12] published by the National Academies. The report calls for taking a learner, knowledge, assessment or community centered perspective as a matter of theoretical basis for the design of a learning environment. The report was not originally intended to be used to guide research designs but rather for designing instruction and learning environments. However the theoretical approach discussed in the report makes a strong link between education inquiry and design. It provides a lens which researchers can use to provide theoretical grounding for their design of education research.

The prior evaluative research on similar programs of the development of engineering education researchers indicates that these programs have the potential of enhancing a scholar's ability to formulate research questions and plan education research. Adams et al.[7] identified that scholars may face challenge as they try to frame a research question by defining and operationalizing the related factors. The process may lead a researcher from an interest in classroom innovation to an interest in a more focused and generalized issue of education research. Borrego[13] similarly identified difficulties that engineering faculty may face as they participate in a workshop to develop their skills of rigorous research in engineering education. These may include a tension between an interest in solving a problem and the operationalization for a scientific inquiry, recognizing the need to identify a theoretical framework for grounding the education research, and conceptual development for the application and design of qualitative research. The challenges may be associated with the expectation that engineering faculty have from their experience of engineering research and the frustration in applying engineering methods for education research. Adams et al.[7] found that while engineering faculty might not be familiar with qualitative research, they are curious and interested in learning about qualitative research methods. Workshops also provide an arena to develop collaborations and past workshops illustrate a keen interest in participants for interacting with other engineering education researchers[7, 8].

Evaluation Plan

The evaluation plan of the project at a broader level includes both short-term and long-term evaluation goals that span formative and summative assessment strategies. The short-term goal, which is the focus of this paper, is to illuminate the relationship between program processes and program impact. As such, it is not meant for quality control to measure if outcomes meet some prescribed minimum standards; rather, it is a formative evaluation to enhance the understanding of the transformative process that contributes to the development of engineering education researchers and their community with the assumption that specific outcomes will be different for each participant. The long-term goal is to provide evidence of the impact of the program and contribute to theories regarding learning how to conduct engineering education research (e.g., approaches to engineering education research and the knowledge that guides these research

decisions), how to use empirical research on how students learn engineering to guide instruction and curriculum development, and how to impact institutional or curricular change (e.g., ways to influence peers and administrators, educational policies, or future curriculum efforts). The long-term evaluation goals will be addressed in a future paper. To meet these evaluation goals, the evaluation plan included surveys, participant observation, end of day reflection, focus groups, and follow-up interviews (Table 1).

Table 1. Evaluation plan - mapping of data collection methods to evaluation questions

	Engineering education research capability	Impact on institution / teaching	Workshop expectations
Surveys	Data on prior knowledge and familiarity, and any short-term changes	Data on current practices in connecting teaching and research	Data on expectations and motivations for attending, and any short-term changes
Participant Observation	Data on how participants experienced the workshop (e.g., challenges, language/concepts used, evolution of plans); Data on how participants understand rigorous engineering education research	Data on how participants linked research and teaching, and how they described personal theories of institutional or curricular change	Data on expectations – personal and institutional, and any changes over time
End of day Reflection	Data on what participants perceive as learning outcomes or insights and issues they are still struggling with; Data on how participants understand rigorous engineering education research	Data on what participants perceive as insights regarding institutional or curricular change	Data on what participants expected as learning outcomes
Focus Groups	Data on how participants experienced the workshop, what they perceived as learning outcomes or challenges or new insights; How participants understand rigorous engineering education research	Data on how participants understand engineering education research as it relates to teaching or curriculum, and the nature of institutional or curricular change	Data on their motivations for attending the workshop and elements of workshop that impacted them (and how)
Follow up Interview	Data on participants' perceptions of long term workshop outcomes, what they perceived as or challenges or new insights; The evolution of research plans; How participants understand rigorous engineering education research	Data on how participants understand engineering education research as it relates to teaching or curriculum, and the nature of institutional or curricular change – as well as what influenced these perceptions	Data on how attending the workshop fits with new short and long term goals, and elements of workshop that impacted these goals (and how)

Studying the Short-Term Impacts

In this paper we focus on the short-term impacts of the workshop. The data was collected through surveys conducted at the start and at the end of the two and half day workshop, and is the first data collection method listed in Table 1. There are three evaluation questions for assessing short-term impacts that are the focus of this paper:

(1) What is the impact of the workshop on participants' familiarity and confidence for engineering education research?
(2) What is the impact of the workshop on participant's perception for conducting research on how students learn engineering and using findings to inform teaching, curriculum, or institutional change?
(3) What are participants' expectations for the workshop and how did they evolve during the process?

The survey instruments were developed to answer these three questions. Survey responses were analyzed as an aggregate as well as across two important variations in the data set. In particular, we sought to answer two additional questions:

(4) What are patterns in the data distributions that relate to differences in participants' level of engineering education research experience?
(5) What are patterns in the data distributions that relate to differences in participants' level of teaching experience?

A secondary goal of this paper is to identify follow-up interview questions to delve more deeply into the relationship between program processes and program impact on individual participants. In the following sections we describe the survey, present and discuss results from the analysis of closed-ended and open-ended survey questions, and identify future work.

Pre and Post-Survey for Short-Term Program Impact

A survey was administered at the start and at the end of the workshop to measure the influence of the workshop experience on participant's familiarity, confidence and engagement in conducting engineering education research and using research to inform teaching or curriculum. The pre and post-survey instruments were designed to answer the three primary evaluation questions given in the previous section and had five distinct constructs (Table 2) using close-ended items with an associated response scale. The first construct on familiarity with the issues of education research and the second construct on confidence working with education research address the first evaluation question. Examples of questions include familiarity with using principles of rigor in education research and confidence in creating a plan to answer a research question. We also asked participants to write what the phrase "How People Learn?" means to them to elicit their prior knowledge of theoretical frameworks in education as an open-ended question. The third construct on the level of engagement with education research and the fourth construct both address the second evaluation question on conducting research and using it to inform teaching, curriculum, or institutional change. The fifth construct addresses the third evaluation question on workshop expectations and mapped to 10 survey items. Examples of the questions include

participants asked to rate the importance of learning about psychological models of student learning and about various research methods in education. In relation to the third evaluation question participants also wrote open-ended comments at the end of the pre-survey on their expectations for the workshop. Similarly at the end of post-survey they wrote what they found most useful and what they wanted more from the workshop. Furthermore, the pre-survey asked the respondents to specify their teaching experience and their experience with working on engineering education research projects. This was used to understand the variation in experiences and knowledge across participants to answer the fourth and fifth questions respectively.

Table 2: Pre and Post Survey Constructs

Construct	Number of Items	Evaluation Question
1. Level of familiarity with the education research issues	6	1
2. Level of confidence working with education research	10	1
3. Level of engagement with education research	4	2
4. Perspective towards conducting education research to inform teaching or curriculum	5	2
5. Expectations of the workshop	10	3

Results and Discussion

Pre and post-survey responses were analyzed at an aggregate level to reveal the short-term impact of the program in terms of mean ratings of the respondents for various constructs. The rationale for this approach is because aggregate analysis is considered more suitable for an evaluation at the program level as compared to individual case study, which is appropriate when the focus is on individual outcomes[14].

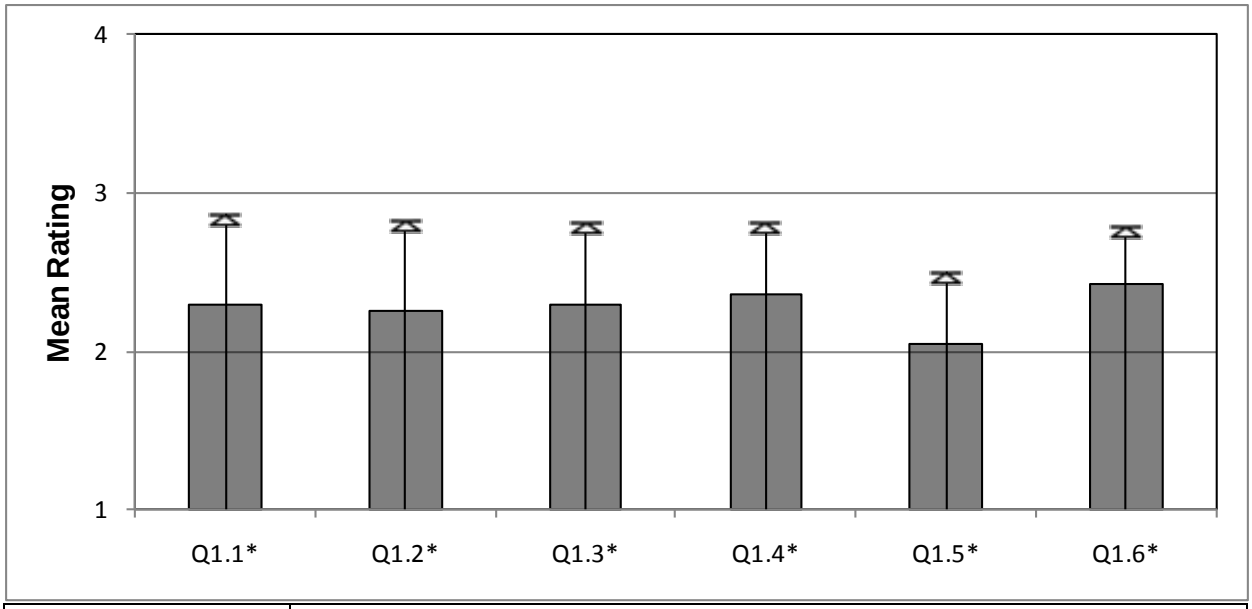
In this section we report and discuss the results (see Figures 1 through 5) according to the three primary evaluation questions. To understand the variation of short-term impacts on participants, we conducted a secondary analysis on the relationship between teaching and research experience with their responses to the questions for Constructs 1 through 5 to address fourth and fifth evaluation questions which is also discussed in this section.

For each analysis of closed-ended questions, a list of associated survey items is provided. Forty-three participants returned the pre-survey while forty-one returned the post survey. The plotted results include only the forty-one paired submissions. The solid bars on each plot represent the mean rating for a question on the pre-survey. The results of the post survey are plotted using the following scheme of legends relative to the ratings of pre survey:

The questions, for which there is a statistically significant difference between pre and post survey ($p < 0.05$ on t-test), are indicated on the plot with an asterisk (*) beside the question number.

Evaluation question 1: Familiarity and confidence for engineering education research

The mean participant perception regarding familiarity with education research issues (Construct 1) is plotted in Figure 1. The participants considered themselves to be familiar with these issues to some extent but not to a level of "very familiar". Adams et al.[7] made a similar observation that engineering faculty face difficulty with education research because of the differences in disciplinary language and the use of qualitative data in education research. Choosing an appropriate conceptual framework for education research (Q 1.5) was rated the lowest. This conforms to Borrego's[13] finding that when learning educational research methods, grounding research in a theoretical framework is among the conceptual issues that engineering faculty find less familiar. As Borrego observes, the scientific and engineering theories these faculty use are universal and often do not need to be explicitly considered and mentioned. As such, it is likely that engineering faculty are not used to formulating theoretical frameworks, which may contribute to a lack of familiarity with understanding the role of these frameworks in education research.



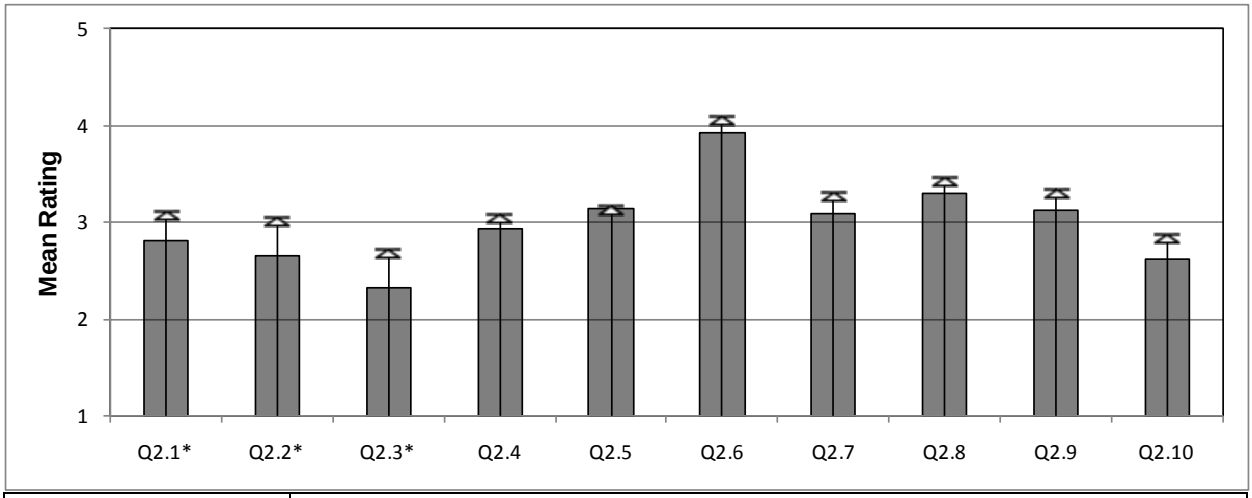
4 Extremely familiar	Q1.1 How engineering research and educational research are different
3 Very familiar	Q1.2 How engineering research and educational research are similar
2 Somewhat familiar	Q1.3 Designing research questions with educational issues in mind
1 Not familiar	Q1.4 Using principles of rigor in education research
	Q1.5 Choosing an appropriate conceptual framework for education research
	Q1.6 Creating a plan to answer a research question

Figure 1: Construct 1: Level of familiarity with the issues of education research

As shown in Figure 1, the mean level of familiarity significantly increased for all the educational research issues in the post survey. All these issues were discussed during the workshop and this

demonstrates an impact of the workshop process on participants' level of familiarity with educational research issues. However the mean rating still did not reach the level of "very familiar." It is likely that a period of two and half days would not be sufficient to bring the familiarity to a high level.

The mean confidence level of the participants with respect to doing various education research tasks (Construct 2) was mostly in the range of fair to good (Figure 2). There was a relatively higher level of confidence for attending conferences on education research (Q 2.6), discussing research with colleagues (Q 2.8), and publishing or presenting work on education research (Q 2.5). These results may be an indicator of the inclination of these engineering educators to participate in the community of education research. Similar observations were made in the evaluation of previous workshops[7, 8]. As with the familiarity ratings, choosing an appropriate conceptual framework (Q 2.3) was rated the lowest in confidence levels.



5 Excellent	Q2.1 Designing research questions with educational issues in mind
4 Very Good	Q2.2 Using principles of rigor in education research
3 Good	Q2.3 Choosing an appropriate conceptual framework for education research
2 Fair	Q2.4 Creating a plan to answer a research question
1 Poor	Q2.5 Publishing or presenting work on an education research project/grant
	Q2.6 Attending other conferences or workshops on education research
	Q2.7 Analyzing journal articles on education research for quality
	Q2.8 Discussing education research with colleagues
	Q2.9 Changing curriculum in your classes based on education research
	Q2.10 Changing curriculum in your program based on education research

Figure 2: Construct 2: Level of confidence working with education research

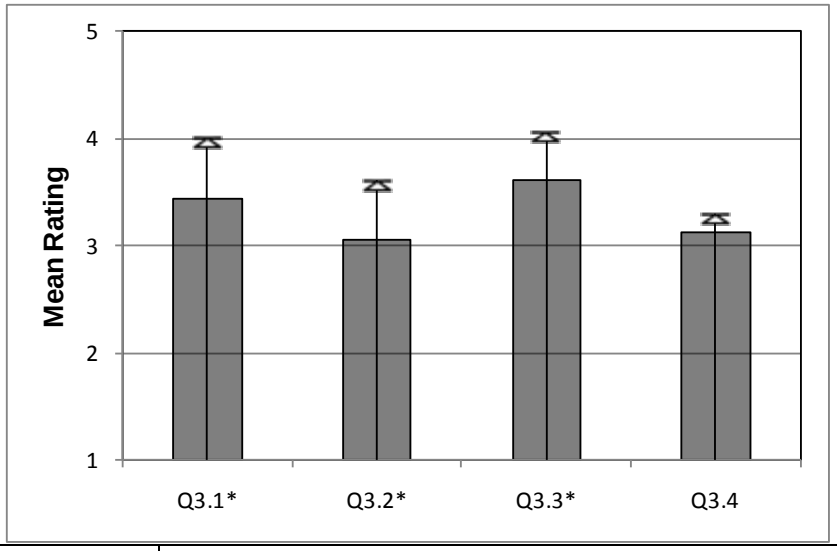
As shown in Figure 2, a statistically significant change from pre to post survey was observed for Q2.1, Q2.2, and Q2.3. Designing research questions, using principles of rigor in education research, and choosing an appropriate conceptual frame are the three topics for which significant time was allotted during the workshop. Creating a plan to answer a research question (Q 2.4) was a significant workshop activity; however there was only a limited impact. This result may

be because creating a plan is a time consuming task and there may have not been sufficient time to work on it in detail. The issue of limited time also appeared repeatedly in the responses to the open-ended questions which are discussed later where participants indicated their desire for more time and interaction with the workshop facilitators. While the workshop had a noticeable impact on improving the level of familiarity, the impact in enhancing the level of confidence is limited. This finding is expected because while a workshop can help develop familiarity, the development of confidence requires working on actual research projects. This finding will be further evident later in the analysis correlating levels of experience with working on research projects with levels of confidence.

We asked in the pre and post surveys what participants understand about the phrase "How People Learn?" (HPL). In the responses we sought to identify how participants relate the expression "How People Learn?" to education research to elicit information on their prior knowledge of theoretical frameworks in education. Most of the pre-survey responses do not explicitly describe "How People Learn?" in terms of research although there were 4 pre-survey responses in which there was a mention of research. As an example, one participant wrote: *Framing my research around this concept so that my teaching (curriculum and protocols) can be enhanced*. The number of responses that explicitly referenced research in relation to the HPL concept significantly increased in post-survey responses with up to 15 responses mentioning a relationship. This change aligns with the increase in familiarity with education issues while considering the variability of experience of participants as we will discuss later. For example one participant who did not relate HPL to research in the pre-survey demonstrates a new awareness in their post-survey response: *I can now better place different research amongst the different theoretical frameworks*. This new awareness occurred in a few other responses. For example one participant writes: *I have a much better appreciation … but now I realize I have a long way to go*. Another theme in the post-survey responses is the issue of complexity. Many participants identified a new awareness that learning is a complex issue and the perception of learning depends on the perspective from which one approaches it. One participant writes: *This is not an easy question! Learning is very complex. Assessing it is very difficult. It must be broken down into much more specific questions. And the answer is very dependent on the perspective from which the question is asked*.

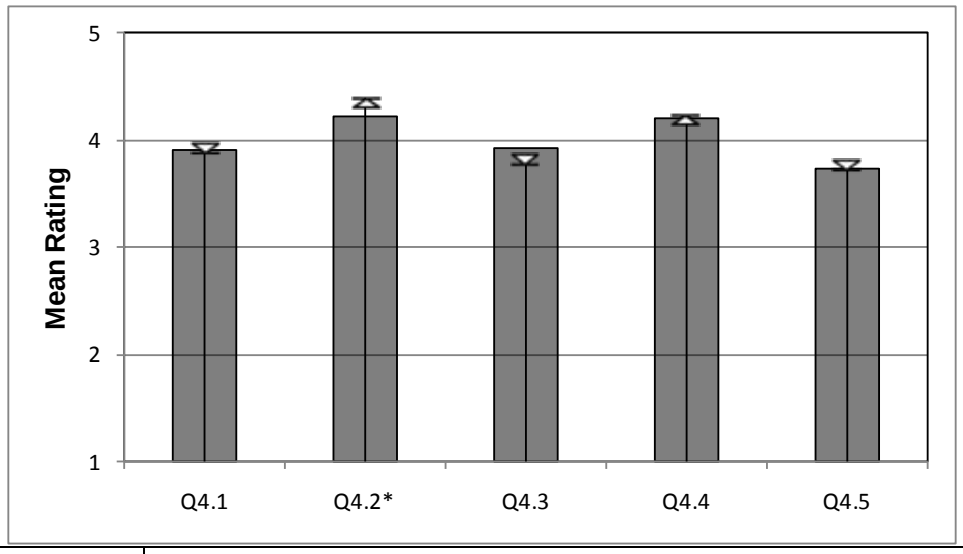
Evaluation question 2: Impact on conducting research and to inform teaching, curriculum, or institutional change

The mean rating of participants' level of engagement with education research (Construct 3) is represented in Figure 3. The rating for all the activities is in the range of once a month to once a semester. What is interesting is that there is a statistically significant increase in the rating of Q3.1, Q3.2 and Q3.3 indicating an impact of the workshop in participants' anticipation that they will be more frequently engaged in reading the literature on engineering education research and talking with peers about engineering education research. This finding may also be an indication of participants' realization that they need to spend more time and effort to develop their capacity for the education research.



5 At least once a week 4 At least once a month 3 At least once a semester 2 At least once a year 1 Never	Q3.1 Reading empirical literature on engineering education Q3.2 Reading empirical literature on learning (outside of engineering) Q3.3 Talking with my peers about engineering education research Q3.4 Incorporating new techniques into my teaching

Figure 3: Construct 3: Level of engagement with education research



5 Strongly Agree 4 Agree 3 Neutral 2 Disagree 1 Strongly Disagree	Q4.1 Participation in the workshop will be a positive addition to my CV. Q4.2 The education research that I will do following the workshop will be well-integrated into my career goals. Q4.3 I believe that my participation in the workshop will advance my career. Q4.4 The workshop will inform teaching and curriculum in my classes. Q4.5 The workshop will inform teaching and curriculum in my program.

Figure 4: Construct 4: Perspective towards conducting education research to inform teaching or curriculum

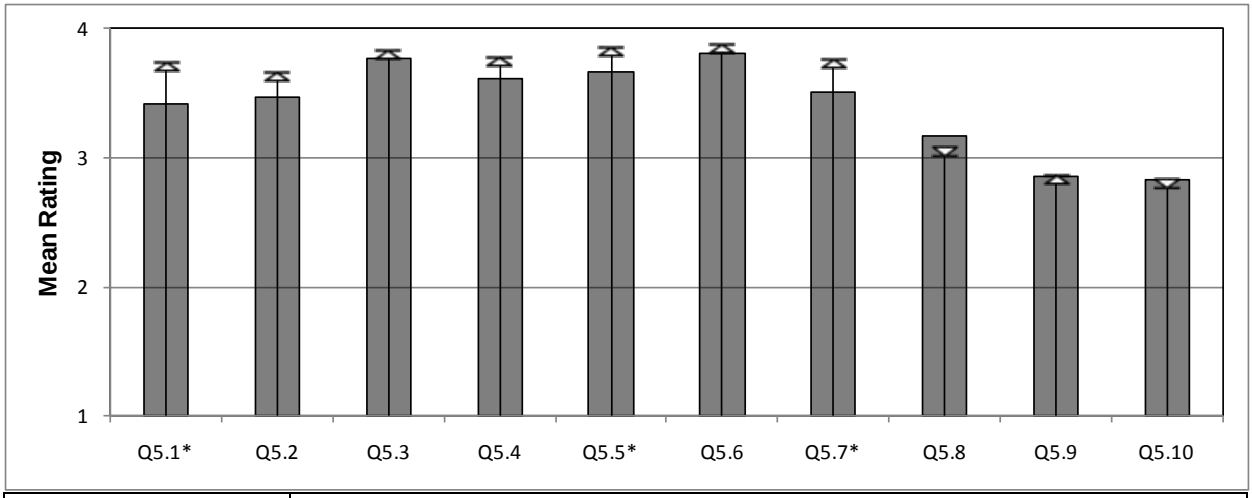
Participants' perception of the relationship between conducting educational research with their career and academic role or with informing their teaching and curriculum (Construct 4) is depicted in Figure 4 and emphasizes a positive relationship (Figure 4). This conforms to the results of an earlier report in which scholars indicated a positive perception for the integration of education research in their career goals and demonstrates a sense of passion for education research[7]. Mean perceptions remained almost unchanged with only a slight raise or drop in the ratings in the post survey. Open discussions on questions relating research to career goals and teaching practice were not included in the scope of the workshop. Regardless, the commitment with which a participant entered this workshop seems to have been sustained. There is a statistically significant change only in the case of Q 4.2 regarding the place of education research in career goals. The opportunities for critical self-reflection provided in the workshop may have had some positive impact in participants' vision for the place of education research in their career goals.

Evaluation question 3: Expectations and how they evolved over the workshop term

The results for Construct 5: Expectations of the Workshop are provided in Figure 5. Participants' expectations seem to be well aligned with the main objectives of the workshop which are represented by Q5.1 - Q5.6. A similar alignment of participant expectations with the workshop objectives has been observed on previous occasions[15]. Participants have indicated that these objectives and activities have a high significance for them. The activities described in Q5.8 - Q5.10 were secondary objectives of the workshop and were not addressed explicitly during the workshop.

There is a statistically significant difference between pre and post surveys for Q5.1, Q5.5, and Q5.7. A substantial amount of time was spent on discussing psychological models of student learning, identifying research questions, and building a community of researchers with common interests. The increase in ratings for these three aspects of the workshop indicates a positive impact of the workshop and an alignment with participant expectations.

The pre-survey included a question for participants to provide additional comments on what they wanted from the workshop. Responses emphasized theories of education research, knowledge and skills to design education research, and finding research collaborators. As is customary in such surveys, post-survey included a question on what participants' perceived as the most useful aspects of the workshop. The most cited aspect that participants found useful was interaction with peers. As one participant responded: *Working collaboratively with others to develop a joint project - the interactive process helped to more quickly hone in on a research question*. Participants also identified one-on-one interactions with workshop facilitators as very useful. One participant writes it succinctly: *1) Most important: Discussion with facilitators about my topic 2) Second most important: Discussion with participants about my topic*. Participants also appreciated the presentation on theoretical frameworks and the opportunity that the workshop provided for developing their research questions. Common responses to the question about what they wanted more from the workshop included more interaction with the facilitators, and a longer workshop with more content coverage. Participants also indicated in both their pre and post survey responses that they wish to find research collaborators and form collaborations.



4 Very Important 3 Somewhat Important 2 A little Important 1 Not at all Important	Q5.1 Learning about psychological models of student learning Q5.2 Learning about how psychological models of student learning can be used in teaching Q5.3 Learning about up-to-date research on engineering education Q5.4 Learning about various research methods in education Q5.5 Identifying one or more substantial questions for my engineering education research Q5.6 Developing a plan to answer the research questions Q5.7 Building a community among the researchers of similar interests Q5.8 Discussing how to integrate research on engineering education in my teaching Q5.9 Discussing how to integrate research on engineering education with my other academic roles Q5.10 Exploring where research on engineering education might have impact on my campus

Figure 5: Construct 5: Expectations of the workshop - Rate the importance of objectives and activities

Evaluation question 4: Impact of participant's experience with education research on survey results

In this section we describe the distribution of survey responses based on the variations in the level of participants' experience of engineering education research. Like Borrego et al.[15] we observed that more experienced participants reported more gains and satisfaction with the workshop experience. All participants reported having worked on at least one engineering education research project while a few have worked on as many as ten projects. As shown in Table 3, participants were grouped based on the levels of experience with working on research projects and the grouped survey responses were analyzed to identify relation with research project experience. Thirty-nine participants reported their project experience and only their data is used for this analysis. The analysis is primarily based on interpreting the plots for patterns. As an additional measure of analysis we also looked at the coefficient of correlation between education research and the rating given for an item. A statistically significant correlation for N=39 and a value of two-tailed p=0.05 occurs when the value of the correlation coefficient is greater than 0.316. This is indicated on the plots by using a symbol † for pre-survey and a symbol § for post survey beside each question. A correlation coefficient value less than this

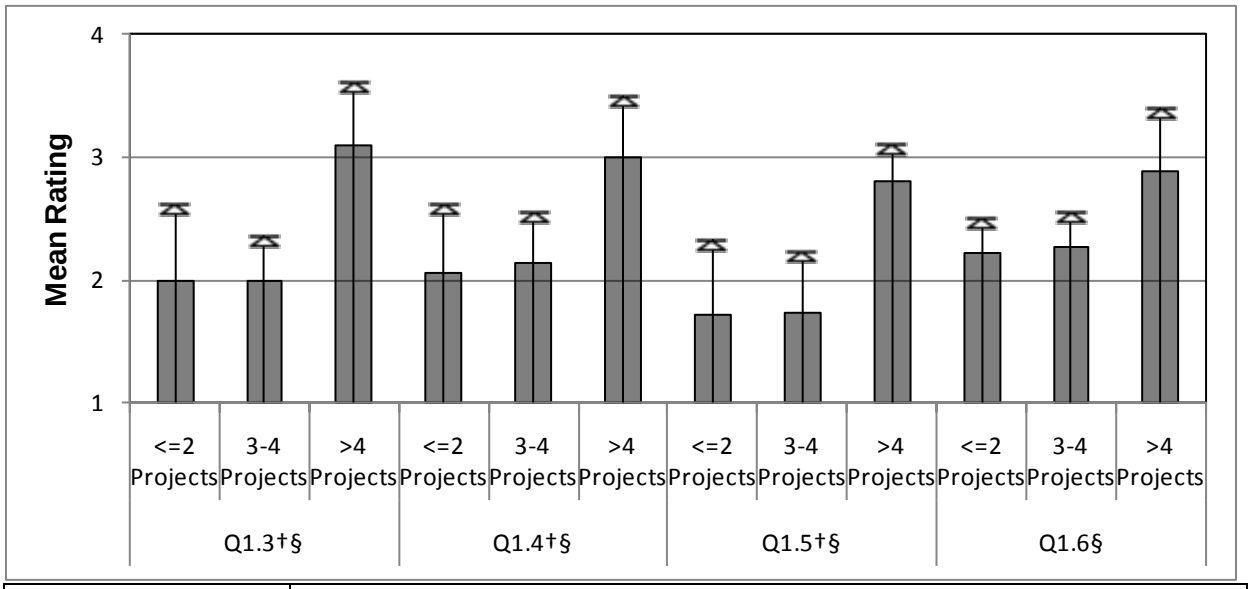
value (0.316) would mean that p is greater than 0.05 and thus the probability of correlation is lower.

Table 3: Groupings by Project Experience

No.	Number of Engineering Education Research Projects	Number of Participants
1	<= 2	18
2	3-4	11
3	>4	10

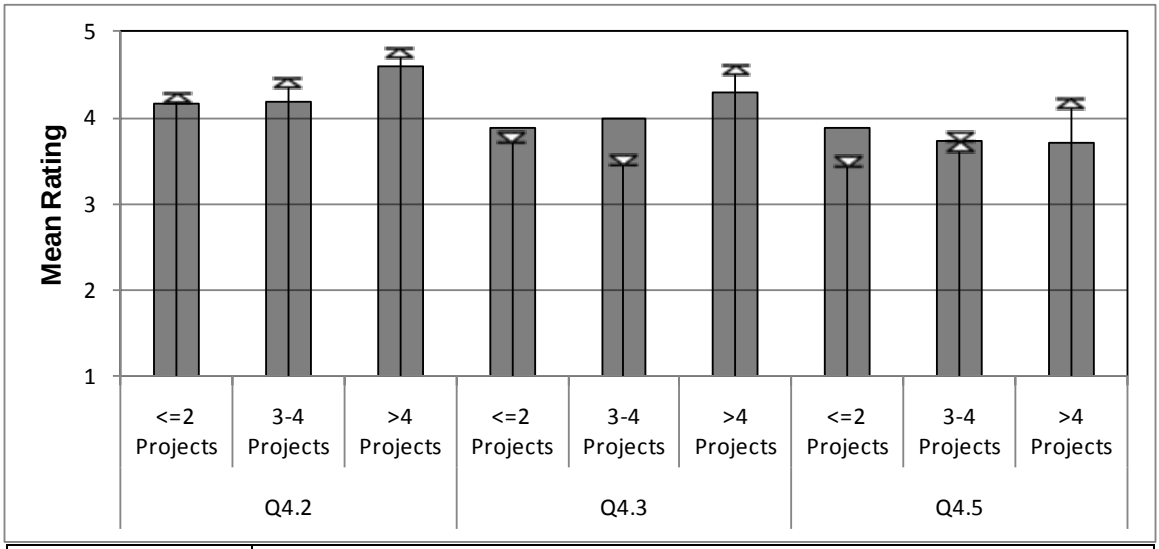
Note: Not all reported their project experience.

It is not surprising that there was a positive correlation of experience with the level of familiarity of education research issues (Figure 6). The level of familiarity seems to increase in an exponential manner with project experience. While we have not included a plot for it, the level of confidence working with education research (Construct 2) had a similar significant positive correlation with the project experience. Similarly, there was a strong correlation between projects experience and the frequency of engagement with education research activities (Construct 3).



4 Extremely familiar	Q1.3	Designing research questions with educational issues in mind
3 Very familiar	Q1.4	Using principles of rigor in education research
2 Somewhat familiar	Q1.5	Choosing an appropriate conceptual framework for education research
1 Not familiar	Q1.6	Creating a plan to answer a research question

Figure 6: The correlation of projects experience with Construct 1: level of familiarity with the issues of education research

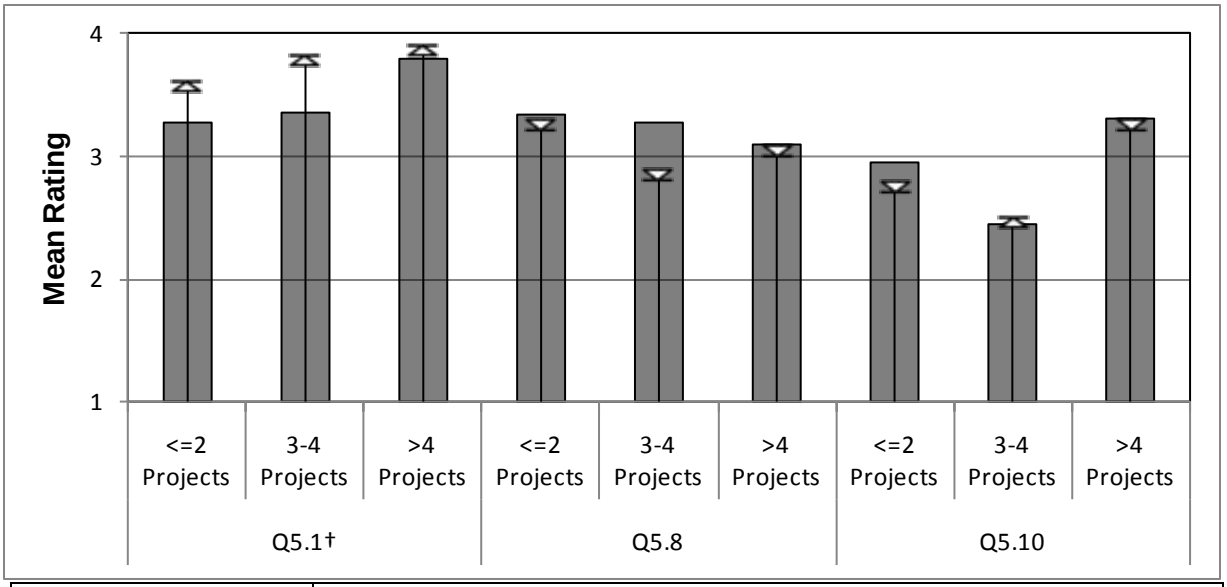


5 Strongly Agree	Q4.2 The education research that I will do following the workshop will be well-integrated into my career goals.
4 Agree	
3 Neutral	Q4.3 I believe that my participation in the workshop will advance my career.
2 Disagree	Q4.5 The workshop will inform teaching and curriculum in my program.
1 Strongly Disagree	

Figure 7: The correlation of projects experience with Construct 4: Perspective towards conducting education research to inform teaching or curriculum

The pattern in figure 7 seems to indicate that the number of projects one has conducted has a somewhat positive relationship to the integration of engineering education research with one's career and teaching goals (Q 4.3 & 4.3). It is also interesting to note that the workshop had a positive impact on those with greater engineering education research experience in terms of perceived impact of the workshop on their campuses (Figure 7 - Q 4.5). Those with less experience decreased their perception of how their research can have the potential to inform curriculum in their program. On the other hand, the opportunity for reflection that the workshop provided to those with more projects experience seems to have helped them in exploring the possibilities of research informing curriculum on their campuses.

Figure 8 depicts a relation between project experience and some of the items related to workshop objectives and activities. There was a positive correlation (correlation coefficient Pre: 0.32, Post: 0.25) between project experience and the importance of learning about psychological models of student learning. The more experienced participants already had a high level of awareness of the importance while others had a substantial increase for this in their post survey ratings. The rating for Q5.8 and Q5.10 dropped slightly in the post survey, and these activities were not explicitly discussed in the workshop. It is, however, interesting to note a pattern of somewhat negative relation for Q5.8 while there was a slightly positive relation for Q 5.10. This may be an indicator that experienced participants were relatively more interested in the broader impact of their research on the campus than the issue of how to integrate research in their own teaching.



4 Very Important	Q5.1 Learning about psychological models of student learning
3 Somewhat Important	Q5.8 Discussing how to integrate research on engineering education in my teaching
2 A little Important	
1 Not at all Important	Q5.10 Exploring where research on engineering education might have impact on my campus

Figure 8: The correlation of projects experience with Construct 5: expectations for the workshop objectives and activities

Evaluation question 5: Impact of participant's teaching experience on survey results

We also analyzed the relation of participants' responses on survey items with their teaching experience. Forty participants reported their teaching experience. The teaching experience of the participants varied from 1 to 34 years. We grouped the participants based on their teaching experiences and labeled the groups as shown in Table 4. The interval of seven years for a group is selected to match with the time it may take for a faculty member to get tenure and also estimates a significant threshold in developing expertise. Group 1, therefore, represents more junior faculty who may not be tenured. The other groups of teaching experience are made to have same seven year interval. We plotted the distribution of mean ratings on survey items over these groups of teaching experience to analyze the relation from the patterns that are observed in the plot. Correlation coefficient is used as an additional statistic to facilitate inferences. Statistically significant correlations for N=40 and a value of two-tailed p=0.05 occurs when the value of the correlation coefficient is greater than 0.312. This is indicated on plots (Figures 10-12) by using a symbol † for pre-survey and a symbol § for post survey beside each question. As indicated on the plots, most of the correlation coefficients are lower than this value of 0.312. Patterns that emerge in the plots, however, still lead to some interesting inferences. This seems to suggest that teaching experience groupings are more qualitative in nature and are not clearly ordinal relative to each other.

The distribution of project experience within a group of teaching experience is plotted in Figure 9. The group of junior faculty members (Teaching Experience: 0-7 years) are mostly distributed

among the two extremes. The intermediate groups, on the other hand, have a lower concentration for the >4 projects group. The > 21 years teaching experience group is relatively smaller which has a somewhat uniform distribution with some concentration towards the higher project experience group. This portrays an interesting picture of motivation and commitment that brought faculty to participate in the workshop. The junior faculty group and the senior faculty group have a substantial number of those who already have experience of education research. The participants with an intermediate level of teaching experience, however, have mostly come as they are beginning to explore education research.

Table 4: Groups of Teaching Experience

No.	Teaching Experience	Interval	Number of Participants
1	0-7 Years	$0 < \text{Experience} \leq 7$	10
2	7-14 Years	$7 < \text{Experience} \leq 14$	13
3	14-21 Years	$14 < \text{Experience} \leq 21$	11
4	>21 Years	Experience > 21	6

Note 1: Not all reported their teaching experience.

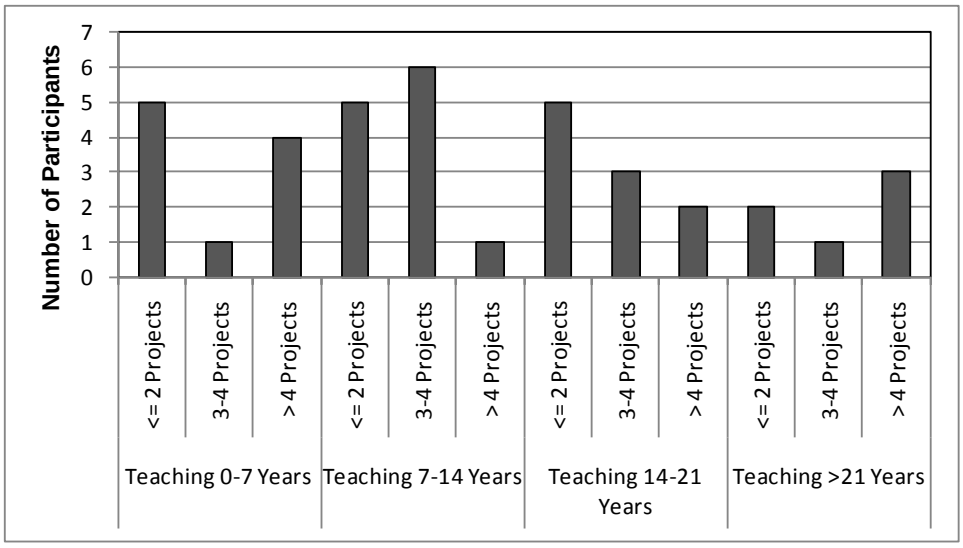
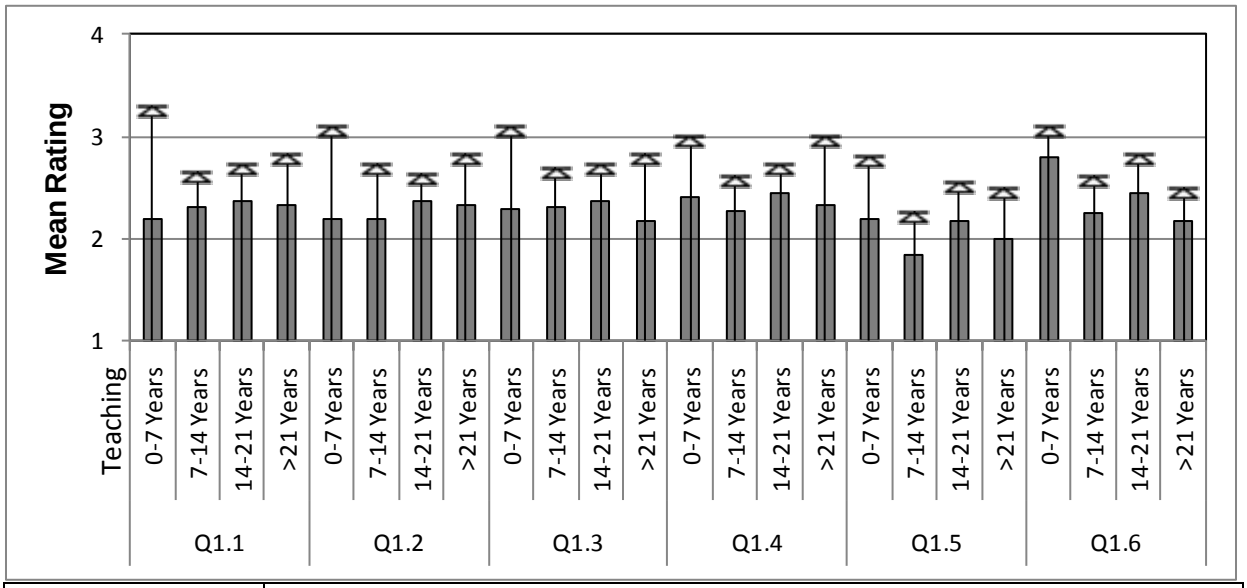


Figure 9: Participant Distribution - Projects experience groups within teaching experience groups

While there was not a statistical correlation between teaching experience and the level of familiarity with education research issues (Figure 10), it is interesting to note that younger faculty members have reported more gains in their familiarity by the end of the workshop than the more senior faculty. While some of the junior faculty members have considerable experience with working on research projects this may be an indicator of the level of enthusiasm these faculty members have towards education research. The two groups, 0-7 Years, and > 21 Years are leading in gains in many of the issues of familiarity as compared to the two intermediate groups. This can be because the two groups have the greater proportion of those who have >4 projects experience (Figure 9).

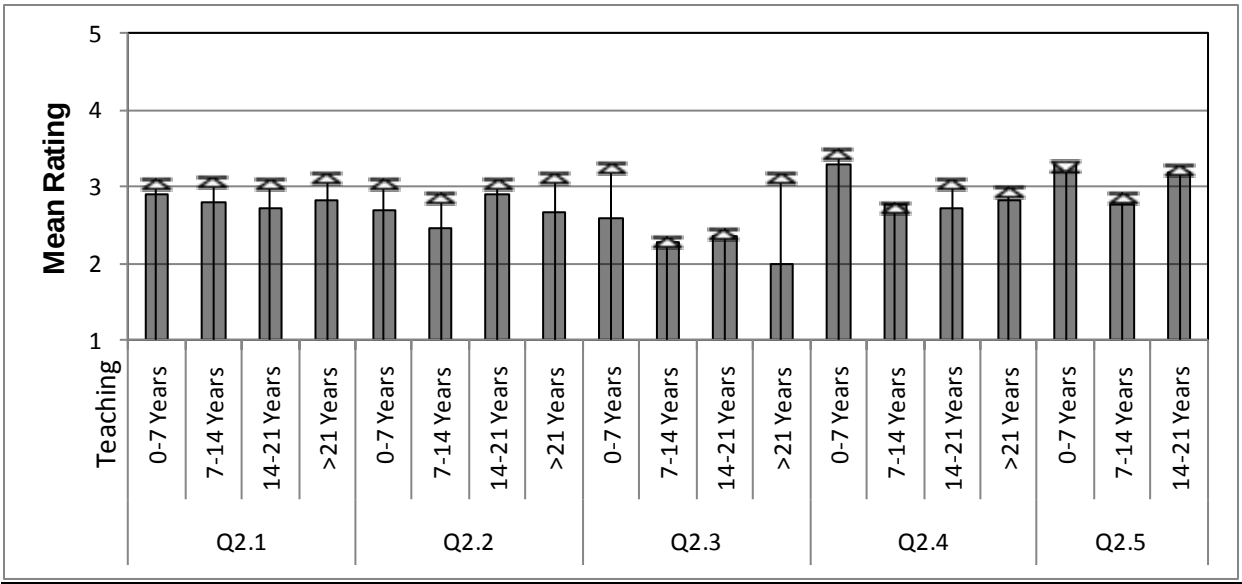


4 Extremely familiar	Q1.1	How engineering research and educational research are different
3 Very familiar	Q1.2	How engineering research and educational research are similar
2 Somewhat familiar	Q1.3	Designing research questions with educational issues in mind
1 Not familiar	Q1.5	Choosing an appropriate conceptual framework for education research
	Q1.6	Creating a plan to answer a research question

Figure 10: The correlation of teaching experience with Construct 1: level of familiarity with the issues of education research

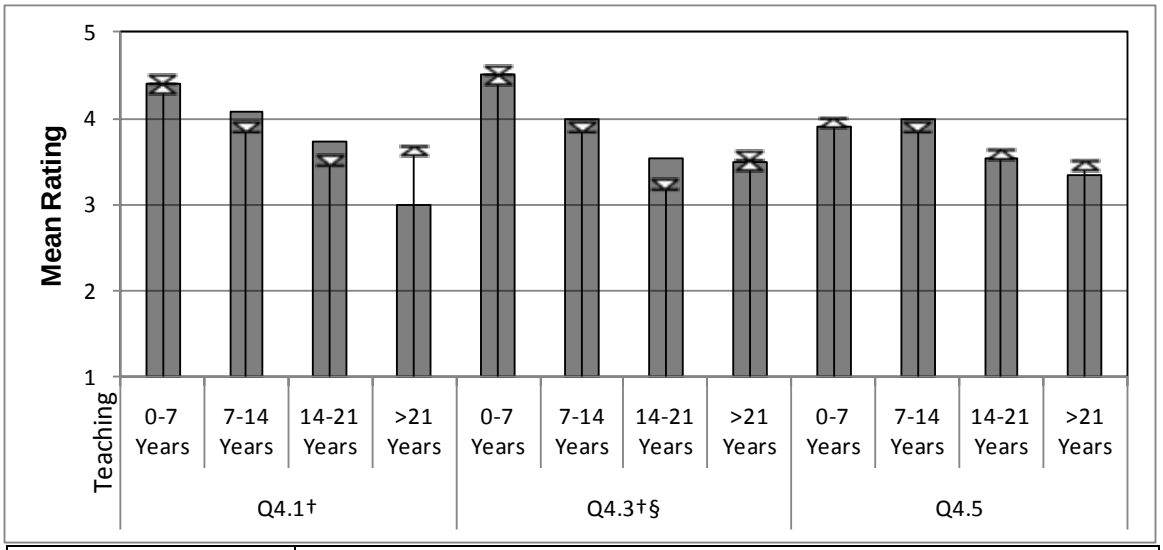
The level of confidence working with education research is somewhat uniform among the groups of teaching experience. Figure 11 shows some variation in select issues shown in the figure. Designing research questions (Q 2.1) particularly seems to be an issue of equal level of challenge for all participants. For the case for Q 2.3 the gain in the level of confidence of the 0-7 Years and > 21 Years groups is relatively higher than the other two groups. The 0-7 Years group seems to be somewhat leading in some of the issues shown in Figure 11.

As shown in Figure 12, there was a statistically significant correlation between teaching experience and the perception of the impact of the workshop on careers and institutional programs (correlation coefficient: Q4.1 Pre -0.47, Q4.1 Post -0.31, Q4.3 Pre -0.36, Q4.3 Post -0.35). The participants with less teaching experience had a more positive perception for the value of workshop in advancing their careers by the end of the workshop. The correlation is not as strong for Q4.5 but still the participants with less teaching experience are slightly more positive for the workshop informing curriculum in their programs.



5 Excellent	Q2.1	Designing research questions with educational issues in mind
4 Very Good	Q2.2	Using principles of rigor in education research
3 Good	Q2.3	Choosing an appropriate conceptual framework for education research
2 Fair	Q2.4	Creating a plan to answer a research question
1 Poor	Q2.5	Publishing or presenting work on an education research project/grant

Figure 11: The correlation of teaching experience with Construct 2: level of confidence working with education research



5 Strongly Agree	Q4.1	Participation in the workshop will be a positive addition to my CV.
4 Agree	Q4.3	I believe that my participation in the workshop will advance my career.
3 Neutral		
2 Disagree	Q4.5	The workshop will inform teaching and curriculum in my program.
1 Strongly Disagree		

Figure 12: The correlation of teaching experience with Construct 4: Perspective towards conducting education research to inform teaching or curriculum

The variability in the experience of participants (Figure 9) is also evident in their responses to the open-ended questions. The pre and post surveys asked participants what the phrase "How People Learn?" means to them. Themes among the responses included a focus on learning styles, assessment, the complexity in understanding learning, affective aspects of learning, engineering professional attributes and minorities. There were a few responses in the pre survey that explicitly mentioned the "How People Learn?" (HPL) report. These responses were mostly from those with a higher level of experience working on education research projects. The responses from most of the participants, however, do not explicitly indicate prior knowledge about the report. Among these a significant number of responses were still able to relate the phrase with the theories of learning. For example one participant wrote in the pre survey response his perception for the term "How People Learn?": *To understand the cognitive psychological process as to how individuals acquire/enhance knowledge, abilities & skills*. This response does not explicitly mention HPL; however, the focus on psychological processes is explicitly made in the response. The focus in several of the responses was on an issue other than HPL being a theoretical lens for research. For example several responses describe HPL as a way to identify the factors which influence student learning and performance: *"How People Learn" means understanding how different factors (physical, environment, cognitive, socio-cultural, and personal), and learner capabilities & limitations affect academic performance.* A participant wrote in the pre-survey response: *Working to know what students learning processes are to better teach them*. In this response the implicit reference to theory is made when it says "to know what students learning processes are" and this is with the goal "to better teach them" which demonstrates an applied perspective of the participant. Some responses have more varied and explicit focuses: *Cognitive aspects of learning; technological factors impinging on education today. Social underpinning & inclusion of underrepresented minorities in engineering education agendas*. Overall there is a variety in how participants responded to the question which relates to the variability in the participant experience.

Conclusion and Future Work

The results of the pre and post survey of the two and a half day workshop were analyzed in this paper as a means to evaluate the short-term impact of the workshop. The study was designed to answer three primary evaluation questions: (1) What is the impact of the workshop on the participants' familiarity and confidence for engineering education research? (2) What is the impact of the workshop on participant's perception for conducting research on how students learn engineering and using findings to inform teaching, curriculum, or institutional change? (3) What are participants' expectations for the workshop and how did they evolve during the process?

In relation to the first evaluation question the short-term impact results indicate a significant impact in terms of enhancing participants' familiarity with education research issues. Participants having prior experience working on several education research projects rated gains at a level beyond "very familiar". In comparison, participants rated relatively limited gains in their confidence with education research issues. A significant amount of workshop time was allotted to topics of designing research questions, using principles of rigor in education research, and choosing an appropriate conceptual frame and there was a related significant gain in confidence for the three issues. Choosing an appropriate conceptual framework for education research was among one of the items with lowest rating for familiarity and confidence. Previous

studies also identify this as a conceptual hurdle for engineering faculty learning education research methods[13]. There is a noticeable gain in confidence on this issue for the participant group with less than seven years of experience and the group with more than twenty-one years of experience. The recognition of "How People Learn?" as a possible source for theoretical education research frameworks increased over the duration of the workshop. At the same time, a number of participants became more aware of the complexity of learning phenomena and education research as a means to understand it further.

Regarding the second evaluation question, participants indicated a short-term increase in their anticipated engagement in education research related activities after the workshop. The workshop did not have a significant impact on participants' perceptions for the role of education research in their career and education research to inform their teaching or curriculum. This was not surprising since these issues were not explicitly included in workshop activities. It is interesting to note that junior faculty members indicated a relatively more positive perception on the role of education research in their career goals and success.

Regarding the third evaluation question, participants' expectations appear well-aligned with the workshop objectives. In particular, responses to open-ended questions emphasized interests in learning about theory, designing education research, and finding research collaborators. The analysis suggests that particular strengths of the workshop include interaction with peers and facilitators and the presentations on theory and the design of education research and that these aspects of the workshop should continue and perhaps even enhanced. Workshop participants that commented on what was most useful and what they wanted more of said that they appreciated the one-on-one interaction and feedback from experts and wanted even more opportunities for these kinds of interaction. In addition many wished for more content coverage with a longer duration of the workshop.

The analysis revealed considerable variations in experience among the participants. While variation brings diversity it can also create difficulty in focusing workshop discussions to individual needs within the limited time of the workshop. Finding a balance between addressing individual and collective needs will likely be a continual place for improving the workshop. A possible strategy could be to offer workshops for a more focused audience.

The wide variation across participants in the workshop in terms of the years of experience and successful grant writing in engineering education research combined with the cross-disciplinary expertise within the team of program evaluators supported an emergent evaluation process in which early analyses of short term program impact can guide the design of future evaluation efforts. Based on the results of this short-term evaluation, several questions emerge which can guide future evaluation efforts. Did the participants retain their level of engagement with education research over the duration of the workshop? What kind of research questions did participants consider and later pursue (e.g. solving specific class problems vs. addressing more general questions about learning and teaching)? How can we categorize these questions to understand different conceptions regarding engineering education research? What can we say about participants' abilities in designing rigorous research and situating their research into theoretical frameworks? What unique issues emerged from the variation across participants (e.g., why did junior faculty indicate more interest in their survey responses)?

This work is the first stage of a larger program evaluation effort. The follow up interviews are now being planned in which select participants will be interviewed. The analysis of short-term impacts and variations among participants has helped develop the focus of these interview questions.

Acknowledgement

We would like to thank the participants of the study for sharing their views and perceptions in relation to the questions of this study. This research is based upon the work supported by the National Science Foundation through grant CCLI-0817498 "Collaborative Research: Expanding and Sustaining Research Capacity in Engineering and Technology Education: Building on Successful Programs for Faculty and Graduate Students".

Bibliography

1. ERM *Call for Papers: 2011 ASEE Annual Conference*; Educational Research and Methods Division, ASEE: Terre Haute, IN, 2010.
2. Lohmann, J. R., JEE Strategic Plan, 2005-2010: A Summary Report. *Journal of Engineering Education* **2010,** *99* (4), 279-283.
3. CLEERHUB: Collaboratory for Engineering Education Research. http://cleerhub.org/.
4. REEN: Research in Engineering Education Network. http://grou.ps/reen.
5. PhD Consortium in Engineering Education. http://engineeringeducationlist.pbworks.com/w/page/27578912/Engineering-Education-Community-Resource.
6. Streveler, R. A.; Smith, K. A., Conducting Rigorous Research in Engineering Education. *Journal of Engineering Education* **2006,** *95* (2), 103-105.
7. Adams, R.; Allendoerfer, C.; Bell, P.; Chen, H.; Fleming, L.; Leifer, L.; Maring, B.; Williams, D. A Model for Building and Sustaining Communities of Engineering Education Research Scholars, *2006 ASEE Annual Conference and Exposition*, Chicago, IL, American Society for Engineering Education: Chicago, IL, 2006.
8. Tenenberg, J.; Fincher, S. Building and Assessing Capacity in Engineering Education Research: The Bootstrapping Model, *2006 ASEE Annual Conference and Exposition*, Chicago, IL, American Society for Engineering Education: Chicago, IL, 2006.
9. Shavelson, R. J.; Towne, L., *Scientific Research in Education*. Committee on Scientific Principles for Education Research, National Academy of Sciences: Washington, DC, 2002.
10. Mezirow, J., Learning to Think Like an Adult: Core Concepts of Transformation Theory. In *Learning as Transformation: Critical Perspectives on a Theory in Progress*, Mezirow, J.; Associates, Eds. Jossey-Bass: San Francisco, 2000; pp 3-33.
11. Mezirow, J., *Transformative Dimensions of Adult Learning*. Jossey-Bass: San Francisco, CA, 1991.
12. Bransford, J. D.; Brown, A. L.; Cocking, R. R., *How People Learn: Brain, Mind, Experience, and School*. National Academy Press: Washington, D.C, 2000.
13. Borrego, M., Conceptual Difficulties Experienced by Trained Engineers Learning Educational Research Method. *Journal of Engineering Education* **2007,** *96* (2), 91-102.
14. Patton, M. Q., *Qualitative Research & Evaluation Methods*. 3rd ed.; Sage Publications, Inc: Thousand Oaks, CA, 2002; p 688.
15. Borrego, M.; Streveler, R. A.; Chism, N.; Smith, K. A.; Miller, R. Developing an Engineering Education Research Community of Practice Through a Structured Workshop Curriculum, *2006 ASEE Annual Conference and Exposition*, Chicago, IL, American Society for Engineering Education: Chicago, IL, 2006.