

## **2006-1740: A MODEL FOR BUILDING AND SUSTAINING COMMUNITIES OF ENGINEERING EDUCATION RESEARCH SCHOLARS**

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# A Model for Building and Sustaining Communities of Engineering Education Research Scholars

## Abstract

Building and sustaining communities of new engineering education researchers is crucial for bringing people into an area of scholarship, supporting them working in this area, providing opportunities for long term professional development within a community of practice, and building capacity in the engineering education research infrastructure. The Institute for Scholarship on Engineering Education (ISEE), an element of the NSF-funded Center for the Advancement of Engineering Education (CAEE), is designed to build and sustain communities of engineering education scholars who can investigate student learning issues and transform findings into actionable improvements. The Institute has a revolving host structure across three schools – University of Washington, Stanford University, and Howard University. Over three consecutive year-long cycles, ISEE builds and extends a cohort of scholars at host and partner schools. In this paper we explore the question “how do we build capacity in engineering education research?” We pursue this question by examining the ISEE model, the successes and challenges experienced as we near completion of the second of three cycles, and implications for future community building efforts.

## Introduction

There is a critical need to invest in the infrastructure for scientific research in education in particular by developing mechanisms for educating and sustaining scientifically competent and highly qualified communities of education researchers<sup>1</sup>. This is particularly relevant for the engineering education profession. By investing in the research infrastructure in engineering education we can 1) advance the scholarship in teaching and learning and strengthen its capacity; 2) build coherence and rigor within the community; 3) assist collaborative and interdisciplinary research as well as relationships between practitioners and researchers; 4) promote professional development of current and future faculty; and 5) facilitate distributed cognition within a community of practice<sup>2,3</sup>. Given this motivation, a researchable question is how to proceed to meet this need: “how do we build capacity in engineering education research?”

Strategies for building capacity are often linked to community of practice models and a goal of identity development within that community. Communities of practice emphasize a social structure that allows novices access to roles that allow them to grow in their understanding and become members of the community; hence, a community of practice model recognizes the importance of social relationships in developing professional lives. As such, communities of practice foster learning and professional development by providing access to roles that encourage learning and membership in a community, cultivating and practicing leadership, and establishing an identity in the context of the community<sup>2</sup>. They also afford opportunities for building collaborative knowledge in which individual experiences become communal, distributed expertise can be shared, and standards of practice can evolve<sup>4-6</sup>.

One strategy for building capacity is the Institute for Scholarship on Engineering Education (ISEE), an element of the Center for the Advancement of Engineering Education (CAEE)<sup>7</sup>. The mission of the ISEE is to cultivate, foster, and sustain a community of engineering education “Scholars”. As such the ISEE experience involves immersion of engineering faculty and graduate students (engineering and education) in the scholarship of engineering teaching and learning and maintenance of these cohorts as distributed learning communities. Previous work informed the ISEE design, for example a year long research experience in computer science education<sup>8,9</sup>, the CASTL Scholars program<sup>10,11</sup>, and workshops linking engineering education research and practice<sup>12,13</sup>.

In addition, a literature review was conducted to identify critical design issues. Research findings stress the importance of intensive formal education with liberal opportunities for active and situated learning, a cohort of appropriate size and diversity, informal education such as mentoring, efforts to increase support and recognition at the home institution, support for helping projects move forward and sustaining motivation, fostering a community of practice, and understanding the relationship between disciplinary styles and conceptions of education research<sup>11,6,3</sup>. For example, Huber and Morreale<sup>11</sup> discuss the challenges of crossing disciplinary styles of inquiry and how it may cast a dark shadow over faculty interested in exploring teaching and learning in their own classrooms. Research on understanding and assessing the role of technology in supporting communities of practice was also used to inform the design of the Institute. These studies provide insight for addressing the challenges of using virtual technologies such as adoption, normative conventions, developing a shared purpose, and power dynamics<sup>14,15</sup>. They also identify mechanisms for promoting on-line communities as a form of professional development<sup>14</sup>.

In this paper we highlight and synthesize what we are learning about ways to build capacity in engineering education research by examining the ISEE model. We also describe the successes and challenges experienced as we near completion of the second of three cycles, and implications for future community building efforts. One finding is that community at the local level is crucial. While expanding the national community of engineering education researchers is important, scholars who are new to the field need a community of like-minded colleagues with whom they can give and receive feedback on works-in-progress. We also found that engineering faculty tend to have difficulty with particular aspects of educational research, such as navigating a new disciplinary language, utilizing qualitative research methodologies, and analyzing qualitative data. We found that certain strategies are useful in helping scholars move past these barriers, and we learned what type of support these scholars need in order to move their work forward.

### **The Institute for Scholarship on Engineering Education (ISEE) Model**

The following sections highlight characteristics of the ISEE model, including 1) goals and objectives; 2) organization and sequencing; 3) a conceptual framework describing how the three ISEE cycles relate; and 4) characteristics of the learning environment.

### *Goals and learning objectives*

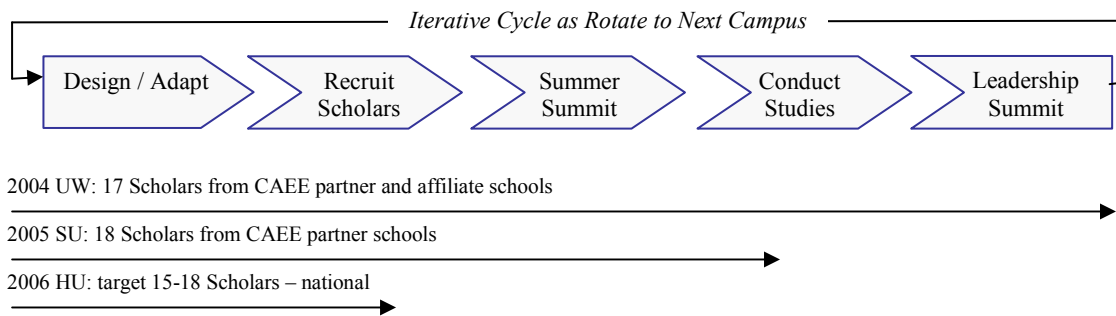
The Institute for Scholarship on Engineering Education (ISEE) is a year long, intense, interactive, and hands-on approach for impacting engineering education in a scholarly way. The primary goal is to cultivate a diverse community of engineering education Scholars who can think and work across engineering and education disciplines with the ultimate aim of improving the engineering student experience. A secondary goal is to formulate principles and models for advancing this scholarship community. Both goals address a mission of *building capacity* (people and models) to advance engineering education.

Transforming ISEE goals to objectives encompasses two ways of considering impact: impact *on* participating Scholars and impact *of* Scholars on engineering education. Impact “on” participating Scholars is defined by the following meta-level learning objectives: contribute to engineering education scholarship (includes an understanding of the complexities of teaching and learning and the capacity to design and conduct studies), promote local change, become a community and social network, and demonstrate engineering education as a professional endeavor. Impact “of” participating Scholars is defined by traditional outcomes such as the resources they create (e.g., publications, educational and research tools) that have the potential to affect the broader engineering education community. The impact of Scholars on their local campuses is also documented. These objectives include intermediate impacts such as the networks Scholars create for influencing education change (as informed by their research) and, to the extent possible, longer term impacts related to the engineering education populations they seek to effect (e.g., students).

Taken together these objectives are the organizational framework for designing the content and pedagogy of the ISEE experience. As such, the ISEE implementation strategy focuses on developing and/or enhancing the knowledge, skills, and attitudes necessary for Scholars to investigate engineering student learning, apply research to make a difference locally or nationally, develop community networks for long term professional success, and contribute to advancing the scholarship of engineering education. As such, we hope to promote Scholars as agents of change<sup>16</sup> able to conduct and use research for impact with people, courses, and programs.

### *Organization and sequencing*

Year-long Institutes will be hosted on three of the five CAEE campuses: University of Washington (2004-05), Stanford University (2005-06), and Howard University (2006-07). As shown in Figure 1, the ISEE cycle involves an iterative improvement process informed by extensive evaluation activities implemented at various points in the cycle. It begins with designing and adapting the Institute model, recruiting Scholars, a Summer Summit kick-off, academic year activities to support Scholars conducting their studies, and a culminating Leadership Summit event (see Figure 1).



**Figure 1. Institute cycle and progress to date.**

A brief description of each part of the cycle is provided below:

**RECRUITING AND SELECTING SCHOLARS:** Each ISEE cycle brings together a cohort of engineering faculty and graduate students. The selection and review process emphasizes recruitment of diverse participants and a focus on building community and promoting change at CAEE partner and affiliate schools. Honorariums for faculty and fellowships for graduate students are provided.

**THE SUMMER SUMMIT:** This is an intensive, interactive, face-to-face learning experience to launch the Institute year. Scholars 1) learn about research design and methods from the learning sciences as well as the complexities of learning within a domain; 2) have opportunities to practice research methods; 3) develop as a community; 4) discuss current issues in engineering teaching and learning; and 5) formulate a research study to be conducted during the academic year. Where appropriate, Summit activities draw on research findings from CAEE investigators, such as findings from the Academic Pathway Study<sup>17</sup>.

**CONDUCTING A YEAR-LONG RESEARCH STUDY:** During the academic year Scholars are mentored (by both peers and experts) as they finalize and implement a research study. A variety of methods are used to sustain community and provide resources for moving studies forward (e.g., just-in-time presentation of content, work-in-progress meetings, invited experts across the community). A web-based “wiki” tool, Idealog, is used to build and support a community of practice culture among the Scholars, both during the Summer Summit and when they return to their home campus<sup>18,19</sup>. The Idealog is like an informal sketchbook in which Scholars have a shared space to capture information and inspiration in ways that are personally meaningful. To promote continual feedback, Scholars are encouraged to visit and respond to each other’s postings. The tool was developed by the Xerox Corporation and used by the Stanford Center for Design Research, and is implemented with an understanding that the Idealog requires adaptation and tuning to the adopting community.

**THE CULMINATING LEADERSHIP SUMMIT:** This is an event in which Scholars present their work to specific communities (e.g., at professional conferences or local meetings), are

introduced into the broader engineering education community, and refine leadership skills.

**MAPPING AND ADAPTING THE INSTITUTE MODEL:** The ISEE leadership team collaborates with an evaluation team from the Office of Educational Assessment at the University of Washington to distill what has been learned, identify opportunities for improvement, and align the Institute model with the needs of the next host campus.

As we begin 2006, we are preparing to launch our third ISEE at Howard University, we completed the launch of our second ISEE at Stanford University in June 2005, and we completed the cycle of the first ISEE at the University of Washington in October 2005 (see Figure 1). The ISEE leadership team has had the opportunity to reflect deeply on the successes and challenges encountered during two ISEE cycles. The following section highlights what we are learning about the concepts framing the ISEE, and key elements of the ISEE model. The subsequent section summarizes insights from our evaluation team highlighting implications for the final ISEE at Howard as well as other capacity-building activities within the broader community.

### *Conceptual themes across ISEE cycles*

Each year the location of the Institute rotates to a different host campus, providing opportunities for robust investigation regarding the strengths of the model, areas for improvement, and flexibility in adaptation. As such, each implementation of the ISEE is influenced by the local needs and culture at the host university. Specific Institute characteristics are determined by meeting with decision makers within colleges of engineering, reviewing information characterizing the infrastructure and culture of the institution (including demographics of the students and faculty), and assessing the interest in engineering education scholarship.

As summarized in Table 1, local needs play a major role in defining the organizing theme, recruitment strategies and pathways, the nature of the culminating event, and the focus of Scholars' studies. For example, each ISEE adopted a theme of investigating learning environments as research laboratories, but differed in scope and intent. The benefit of this "lab" theme is that it promotes a view that all learning environments are laboratories for understanding learners and the learning process. For the first ISEE, the theme was "class as laboratory". This focus put the classroom as the primary zone of impact and Scholars' studies followed a "scholarship of merit" model (e.g., a traditional model of conducting research). For the second ISEE, the theme expanded the zone of impact to the program or college level ("campus as lab"). For this cycle, a "scholarship of impact" was the central format. "Impact studies" emphasize a process of bridging research and practice and involve using research findings to develop an impact plan at the program level. Impact plans included information on potential impact networks or pathways, as well as the needs and communication practices of people within those networks. For the third cycle, the theme is "nation as lab," reflecting an interest at the host school, Howard University, to focus on addressing the diversity needs of the 21<sup>st</sup> century – a priority highlighted in the *Engineer of 2020*<sup>20</sup>.

To illustrate the influence of local differences, the University of Washington, the host of the first ISEE, had a strong interest in promoting engineering education research. The Dean of the

College of Engineering was very supportive and provided additional funds for six local Scholars. There were also resources available to sustain Scholars after the year long ISEE cycle. For example, the college was home to the Center for Engineering Learning and Teaching (CELT), a center with dual goals of providing instructional resources and conducting research on engineering learning. Although there was a high level of faculty interest, an initial survey suggested that many already engaged in engineering education scholarship felt isolated. Therefore, the first ISEE prioritized building local community and a scholarship of merit.

**Table 1. A Comparison of ISEE Conceptual Themes**

	2004 U WASHINGTON	2005 STANFORD	2006 HOWARD
THEME	“Class as lab – a focus on maximizing learning”	“Campus as lab – a focus on the Scholarship of Impact”	“Nation as lab – a focus on addressing the diversity needs of the 21 <sup>st</sup> century”
RECRUITMENT EMPHASIS	ISEE host schools CAEE affiliate schools Schools with departments of engineering education	ISEE host schools ISEE alumni	ISEE host schools ISEE alumni CASEE affiliate schools CAEE affiliate schools and partners Engineering Education networks
SCHOLARSHIP FOCUS	Scholarship of “merit”	Scholarship of “impact”	Scholarship of “merit” and “impact”
PROJECTS: SCOPE	Classrooms, departments	Programs	Colleges
PROJECTS: GROUPING	Working individually, some collaborations	Working collaboratively, some individuals	Encourage collaborations, local and national

As a comparison, the second ISEE prioritized impact – a scholarship of impact and developing impact pathways (e.g., collaborating with those who make decisions at the program level). The rationale for this design was a belief held by both faculty and administrators at the host campus regarding a critical need to create examples of using research to impact engineering education. The design also leveraged research being conducted through other CAEE activities, particularly the Academic Pathway Study<sup>17</sup>, a longitudinal and mixed-method study of the engineering student experience at four campuses: Colorado School of Mines, Howard University, Stanford University, and the University of Washington. Given the multi-focused structure of CAEE, a focus on impact in the second Institute provided an opportunity to link ongoing research characterizing students at the host schools with opportunities for improving the engineering student experience.

Community building goals affected the pathways used to recruit Scholars. For the first and second ISEE cycles the recruitment plan focused on a waterfall model for building up local community over time. As such, the primary recruitment path involved the host schools (U Washington, Stanford, and Howard). Recruitment also targeted opportunities to link to emerging departments of engineering education such as at Purdue University as well as schools affiliated with the grant such as North Carolina A&T State University. To sustain the Scholar community, the second and third cycles include opportunities for ISEE alumni to participate. Finally, to promote the theme of “nation as lab” for the Howard ISEE, the recruitment path has expanded to



include more schools that together can provide a richer understanding of diversity needs for the 21<sup>st</sup> century.

### Insights from evaluating the ISEE model

The previous section highlights the intent of the ISEE model. In this section we share findings from evaluating the ISEE model. The evaluation plan was designed and implemented by program evaluators from the Office of Educational Assessment at the University of Washington. The purpose of the evaluation was to provide feedback for improvement of the Institutes and to understand the impact of the Institute on Scholars as well as their potential impact on engineering education. The evaluation team worked with the ISEE team to determine what specific evaluation topics would be most relevant to the overall concepts and themes of the Institutes. The following table provides a brief description of assessment themes used to guide the evaluation plan.

**Table 2. ISEE evaluation themes**

<p><i>Contribution to building capacity – increasing diversity of Scholars</i></p> <ul style="list-style-type: none"> <li>- Number of Scholars and number of Scholars that continue interactions beyond the ISEE cycle</li> <li>- Diversity of Scholars (gender, ethnicity, level of engineering education experience, academic rank)</li> </ul>
<p><i>Scholars’ ability to contribute to engineering education</i></p> <ul style="list-style-type: none"> <li>- Evidence of growth in understanding engineering education research issues (including diversity as research design issue)</li> <li>- Ability to meet project milestones for designing and conducting a study</li> <li>- Dissemination of work (e.g., publications, presentations, tools)</li> </ul>
<p><i>Scholars’ ability to build community</i></p> <ul style="list-style-type: none"> <li>- Evidence of community among Scholars and beyond Scholars</li> <li>- Ability to create a “change network” to facilitate implementation of research implications</li> <li>- Scholars’ identity development and perceptions as members in broader community</li> </ul>
<p><i>Understanding Scholars (as input into the model)</i></p> <ul style="list-style-type: none"> <li>- Previous knowledge and experience, preconceptions</li> <li>- Interests, motivations, goals</li> <li>- Climate at home institution</li> <li>- Challenges anticipated and experienced</li> </ul>
<p><i>Feedback on ISEE model</i></p> <ul style="list-style-type: none"> <li>- Most valuable components of experience</li> <li>- Aspects that contributed to learning and community building</li> <li>- Suggestions for improvement</li> </ul>

The plan draws on a variety of techniques such as surveys, focus groups, observations, interviews and tracking of Scholars’ progress and outputs. For example, a pre-ISEE survey was implemented prior to the Summer Summit kick-off to gain insight into Scholars’ interests, knowledge, experience, backgrounds, and climate at their home institution. Surveys, focus groups, observations, and interviews were used to track Scholars’ progress at key ISEE

milestones (first / last day of Summer Summit, academic year meetings, culminating Leadership Summit). At each of these milestones Scholars were also asked to reflect on strengths of the experience, what contributed most to their learning, and opportunities for improvement.

Given the complexity and scale of the evaluation plan, only selected results are included in this paper. An overview of results will be provided for each evaluation objective; a more in depth example will be provided for one particular issue to give a sense of the evaluation process as a whole. As a note, many of these results pertain to the first ISEE cycle at the University of Washington because this cycle represents the bulk of the evaluation data.

#### *Contributions to building capacity – increasing diversity*

Seventeen Scholars participated in the first ISEE cycle, and 18 in the second cycle. Accounting for returning alumni, the total number of Scholars is 32. This group is diverse in terms of gender (26% women), ethnicity (31% under-represented minorities), and academic rank (23% senior faculty with little engineering education experience). We anticipate increasing the final number by 15-18 with the launch of the Howard ISEE.

Some Scholars have made significant commitments to participating in the engineering education community and developing an identity in this community. One Scholar is pursuing a master's level degree in educational psychology, one has a dual track position (part in engineering, part in education), and at least three Scholars are using this experience as part of their doctoral work or theses.

#### *Scholars' ability to contribute to engineering education*

An evaluation of Scholars' growth and completion of milestones illustrate that many Scholars have enhanced their ability to formulate education research questions and plans. Many Scholars repeatedly indicate they had learned a considerable amount about education research. The following example illustrates one Scholar's journey in formulating a research question during the Summer Summit.

In a pre-survey before the Summer Summit kick-off, one Scholar articulated his primary interest as “How does context increase student learning? What constitutes appropriate context?” On the first day of the Summer Summit, Scholars wrote their research interests on an interactive poster that stayed up “on the wall”<sup>8,9</sup> during the week. For this Scholar, the question on the poster had to do with investigating the role of storytelling in student learning. Throughout the week, the challenge for this Scholar was to define and operationalize the factors involved in the question. Although the question evolved by the second day (as the result of an interactive activity on what makes a good research question), this Scholar was still struggling with how to approach this question as research. On the third day, this Scholar engaged in a triad interview during which three people took turns being an interviewer, an interviewee, or a reporter documenting the process. During his discussion, this scholar started defining “storytelling,” considering the possibility of using a different term and delineating the format of the stories. In addition, he discussed what kinds of data he would want to collect and how he would measure a “deeper understanding.” One suggestion from the group was to narrow the focus of the research to several key concepts that he had previously taught without using stories. In the upcoming, experimental version of the course, he could then use storytelling in teaching those concepts and

compare responses to a select number of exam questions with students' performance on parallel questions from previous years. By the end of the summer summit, this Scholar's research question was "Do student develop deeper understanding when presented concepts through contextually relevant narratives in the format of ten minute stories?" This question clearly defines the format of the storytelling and describes the predicted effect. During a discussion on diversity he began considering how storytelling could have broad implications for diversity. By the end of the week, this Scholar had progressed from being interested in a classroom innovation that had worked (from his perspective and experience) to having a clearly defined research question and possible investigatory methods.

Scholars from the first cycle (2004-05) have been productive in disseminating their work. At last count, 4 submitted engineering education grant proposals, 7 presented peer-reviewed conference papers in a variety of communities (engineering education, computer science education, research on college science teaching), 3 presented at diversity forums, and at least one is in the process of preparing a journal article. As part of the culminating Leadership Summit, 8 Scholars presented their work in an interactive poster session at the annual Frontiers in Education (FIE) Conference<sup>21</sup>. It was a widely-attended interactive session (range of 50-60 people) and 72% of those who completed the evaluation survey rated the importance of the topic as "very high" on a 4 point scale. Participants identified the session as a highly and richly interactive experience during which personal stories about the research endeavor were used to build community, create spaces to discuss issues they were passionate about, and build new knowledge and promote critical thinking and reflection. For Scholars, the experience was seen as "very energizing and affirming" prompting a desire to continue this format at future conferences. For the ISEE leadership team, the session was an opportunity to disseminate the use of interactive storyboard posters in building community and promoting discussion. The evaluation team is conducting a follow-up assessment of this session to characterize the impact of ISEE 2004 in a national forum.

#### Scholars' ability to build community

Observations during the first Summer Summit indicate a high level of interaction, and a similar pattern was observed during the second Summer Summit in which Scholars used an interactive website – Idealog – to share ideas and provide feedback<sup>18,19</sup>. As an illustration, groupings (both formal and informal) of Scholars on nine separate occasions throughout the first Summer Summit week were recorded to quantify level of interactions within and across Scholars (and their home institutions). Specifically, Scholar groupings were analyzed to indicate who had interacted with whom during the week. Although no one sat with every other Scholar at least once, several sat with 14 (out of 17) different Scholars during the week. The median and modal number of interaction partners was 12. A further examination of discrete table-sharing instances illustrated that Scholars spent more time with Scholars from other schools than with those from their home institutions (see Table 3, shaded cells indicate within-school interactions). The analysis took into account the unequal representation of Scholars across the home institutions. The results indicate that Scholars distributed their time with Scholars from other institutions fairly closely to what would be expected given the overall proportion of Scholars present. This is in contrast to a model where Scholars might spend considerably more time with people from their own institution than with individuals they did not know.

**Table 3: Predicted and observed percentages of table-sharing incidents according to University.**

	Howard University (HU) (n = 2)		Stanford University (SU) (n = 3)		University of Washington (UW) (n = 10)		Affiliates (Aff) (n = 2)	
	<i>Observed</i>	<i>Predicted</i>	<i>Observed</i>	<i>Predicted</i>	<i>Observed</i>	<i>Predicted</i>	<i>Observed</i>	<i>Predicted</i>
<b>HU</b>	2.0%	6.3%	10.0%	12.5%	23.4%	12.5%	18.2%	12.5%
<b>SU</b>	11.8%	18.8%	16.7%	12.5%	21.4%	18.8%	13.6%	18.8%
<b>UW</b>	70.6%	62.5%	63.3%	62.5%	32.5%	56.3%	68.2%	62.5%
<b>Aff.</b>	15.9%	12.5%	10.0%	12.5%	19.5%	12.5%	0.0%	6.3%

Community building did not end with an ISEE cycle. Of the 17 Scholars from the first cycle, 11 (with representation across all host campuses) are continuing to participate either by extending their project through a second cycle or contributing to the design of future Institutes. Some participated in the Stanford Summer Summit as alumni “experts” for a day. This trend suggests that our tiered waterfall model for building local community over time is an effective approach. In addition, there is evidence of Scholars building networks beyond their ISEE peers (e.g., education and engineering communities, administrators, education research centers such as the LIFE center<sup>22</sup>, and programs for increasing the diversity of the engineering profession) and with other CAEE colleagues such as the Academic Pathway Study group.

Understanding Scholars

As stated earlier, a considerable level of work went into identifying the challenges Scholars might experience during the ISEE Institutes, with particular attention paid to challenges specific to Scholars’ home institutions. A pre-survey administered before participation in the first ISEE cycle was used to gauge Scholars’ backgrounds and attitudes with regards to engineering education research, as well as their expectations for the Institute. In one series of items, Scholars were asked to rate on a scale of 1 to 4 (1=never heard of it to 4=use it) how familiar they were with various methods in educational research and which of these they wanted to learn more about. Mean scores indicated that ethnographic observation ( $\bar{M}$  = 2.00), clinical interviews ( $\bar{M}$  = 2.23), performance-based studies ( $\bar{M}$  = 2.23), and the general category of qualitative studies ( $\bar{M}$  = 2.46) were among the methods that were least familiar. At the same time, participants most frequently mentioned that they wanted to learn more about performance-based studies, qualitative studies, and ethnographic observation. These results suggested that although Scholars were not familiar with more qualitative approaches they were clearly amenable and curious about learning about them. The level of familiarity also suggested that Scholars might have misconceptions about these methods that may need to be addressed. As a result of this analysis, the research methods emphasized during the Summer Summit matched these interests. As an interesting point, during the academic year some Scholars noted that although they conduct quantitative experiments in their primary area of research they were unsure about how to analyze quantitative educational research data.

Data from the pre-survey also suggested that the 2004-2005 Scholars did not perceive their departments or Universities as particularly supportive of education or research on education. In contrast, these Scholars did feel that their participation in the Institute fit with their career goals; 100% of Scholars agreed or strongly agreed with the following statement “The education research that I do as an Institute Scholar will be well-integrated into my career goals.” As a cross-validation, a common theme from the focus group sessions was that Scholars had a passion for education and an interest in improving their own teaching. The word “passion” showed up repeatedly in discussions as to why they chose to participate. Overall, the survey results suggested that although their work might not have been enthusiastically received by their departments, they did not perceive participation as being in conflict with their personal career goals. It is not clear, however, whether these Scholars considered their own career goals as aligned with the values of their respective departments. This last finding is particularly interesting, as it suggests that these Scholars pursued the Institute program in spite of the fact that they might not have full support from their departments. In addition, it is possible that the ISEE Institute fostered a local community that could provide such support.

In the focus groups and interviews, Scholars self-identified a number of challenges they experienced or anticipated in the future. A primary challenge involved formulating research or impact questions. One Scholar even noted that formulating a research question was its own form of research. Other challenges included 1) knowing when, why, and how to employ various research methods (and how to analyze the data once you get it); 2) support for navigating the human subjects process; 3) setting project milestones; 4) continuing community building (particularly distributed community building) and peer interactions; 5) learning how to narrow down the scope of a project so that it is feasible; 6) finding time and managing conflicting obligations; and 7) knowing that help would be available but not being sure about how to ask for help (or what help was needed). Time was particularly an issue for those who wanted to employ qualitative approaches and were realizing that these methods can be time-intensive. Scholars also wanted to be held more accountable for project milestones, perhaps as a mechanism to stay on task. The quality of self-identified challenges evolved over time. In later interviews, Scholars from the first cycle focused more on the intricacies and complexities of their projects such as recruiting participants and creating methods for disseminating their work to the community. Some of these Scholars also shared their strategies such as building networks for change, scaling studies down to smaller phases of activity, and finding and maintaining a community.

### *Feedback on the ISEE model*

For the most part, Scholars have been very satisfied with their ISEE experience, and most were extremely positive in their evaluations. The paragraphs below highlight strengths of the ISEE model and areas for improvement from the perspective of our Scholars. These are organized separately for the first and second ISEE cycles.

For the first cycle, we provide two data points. First, an evaluation report from the end of the 2004 Summer Summit summarized Scholar-identified strengths of the ISEE experience. In particular, participants mentioned the various interaction feedback sessions (e.g., triad interviews, interactive study posters, “firehose” presentations), building a community, an

interactive and hands-on format, and creating a project plan by the end of the Summit week. Some suggestions for improvement involved small adjustments such as varying the kinds of interactive feedback activities to account for personal preferences. Other suggestions reflected concerns about sustaining community, finding time to complete the projects, and successfully disseminating their work. Other suggestions included a request for more direct instruction on how and when to use various research methods, a focus on diversity issues that involved Scholars sharing their own experiences, ensuring that activities promoted progress on projects, allotting more project and social time, and encouraging connections with existing engineering research knowledge and experience to help transition to a new form of research. These insights were fed back quickly into the design of the ISEE experience; for example, as part of the academic year activities in 2005, additional emphasis was placed on inviting experts and implementing activities to help develop social networks and impact pathways.

One year later, in the summer of 2005, Scholars were interviewed about their overall ISEE experience. Many self-identified strengths remained constant, such as receiving extensive feedback and building community (although this expanded beyond the ISEE to include industry, academic peers, K-12, and researchers from other education programs or centers). Scholars also identified new strengths that suggested concerns about community building were addressed over the ISEE cycle: having a support group, meetings with “experts”, frequent work-in-progress meetings to stay “plugged in and energized”, and a tolerance for Scholars’ other commitments. These comments were more common among Scholars who had a local community, such as the University of Washington Scholars who met bimonthly.

Feedback from Scholars from the second ISEE cycle is similar although some new issues emerged. High points of the Summer Summit included engaging in engineering education conversations with like-minded people, validation and reinforcement of interest in engineering education, on-campus community building, learning about research approaches, learning about impact studies (as not just generating and interpreting findings but working towards impact), interactive feedback sessions via the web-based tool Idealog, and having a draft impact plan by the end of the week.

Similarities across each cycle highlight a focus on interactive feedback sessions, building community, learning about engineering education research, and having a concrete project plan by the end of the week. A new issue was learning about impact studies, which began as a unique aspect of the Stanford ISEE (see Table 1), and was later built into the last part of the U Washington ISEE. Areas for improvement are also consistent across cycles, suggesting that either the issue wasn’t addressed or that the most effective mechanism for addressing the issue is through the academic year-long activities. For example, Scholars were concerned about being held accountable for their project, sustaining community, and more in-depth learning on research methods. Scholars were also concerned about narrowing the scope of projects to more feasible studies. Many of these issues were addressed over the academic year. A common point central to the academic year activities was a deepening of personal, teaching, and research relationships that facilitated continual engagement.

## Discussion

The primary goal of the ISEE is to cultivate a diverse community of engineering education Scholars who can think and work across engineering and education perspectives with the ultimate aim of improving the engineering student experience. Common themes across the most critical design principles underlying the ISEE model are two issues: community building and interactive feedback. At the same time, an effort to understand our Scholars (our “users”) played an important function in our approach to designing the ISEE. These themes align with frameworks for designing effective learning environments<sup>23</sup>.

While expanding the national community of engineering education researchers is important, we have found that scholars in our Institutes who were new to the field needed a local community of like-minded colleagues with whom they could give and receive feedback on work in progress. We also found that the engineering faculty we worked with had difficulty with particular aspects of educational research, such as navigating a new disciplinary language, utilizing qualitative research methods, and analyzing qualitative data. Some of the strategies we found useful in helping scholars move past these barriers have been 1) providing structured and formalized interactions throughout year; 2) using project plans as milestones; 3) providing just-in-time activities addressing various research methods and educational theories; 4) providing templates and guidelines for human subjects processes; 5) using work-in-progress meetings to promote accountability and support feedback interactions; 6) seeking resources (and working with administrators to access resources); 7) sustaining continued community building (outside ISEE in particular) to support motivation; and 8) implementing activities on how to build social networks and how to communicate ideas to different audiences. We are continuing to learn about what types of support our Scholars need to move their work forward.

Overarching design principles behind the ISEE model (as evidenced by our evaluation efforts) include: 1) a tiered waterfall model for recruiting Scholar cohorts and building local community over time; 2) a user-centered approach informed by evaluations conducted throughout the ISEE process to identify and address the challenges Scholars experience before or during the ISEE; 3) a focus on learning contexts as “laboratories for investigation and impact” where Scholars have or can create the influence to enact change; 4) interactive, community-centered and assessment-centered activities such as interactive study posters, work-in-progress sessions, and sharing ISEE stories; 5) creating a safe environment for open communication and feedback; 6) structured and informal activities for building community; 7) completing the first phase of activity with a draft study plan; and 8) recognizing a focus on impact as a key motivation for participating in this community. Across all of these principles is a realization that the ISEE experience is about facilitating relationships that encourage shared construction of knowledge, mentoring, and enabling others to pursue a passion.

## Conclusion

The ISEE model has the potential to improve engineering education by increasing the number of engineering educators who can contribute to advancing engineering education scholarship. Given the growth in capacity-building efforts nationwide, a broad and significant impact of the

Institute model is sharing what we are learning from this particular program about ways to build and support communities of engineering education researchers. As such, we hope that the information in this paper will be informative for those who are interested in offering capacity-building programs, being a consultant to engineering faculty, or conducting engineering education research. For the authors, the exercise of writing this paper allowed us to reflect on and clarify critical design features for implementing our final ISEE cycle at Howard University. In many ways this process is similar to articulating our collective pedagogical content knowledge around building capacity in engineering education scholarship<sup>24</sup>. As we move forward, we will be building on this work to better understand the process of being and becoming an interdisciplinary engineering education researcher (e.g., challenges and strategies, social networks, and identity development as an interdisciplinary researcher).

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