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Year Eight Annual Report: Activities, Findings and Evaluators' Reports

NCETE Faculty

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Year Eight Annual Report

Activities, Findings and Evaluators' Reports

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National Center for Engineering and Technology Education

Activities and Findings Report
Year Eight: 2011-2012

The National Center for Engineering and Technology Education (NCETE) is a collaborative network of scholars with backgrounds in technology education, engineering, and related fields. Our mission is to build capacity in technology education and to improve the understanding of the learning and teaching of high school students and teachers as they apply engineering design processes to technological problems.

NCETE was granted a no-cost extension for an eighth year of work. Significant activities were focused in three areas: building research capacity within the engineering and technology education field; building on current research programs; and communicating and disseminating NCETE works and findings.

Building Research Capacity

Second P-12 Research Summit

NCETE and the Institute for P-12 Engineering Research and Learning at Purdue University co-sponsored the 2nd P-12 Engineering and Design Education Research Summit in Washington, DC on April 26-28, 2012, co-located with and prior to the 2nd USA Science & Engineering Festival. The P-12 Summit brought together researchers in the nascent field of research on P-12 engineering education. The conference provided a national forum for researchers to discuss findings from their research, to pursue common intellectual interests, and to explore potentially promising collaborative research initiatives. The summit functioned also as a place to develop engineering education research capacity. A pre-session offered invited Ph.D. students an opportunity to meet faculty members from other institutions to discuss mutual research interests and explore mentorship possibilities. Workshop sessions provided professional development opportunities for researchers in this evolving educational arena. Several NCETE personnel made research presentations, chaired sessions, and assisted with the management of the successful events at the Summit. The clear focus on P-12 research resulted in an unusually homogeneous audience at Summit sessions and fertile discussions of research opportunities in P-12 engineering education.

Untenured Faculty Program

The NCETE program of work was initially planned to provide instruction and guidance in research and leadership development, and to provide financial support for the NCETE fellows through the completion of their Ph.D. programs. During the first few years of the Center operation, little attention was given to the possibility of a need for NCETE-supported continuing professional development for the fellows after graduation. However, it recently became clear that it would be advantageous to provide support for the exploratory research efforts of newly-employed professors, since none of them found a faculty position as part of an on-going funded research team. NCETE initiated a seed grant competition, anonymous external reviewers rated the proposals, and several awards were made to recently-graduated fellows. These awards strengthened their early postdoctoral research endeavors and help them initiate their personal research agendas in their new tenure track positions. The reports of those studies are accessible on the NCETE website and on Digital Commons.

Project evaluators scrutinized the doctoral research efforts of the fellows in accordance with the approved evaluation design, but that design had not extended into post-graduate employment and early faculty research experiences. We asked Yolanda Flores Niemann, a social psychologist at Utah State University, to explore the postdoctoral experiences of the 12 Ph.D. graduates during spring, 2012. At that time, the graduates of the University of Georgia, University of Illinois, University of Minnesota, and Utah State University had one to four years of experience after the completion of their degrees. Niemann designed and conducted an intensive, comprehensive study of the professional experiences of the graduates following graduation. Her research involved in-depth telephone interviews with the graduates, starting with a structured set of questions and continuing with follow-up and clarifying questions as needed. Following those interviews, she developed a second set of questions and conducted structured telephone validation interviews with the faculty members who had served as doctoral advisers at the four institutions. In addition, she developed a third set of questions and conducted telephone interviews with members of the NCETE management team to complete the triangulation process. Her draft report was then submitted to the respondents to make sure that the comments were transcribed correctly and that the interpretations of the responses were reported accurately.

Even before the final draft of the research report was prepared, Professor Niemann alerted the NCETE staff to the fact that several alumni fellows expressed their needs for continuing professional development. Concerns ranged from the development of the range of employability skills peculiar to the professoriate to the strategic development and implementation of personal research agendas in their roles as junior faculty members in the rapidly changing field of engineering and technology education. In response to those identified needs, the NCETE staff provided specific individual coaching on interviewing skills and the preparation of the application portfolio. Also, a weekly series of conference calls was initiated. Each Friday afternoon, three alumni fellows were regular participants in the “teleseminars” through late spring and summer 2012. Topics ranged from the identification of employment opportunities to application and interview strategies, critiques of scholarly manuscripts in preparation, and strategies for finding programmatic funding support for the research agendas of the individual professionals. These participants reported that the telephone seminars were especially beneficial to them at their early career stages.

Continuation of the NCETE Seminar Series

NCETE has provided a seminar series for three years spanning 2010-2012. The goal of the 2012 NCETE seminar series was to engage graduate students in critical analysis of current research and methodological challenges surrounding engineering and technology education at the secondary and postsecondary level. The seminar was designed to create a network and venue for faculty and graduate students at selected doctoral granting institutions to collaborate and share views, discuss research protocols and findings, and advance the state of research in engineering and technology education. The 2012 seminar series incorporated suggestions from the internal evaluation of the 2011 seminar. This included comments from the NCETE internal evaluator, participating faculty, and students. Suggestions included the enhancement of the quality of the broadcasting technologies and having the students prepare bio-sketches to share with the other student participants. Students from each institution were grouped by research interest and placed in teams with students from other institutions. Each team was responsible for introducing the session presenters and facilitating discussion during the session. The intent was to provide students with the ability to meet students from other institutions that have common research interests. Graduate students from Utah State University, Colorado State University, Purdue, and Virginia Tech participated in the seminar. External invited speakers included Cindy Atman from the University of Washington and John Gero from George Mason University. This seminar series was successful in introducing graduate students to outstanding researchers and their current work. The structure of the seminar series facilitated increased interaction and communication among graduate students at the participating institutions and strengthened collaboration among faculty researchers at the institutions, as well.

A review of three years of the seminar series points to benefits to the students, faculty and institutions involved. Benefits to students include: meeting researchers that they have been reading about in the engineering and technology education literature over the years; collaboration with PhD students from other universities in engineering and technology education to discuss common research interests; and access to detailed research methodologies from researchers that students would not normally have access to by reading the authors journal article. Benefits to faculty include: improving the quality of the graduate student experience in their program through collaboration with other universities; and collaboration between faculty and students from other universities that can assist with recruiting for perspective faculty positions. Benefits to institutions include increased exposure for the institution through engagement with other institutions; increased ability to recruit students by showcasing the university to students and faculty at other institutions.

Building on the Current Research Program

Several research activities during the final year of the project built upon initiatives begun earlier: a study of the contributions of an afterschool program; a naturalistic study of high school seniors engaged in the development of solutions to situated engineering design challenges; the development of a paper on the selection of engineering design challenges for use in high school STEM courses; issues in infusing engineering concepts into life science and physical science courses; and an exploration of design thinking among groups of high school students. These research efforts are described more fully in this section.

Study of Afterschool Programs: Technology Student Association Students and Their Perceptions of Engineering, Self-Efficacy, and Understanding of Engineering

NCETE began the development of an instrument to assess relevant demographic and academic variables as well as high school student perceptions of engineering activities, self-efficacy in engineering, and understanding of engineering. Pilot testing of the self-efficacy and perception scales occurred in 2010 and 2011. Initial item development of a multiple-choice test to measure the understanding of engineering started during spring, 2011. Further pilot testing of the instrument occurred in the spring of 2012 with North Carolina high-school students enrolled in technology education courses. Jerianne Taylor, Associate Professor in the Department of Technology and Environmental Design at Appalachian State University, was a consultant for this project.

North Carolina was selected for pilot testing because of the state-wide involvement in the Technology Student Association (TSA), a co-curricular organization that fosters opportunities in technology, innovation, design and engineering. Ten high school technology education programs agreed to participate in the study, five with TSA programs and five without TSA program. None of the schools selected for this study had a formal affiliation with *Project Lead the Way*. A total of 546 students in the ten schools agreed to participate in the study. Sixty-one percent of students were from high schools with TSA programs and 39% of the students were from high schools without TSA programs. Eighty-two percent of those who agreed to participate in the survey were male and 18% were female. The students were represented by three primary ethnicities: 61% white, 14% black or African American, and 11% percent Hispanic or Latino/a. The remaining students identified themselves as multiracial, Asian, or American Indian. Twenty-three percent of the students participating in the study were in the 12th grade; 21% were in the 11th grade; 22.5% were in 10th grade; and 33.5% were in 9th grade. Thirty-six percent of the students were from metropolitan schools located in cities with a population greater than 50,000. Thirty percent of the students were from micropolitan schools located in cities with a population ranging from 10,000 - 50,000 people. The remaining 34% of the students were from rural schools located in communities whose population was less than 10,000.

The survey instrument was formatted in SurveyMonkey and made available on the computers in the school computer labs. Students completed the surveys under the supervision of the classroom teacher. Any student could opt out of the survey and withdraw at any time without penalty.

Students were asked to rate their degree of agreement with 19 statements related to their perception of engineers or the field of engineering. Example statements included “engineers are creative” and “engineers are well paid.” While 546 students agreed to participate in the study, only 476 responded to all statements in the perception scale; their responses were included in the data analysis. Using SPSS, Cronbach's Alpha for the perception scale was 0.837.

Students were asked to rate their degree of agreement with 40 statements related to TSA or technology course outcomes. Example statements included "My experience allows me to clarify my college and career goals" and "my experience allows me to be more confident in seeking help." Analysis of the responses of the 476 students to all statements in the self-efficacy scale using SPSS indicated the Cronbach's Alpha for the efficacy scale to be 0.983. Correlation analysis was subsequently used to reduce the number of items in the scale by a factor of two while retaining a large Alpha.

The understanding section of the NCETE Survey was developed to align with the Technology and Engineering Literacy Framework for the 2014 National Assessment of Educational Progress. Twenty multiple choice questions were developed based upon the Grade 12 Benchmarks in sections on Engineering Design; Systems Thinking; Interaction of Technology and Humans; and Ethics, Equity, and Responsibility. The North Carolina study represented the first attempt to pilot test the understanding scale with high school students. Detailed item analysis revealed questions that needed refinement including the development of more effective distractors.

Results of the pilot test of the NCETE survey instrument are very promising. A preliminary investigation comparing the TSA student responses with the non-TSA student responses is underway. The revised instrument can be used in a number of settings to help researchers understand the influences a particular program might have on students' perceptions of engineering, self-efficacy about engineering, and understanding of engineering.

Authentic, Situated Engineering Design Challenges for High School Students

The purpose of this multiple case study was to identify the engineering design processes of two groups of twelfth-graders as they worked together to develop solutions to "authentic, situated" design challenges. Authentic design challenges are those that impact real clients who need solutions. The first challenge entailed improving a bathing transfer system for a man who had muscular dystrophy and needed a device that his caregiver could use to help him in and out of the bathtub; the second challenge entailed improving a water distribution system for an orphanage in Uganda. Both designs were shared with authentic audiences; in the first case, they were shared with the client himself and with the technician who built the original device and continued to work on its improvement, while in the second case, the revised designs were shared with the faculty sponsor of the Engineers without Borders team of students who repeatedly visited the orphanage to improve the water supply system. Amy Alexandra Wilson, an assistant professor in the Department of Teacher Education and Leadership, at Utah State University, was asked to join the NCETE research team because of her research on the in-school and out-of school literacy practices of diverse adolescents and her research that uses sociocultural theoretical frameworks to explain scientific and mathematical literacy.

Situated design challenges are situated in the adolescents' interests, within actual physical settings, and within ill-structured conceptual domains that approximate those inhabited by engineers. In order to situate the design challenges in the context of adolescents' interests, individual students were first interviewed to determine their interests, relevant background experiences, anticipated career trajectories, and the range of engineering challenge issues about which they felt strongly. For example, one group of students all expressed an interest in helping people with physical disabilities as part of their careers, while the second group of students lived in farming communities, helped their grandparents on their farms, and/or identified lack of access to clean water in Africa as a pressing global issue that they wished to address. These challenges were also situated as much as possible in terms of their physical settings, which included the assistive technology lab where the technician built the original bathing transfer system and continued to improve the design. Finally, design challenges were also situated in the sense that they were the types of ill-structured problems faced by engineers.

Previous research findings have suggested that situated problem solving is often different from problem solving in decontextualized settings, such as in schools or research laboratories. For instance, in situated settings, the presence of authentic audiences, purposes, tools, and materials introduces a new and different set of constraints and motivations in contrast to individual motivations to solve problems set in purely abstract, controlled, theoretical spaces. Researchers sought to discover the twelfth-graders' design processes as they sought to solve these authentic, situated challenges through collecting three types of data: individual pre- and post-design interviews, video-recordings of their conversations and actions as they sought to solve the problem, and metarepresentations of the products they produced while solving the designs. Constant comparative analysis revealed that the situated aspects of the design process, such as the available tools and materials, as well as clarifying conversations with the clients, were significant influences in shaping the design process. Instructional implications for offering more situated design challenges, which are based in students' interests and communities, were described.

Outcomes of the 2011 and 2012 Caucuses on Engineering Design in Grades 9-12

NCETE hosted two Caucuses held on the Utah State University campus in Logan; the first August 2 and 3, 2011 and the second May 22-24, 2012. Ten individuals who were early innovators in introducing engineering design activities in high school STEM settings were invited to each Caucus. An annotated bibliography which included papers prepared at the invitation of NCETE in 2011 was made available to the Caucus participants to provide background information. The Caucus groups engaged in intensive dialogues during their on-campus sessions, prepared statements on aspects of the development and selection of authentic engineering design challenges, and suggested revisions of successive drafts. A major outcome of the two Caucuses was a paper entitled "Incorporating Engineering Design Challenges into STEM Courses" which is posted on the NCETE website at http://ncete.org/flash/pdfs/NCETECaucusReport.pdf

The first section of the paper included an examination of goals for incorporating engineering design challenges into the high school STEM setting. The second section included an exploration of the meaning of design in this context, followed by a review of current models of the engineering design cycle. The third section described issues related to classroom implementation, such as student motivation, teaching practice, and managing dimensions of engineering design in the school setting. Guidelines for selecting and implementing engineering design challenges were described in the fourth section, which utilized the NCETE engineering design challenge model as an organizing framework: (1) identify need or problem; (2) research need or problem; (3) develop possible solutions; (4) select the best solution; (5) construct a prototype; (6) test and evaluate the solution; (7) communicate the solution; (8) redesign; and (9) finalize the design. Research results and practice-based recommendations were included where they were relevant to the discussion.

Assessment of the quality of student work on engineering design challenges poses new responsibilities for learners and teachers. Promising approaches to assessment were explored and described briefly in the fifth section. The national educational milieu is changing rapidly and many of these adaptations are likely to have major influence upon possibilities for including engineering design challenges as a part of the education of all Americans. Current proposals, frameworks, and national influences were explored in the sixth section of the paper. The paper concluded with a summary of findings, themes and issues in section seven.

Infusing Engineering Concepts into Science Education

NCETE supported Jenny Daugherty, a former NCETE doctoral fellow, to conduct an exploratory study of the details involved in infusing the conceptual base of engineering into high school physical science and life science courses. It is imperative to provide strengthen foundational understandings to enable educators and curriculum designers to respond to the *Framework for K-12 Science Education* and other recommendations for incorporating engineering content and approaches into science courses. This study, which built upon earlier NCETE-supported research on the conceptual base for engineering, focused on four key engineering concepts (design, analysis, modeling, and systems) and looked at the potential of two curriculum models: (a) project-based inquiry science; and (b) integrated teaching and learning. An expert panel was assembled in a focus group setting and asked to identify promising approaches and procedures for infusing the engineering concepts into science courses, to suggest appropriate levels of infusion, and to explore the interrelationships between engineering concepts and the science education content and experiences.

The panelists emphasized the importance of framing the learning experiences as design challenges. They also emphasized the need for explicit instruction in “engineering habits of mind” and in drawing distinctions between “doing science” and “doing engineering.” The panelists also emphasized the need for appropriate professional development for the classroom teachers, suggested a strong focus on the infusion of engineering with examples and models of this approach, and advocated the involvement of master teachers, experienced practitioners who could provide examples of effective infusion from their classroom settings.

Team-Based Engineering Thinking

NCETE supported Nathan Mentzer, a former NCETE doctoral fellow, to study the ways teams of high school students allocated the time available for resolving engineering design challenges among such activities as problem scoping (developing definitions and gathering information), developing alternative solutions (generating ideas, modeling, feasibility analysis, and evaluation) and project realization (decisions and communication). Previous studies in this research tradition had asked individuals to resolve the classical playground design challenges, but this study focused on the work of single-gender teams and mixed-gender teams in dealing with this challenge as well as another, more authentic challenge of optimizing pedestrian traffic flow in the crowded corridors of the students' high school.

The protocol and instrumentation in this research provided a relatively high level of control of the research conditions and the data analysis followed the paradigm established in earlier studies. The provocative findings from this exploratory investigation offer insights that will be useful in the design of larger-scale research efforts in the future. For example, the teams of participants devoted substantial time and effort in gathering information, but relatively little effort was directed toward modeling and communication. Participants also experienced difficulty in defining the authentic design challenge and establishing appropriate constraints to guide their work. The researchers were somewhat surprised by the lack of concerted attention to evaluation and decision making among the teams. Results on the performance of mixed gender teams and the respective single gender teams were not definitive, though single gender teams seemed inclined toward the development of more complete descriptions of the problems before brainstorming and choosing from among alternatives.

Communication and Dissemination

NCETE is making its website materials available through an open access repository entitled DigitalCommons@USU. (http://digitalcommons.usu.edu/ncete/) DigitalCommons hosts institutional repositories which bring together all of a university's research under one umbrella, with an aim of preserving and providing access to that research. An important feature of the DigitalCommons site is a monthly report tracking readership for articles provided on the site.

The NCETE doctoral students' dissertations and the final papers resulting from NCETE sponsored research studies are available on DigitalCommons. Also available through DigitalCommons are the NCETE annual reports, which may be of interest to researchers interested in studying the evolution of the Center.

The completed paper, described earlier, "Incorporating Engineering Design Challenges into STEM Courses," is available on the NCETE website and through DigitalCommons and is intended to be useful in planning, organizing, and implementing the infusion of engineering design challenges in high school STEM courses. Also, NCETE invited selected individuals to provide brief statements about their viewpoints on the selection of engineering design challenges for high school STEM courses. Those seven papers are available on the NCETE website and through DigitalCommons.

A comprehensive list, "Scholarly Activities of NCETE Personnel 2004-2012," has been compiled and is also available on the website and through Digital Commons. This document lists papers, presentations, posters, and funded research activities for each investigator affiliated with NCETE and documents many of the dissemination activities undertaken by NCETE personnel.

NCETE was invited to have its publications indexed in the Education Resource Information Center (ERIC) digital library. The agreement has been signed and submitted to ERIC. NCETE reports will be available through the ERIC database and available to interested researchers through the ERIC system.

The written documents developed by the National Center for Engineering and Technology Education will be available to the scholarly community through the Utah State University Library Archives, which has agreed to provide a permanent repository for the materials.

NCETE Internal Evaluation Report: Year Eight
Prepared by Jim Dorward, Project Evaluator
October 8, 2012

Internal program evaluation for the final year of the National Center for Engineering Education project focused on two major center activities. These activities were the Caucus *on Principles of Engineering Design in K-12 Education* and continuation of the *Early Career Faculty Program*.

Caucus on Principles of Engineering Design in K-12 Education

A follow-on to the 2011 Caucus was recommended by participants and the evaluation, and planning for the 2012 Caucus began in March, 2012. The event took place on the campus of Utah State University from May 22-24, 2012. The purpose of Caucus 2 was to *reach consensus on theoretically sound, evidence-based principles that would serve to guide the* development *of authentic engineering design challenges for grades 9-12*. The purpose of Caucus 2 evaluation was to describe how the engineering education experts conceptualized the tasks and determined the extent to which activities contributed to publication of a set of evidence-based principles.

The evaluator employed an embedded case study design (Yin, 2003) to assess caucus activities. There were 10 invitees to Caucus 2, joined by five members of the NCETE leadership team (See Appendix A for agenda and participant list). The 10 invitees were selected for their expertise in K-12 engineering design, and their relative contributions to obtaining a balanced set of participants (i.e., engineering educators, engineers, researchers, program developers, K-12 educators, early career faculty). Data collection strategies included formal post-participation interviews with eight of ten invitees, multiple informal interviews during the caucus with invitees and NCETE team members, and participant observation of caucus activities. Analysis involved thematic interpretation of qualitative data. The following results are organized by six evaluation questions.

Results

1) How do participants conceptualize the Caucus?

Prior to attending, participants had varying expectations. These expectations ranged from nothing, to being provided with a step-by-step process targeting specific audiences for a set of guidelines or best practices. One returning invitee conceptualized the caucus as, "a capstone opportunity for the Center – lessons learned and synthesis of engineering design work of NCETE in the high school". A new invitee responded that the caucus would offer, "a chance to delve deeply into the existing research base with the primary goal of trying to synthesize what is out there to determine what we know (and don't know) about high school engineering education that could inform the design and implementation of engineering design activities in those settings." Based on observations of multiple management team meetings, these two conceptualizations were most consistent with NCETE expectations. Essentially, the management team conceptualized the Caucus as an opportunity to embrace the tensions between engineering design as practiced in the field and those that can realistically be incorporated within the context of teaching and learning, and posing guidelines for authentic practice in K-12 education.

2) What pre-conceptions do participants bring to the Caucus?

While a couple of Caucus participants indicated that they had no pre-conceptions coming into the Caucus, most indicated that they held strong feelings about characteristics of engineering design challenges. One participant commented, “I felt strongly that making explicit connections between the STEM disciplines in the design and implementation of engineering activities would be a high priority for stakeholders interested in high school engineering education, rather than having engineering as its own silo with additional standards to be addressed or some sort of alternative pathway to a diploma.” There were several participants who expressed that knowing more about caucus intent and format would have enabled greater preparation; “I might have been more informed and focused if I had known more ahead of time. “

3) What Caucus discussions prompted change or solidification on specific principles?

There was limited evidence that Caucus discussions did influence change. One participant recognized that, “I think he (Nathan Mentzer) helped me to recognize some interesting research conducted by him and other NCETE members (and others) about the benefits of students thinking about defining ill-defined problems. This made me want to read up on the actual research products that have been produced by NCETE members to broaden my own thinking in that area, since prior to the Caucus I wasn't well read on NCETE work. On the whole, however, observations suggested that caucus discussions were characterized more by solidification or agreeing to disagree, than reasoned change of opinions regarding principles. As one participant described in the interview,

“I had a discussion with my small group members in our first meeting that helped me solidify some more divisive points (that are still divisive). First, that engineering education and practice at the undergraduate, graduate and professional levels is not necessarily appropriate for engineering education at the K-12 level, and so it is important to get a variety of voices and perspectives to shaping what high school engineering should look like (not just the voice of someone entrenched in upper-level engineering whose perspective may be to apply similar models top-down). Second, that the importance of making explicit connections to the other STEM disciplines is not something shared by others, or at least not in the form I had thought about it. I feel like there are open issues in the research literature and in our Caucus group about what importance and role the STM ideas should play in designing and implementing the E (engineering) activities, as well as the ways in which it is most effective to make those connections.”

4) How do participants reach consensus on support or lack of support for a given principle?

Caucus participants had substantial experience with, and held strong opinions about, implementation of engineering design in K-12 education. Despite the potential for acrimony, the tenor of Caucus discussions was respectful, professional, and purposeful from the standpoint of a collective focus on developing a set of research based guidelines. Dan Householder, the caucus facilitator, was credited by several participants as playing a key role in keeping a group of strong-willed people, intensely focused on a singular goal.

As described by a couple of invitees, there was also mutual respect for other participants and recognition of value in collective wisdom, “I was fascinated by how participants’ experiences contributed to discussions and how the large discussions led to more in-depth discussions within the smaller groups.“ “We had a couple of nice, substantive discussions in the early sessions of our group work, which I think brought us closer to consensus. But the consensus was more at the level of getting the controversial ideas on the table, as opposed to the level of actually reaching a resolution.

One participant questioned whether time was a limiting factor in consensus building, “Our group may not have had enough time to identify support from the literature, so we might have been forced into quick compromises. Given that, we were able to reach consensus fairly quickly. Some ideas were dropped, but for the most part, the big ideas got represented.”

5) How do participants view the utility of the Caucus?

All respondents perceived Caucus 2 as a worthwhile and useful endeavor. Supporting comments by participants included, “The product (monograph) will be quite useful within the context of the science standards. “ Overall, the caucus was one of the most professional things that I’ve ever participated in.” “The product (monograph) will be quite useful within the context of the science standards."

At the same time, participants had some reservations about whether seemingly ambitious goals were met. For example, one invitee responded, “Getting together to do this sort of work is important and ultimately worthwhile, but I felt our discussions and work together just started to get us to the point of "defining the problem" in shared and productive terms. I am not sure that we as a group got to the next step of using those shared terms to examine what the existing evidence actually is and isn't, and using that as the primary basis for our conclusions.”

Another respondent recommended that utility and reach could be enhanced by “getting input and buy-in from the folks at Project Lead the Way and Engineering by Design.”

6) How do non-participant stakeholders view outcomes of the Caucus?

At the time of this report, only one of the invited participants had shared the report with members of the stakeholder group. That person stated, “I reported back to (my) team on my interpretations and the expected product. There was a lot of interest and receptivity about seeing the final product. I also mentioned participation to a couple of program officers at NSF who have interest in K-12 engineering education.” It remains to be seen how direct reporting of participants to stakeholder groups will translate into an observable outcome.

There were, however, multiple post-caucus discussions among participants regarding forms that the report might take, and potential outlets whose readers might be interested in the content. Several participants suggested that the draft report was too long. They went on to suggest that “it would be useful if people could access chunks that target specific audiences; for example, a module for teachers and a different one for researchers.” One participant recommended that the document should include “ways to help teachers get off the ground with this information.

TeacherEngineering.org, ASEE, and Engineering is Elementary websites might be two dissemination vehicles for a practitioner oriented paper. I am also in favor of disseminating at conferences where teachers might not otherwise be thinking about engineering design, such as AERA, NCTM, or NSTA."

Another participant who focused more on the theoretical implications of the document suggested, "Dissemination arenas might include: DC coalition (Triangle coalition) roundtable, direct presentations with people on the National Science Board or NSF brown bags, as well as ITEEA and NSTA journals for practitioners. Heidi Schweingruber at the National Academy of Engineering might be interested in an article focused on the research side."

Currently, the Caucus report, *Incorporating Engineering Design Challenges into STEM Courses*, is available for dissemination at: http://ncete.org/flash/pdfs/NCETECaucusReport.pdf

Early Career Faculty Program

The purpose of this component of NCETE Year 8 activities was *to continue building research capacity of early career engineering and technology education* faculty. Early Career Faculty Program activities included a follow-on research topics seminar, an NCETE supported P-12 engineering summit, and multiple smaller efforts targeting needs of specific program graduates. Yolanda Flores Niemann also conducted an independent self-study of underrepresented graduates of the NCETE fellow program, which is reported elsewhere.

During 2011-12, NCETE supported two follow-on activities that were included in the evaluation; the graduate research seminar and the P-12 summit. The purpose of the NCETE Research Seminar series was to "engage graduate students in critical analysis of current research and methodological challenges surrounding engineering and technology education at the secondary and postsecondary level." The purpose of the P-12 engineering summit was to provide a "space to develop engineering education research capacity." The summit included a doctoral consortium providing Ph.D. students the opportunity to "receive mentorship and individual feedback on their proposals" and "sessions … to provide professional development opportunity for staffers and researchers."

The evaluation of these activities assessed the extent to which they influenced the research trajectory of early career faculty. The evaluator utilized multiple methods including observations of five seminar sessions, a group interview with seminar participants, archival analysis of center dissemination activities, a survey of P-12 Summit participants, and observations of leadership team meetings. Analysis included thematic interpretation of qualitative data and descriptive analysis of survey data. The results of the Research Capacity Building evaluation component are presented by evaluation questions.

Results

1) What are characteristics of NCETE supported research capacity building activities?

NCETE supported research capacity building can be characterized as relevant to the intended audiences, focused on increasing the quality and quantity of research in engineering education, designed and implemented by top researchers in the field of engineering education, and responsive to feedback from reflection and analysis. Implementation of the 2012 P-12 summit could be characterized as meeting or exceeding expectations. For the most part, summit speakers and facilitators were knowledgeable, engaging, and adhered to the expectation of significant interaction with the audience.

Implementation of the graduate research seminar in 2012 was prone to technical and implementation challenges that resulted in unrealized expectations. While speakers had been selected for their expertise in relevant areas of research and some presentations were excellent, several of the sessions were characterized by loss of video and/or audio signals and lengthy, esoteric lectures by the speakers. To some degree, technical glitches associated with delivering a synchronous graduate seminar to multiple sites can be expected and alternative plans devised ahead of time. It was not clear that site facilitators always had alternative plans for interruptions. Despite concerted efforts on the part of seminar organizers to request featured speakers to limit presentations to 30 minutes and allow for sufficient time for question/answer and discussion, several presentations lasted for over an hour.

In addition to making contingency plans for technical problems and clearly communicating expectations to speakers, it is recommended that program managers continue to be pro-active in assessing research needs of seminar participants. Post-seminar interviews with participants had several suggestions for interesting future seminar topics, including: trans-disciplinary and international research collaborations; translation of laboratory to field research, persistence and challenge in dissertation projects; fitting together research questions, design, and analysis; and cross-cultural research. Participants also had several suggestions for seminar format, including: increasing discussion time with presenters to assess why and how they used their approach or design; less time spent on formal presentation; more emphasis on networking within the seminar, with a focus on smaller groups of students and peer-support models of interaction.

2) How do NCETE supported activities influence the research capacity of early career *faculty?*

While NCETE supported research capacity building of early career faculty activities have only been formally undertaken for the past two years, there were informal supporting activities dating back to 2005. A review of publications by former NCETE doctoral students and participants in research capacity building activities (See http://ncete.org/flash/publications.php) indicates that five recent participants (Austin, Daugherty, Denson, Lammi, Mentzer) have contributed 23 research or expository articles. Of those, 11 articles have been published in the last two years. This trajectory suggests that capacity building activities of the center have been increasingly effective, however, the impact of these activities may not be fully realized for several years.

3) How have recommendations from earlier Seminar evaluations been enacted?

Recommendations from the earlier evaluation of the graduate research seminar included, 1) enhancing the quality of the broadcasting technologies, 2) encouraging students to submit 4 questions prior to the presentations, 3) involving students more in active research, and 4) increase topical relevance by focusing discussions on research within a given institution.

There was evidence from observations and interviews with students in the 2012 seminar that efforts were made to address recommendations 1, 2, and 4. Different broadcast technologies were used at several sites, site facilitators were successful in encouraging students to prepare questions before each session, and time at each site was allotted during planning for small group discussions. There was no evidence that the seminar attempted to involve students more in active research, but it is possible that the evaluation failed to uncover relevant information. Of the three recommendations where seminar leaders made efforts toward implementation, only one (improve the quality of broadcasting technologies) was relatively unsuccessful.

4) How have project leaders approached proposed dissemination activities through Digital Commons?

Digital Commons is a repository that provides "open access to scholarly works, research, reports, publications, and journals produced by Utah State University faculty, staff, students, and others." A recent search of Digital Commons at USU (http://digitalcommons.usu.edu) using the term NCETE returned 50 results across the fields of Engineering, Education, and Curriculum and Instruction. Entries ranged from 1 entry in 2004, to 8 in 2010 (the most recent catalog date), with more than 70% of the entries added since 2007.

Observations of leadership meetings provided evidence that team members took an active role in working with Digital Commons to catalog relevant artifacts and publications. Results from usage statistics from Digital Commons indicate widespread national and international access to, and interest in, contents of the NCETE database.

5) To what extent *have dissemination activities influenced access to Center publications and artifacts?*

As one participant in NCETE research capacity building activities requested last year, "I want a central location for information (readings, PowerPoint slides, etc.) that the entire group has access to (Cloud, Blackboard site, etc.)." Clearly, the NCETE website and Digital Commons have met that need.

A recent use log compiled by Digital Commons administration indicated there have been almost 8,865 downloads of NCETE articles from October, 2010 through November, 2011. That level of use in less than 1 year suggests that researchers are accessing articles at a very good rate.

Reference:

Yin, R. K. (2003). *Case Study Research, Design and Methods*, CA: Thousand Oaks, Sage.

Appendix A: Caucus 2 Enacted Agenda

NCETE Caucus 2012: Engineering Design in Grades 9-12
Utah State University
May 22-24, 2012

Monday, May 21 – Travel Day; Shuttle from SLC; Check in at University Inn

Tuesday, May 22 – Day 1
7:00 – 8:00 Breakfast – University Inn
8:00 Orientation - Room 507 University Inn
Introductions and personal highlights
10:00 –Break
10:00 – 12:00
Review goals and principles
Establish working teams: (1) Characteristics of Design Challenges; (2) Assessment: Indicators of Success; (3) Pedagogy and Organization of Instruction
Work sessions Rooms 507 and 510 University Inn
12:00 Lunch – Sky Room
1:00 – 3:00 Work sessions Rooms 507 and 510 University Inn
3:00 –Break
3:15 – 5:00 Work sessions Rooms 507 and 510 University Inn
6:30 Dinner – Hamilton's – Minibus leaves Bus Stop on 700 North at 6:15
Optional evening work sessions Rooms 507 and 510

Wednesday, May 23 – Day 2
7:00 -8:00 Breakfast – University Inn
8:00 – 12:00 - Work sessions.
10:00 –Break
12:00 – Lunch – Sky Room
1:00 – 5:00 Work sessions
3:00 Break
6:30 Dinner – Le Nonne – Minibus leaves Bus Stop on 700 North at 6:15
Optional evening work sessions Rooms 507 and 510

Thursday, May 24 – Day 3
7:00 – 8:00 Breakfast – University Inn
8:00 – 12:00 Work sessions Rooms 507 and 510 University Inn
10:00 –Break
12:00 – Lunch – Sky Room
1:00 - 5:00 Review and critique of final draft Room 510
3:00 –Break
6:00 – 9:00 Celebratory Dinner – elements – Minibus leaves Bus Stop on 700 North at 5:45

Friday, May 25 - Travel Day
7:00 – 8:00 Breakfast – University Inn
Shuttle to Salt Lake City Airport

Participants

David T. Allen
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Lynn Basham
Technology Education Specialist, Virginia Department of Education

Taryn Melkus Bayles
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Mary McCormick
Center for Engineering Education and Outreach, Tufts University

Elisabeth McGrath
Center for Innovation in Engineering and Science Education (CIESE), Stevens Institute of Technology

Nathan Mentzer
Technology Leadership & Innovation, Purdue University

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Daniel L. Householder, Co-PI
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Amy Alexandra Wilson, Assistant Professor, Emma Eccles Jones College of Education & Human Services, School of Teacher Education and Leadership, Utah State University

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College of Education and Human Services, Utah State University