National Center for Engineering and Technology Education

Review of NCETE's Research Initiative
by Inverness Research

Jenifer V. Helms

Michelle Phillips

Mark St. John

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Introduction

Inverness Research has evaluated three NSF-funded Centers for Learning and Teaching (CLTs). Through this work, we have identified and vetted five dimensions for examining the work that Centers do. These dimensions are: Leadership; Knowledge Generation and Flow; Relationships and Connections; Programs, Structures, and Policies; and "Centerness." As the external evaluator for the National Center for Engineering and Technology Education (NCETE), Inverness has focused its efforts in year 6 on documenting the progress the Center has made according to these drivers. It is the second dimension—Knowledge Generation and Flow—that concerns itself with research.

There are multiple levels of knowledge a national Center for Learning and Teaching (CLT) is positioned to gather, generate, use, and disseminate, including knowledge of the policy, practice, improvement, and curriculum landscape associated with the Center's domain. This report presents and reviews the key features of the research efforts of the NCETE, an NSF-funded CLT, which intended to build capacity in the areas of leadership and research for its particular domain within STEM education: infusing engineering design concepts into technology education.

It is important to note that CLTs were not initially conceived as primarily research centers; instead, the majority of funding within Centers was originally intended for graduate training and practitioner programs. Over time, NSF increasingly emphasized research as an important outcome for CLTs, but did not earmark funding for research. In reality, most Centers focused on creating what we at Inverness Research have come to describe as a "research rich milieu" for the purposes of shepherding the improvement of the domain that the Center represented.

In the following pages, we highlight the important features of the NCETE research initiative. We provide an overview of the Center's various research initiatives, as well as a wide range of perspectives on the efficacy of those initiatives. The primary audience for this document is potential funders of ongoing and future research efforts initiated by NCETE, and secondarily, other researchers or program leaders interested in learning more about this particular strand of Center work.

Data sources and methods

Our data sources and collection methods for this report included the following (see appendix for protocols and instruments):

1) Interviews (three) and surveys (two) of both cohorts of NCETE doctoral students, regarding their research experiences

2) Observations of NCETE research symposia and meetings

3) Interviews with Center leadership about the history of research in the field

4) Interviews of faculty members regarding advising, leadership, and research opportunities

5) Interviews with doctoral graduates with jobs

6) Interviews with seed grant recipients about their experiences designing and conducting research

7) Interviews with seven field experts to comment on their perspectives on the contribution of the center to the field, including research

8) Review of the 57th yearbook of the Council on Technology Teacher Education (2008) entitled Engineering and Technology Education

9) Extensive reviews of the NCETE research portfolio, provided by five experts in the field of technology education and engineering education, whom we recruited and compensated (these reviewers chose to review the entire portfolio—and provide their comments in writing, as opposed to interview –as presented on the NCETE.org website, along with the CTTE yearbook. See appendix for our invitation to the external reviewers.)

10) Review of all of Inverness' previous reports and presentations to NCETE members and leaders

Goals for research strand

The leaders of the Center identified their goals for the NCETE research strand as:

- To define the current status of engineering design experiences in engineering and technology education in grades 9-12;

- To define an NCETE model for professional development by examining the design and delivery of their effective professional development with a focus on selected engineering design concepts for high school technology education;

- To identify guidelines for the development, implementation, and evaluation of engineering design in technology education.

The challenge NCETE faced was to establish, with empirical evidence and theoretical arguments, that infusing technology education with key design principles from engineering would benefit secondary technology education in a number of ways. This required, to some extent, contributions from both technology educators and engineering educators. Therefore, similar to other NSF-funded CLTs, such as CILS (the Center for Informal Learning and Schools) and ACCLAIM (the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics), NCETE was founded on the basis of the presumed benefits that can come from creating a "hybrid" field. This has implications for the research of NCETE, which will be discussed in detail herein.

Overview of report

Following, we begin with a brief description of the history and current state of the field of technology education, in order to provide context for what the Center has accomplished. What forms the bulk of this report is a summary of a range of perspectives on the quality, cohesiveness, rigor, and contribution of the different research initiatives of NCETE. Perspectives include those of the doctoral fellows from both cohorts; doctoral fellows who have graduated and are currently employed; NCETE faculty advisors; seed grant recipients; faculty and students engaged in research at NCETE institutions; experts in the field we interviewed regarding the Center's work in this domain; and external expert reviewers we recruited to review the Center's research portfolio. After providing a review of perspectives on NCETE's research, we offer our own perspectives on NCETE's progress in research, and discuss potential future directions.

Technology Education in Context

Even as the National Center for Engineering and Technology Education (NCETE) was deep in the throes of research and leadership development in 2008, the CTTE yearbook, entitled Engineering and Technology Education was published with the goal to "spur a scholarly dialog among the constituent groups and… provide a foundation for a mutually valuable collaboration between engineering and technology education" (Custer & Erekson, 2008). This excerpt serves as a reminder that the goal to infuse engineering design principles into technology education was a relatively nascent idea. Collaboration between engineering and technology education was (again, to stress) not a long-standing existing practice nor a theoretical approach. Traditionally, these fields have worked quite separately with separate research agendas (Johnson et al, 2008).

In his essay, *Technology Meets Engineering: Notes from the Ground* (in Custer & Erekson, 2008) Gary Benenson (an engineer) reported:

> *The vast majority of engineering educators have probably never even heard of technology education, let alone sought involvement in it. Conversely, many (if not most) technology educators have little or no contact with engineers or engineering educators, nor awareness of any proposed alliance (p. 204).*

Another of our external expert reviewers, who happens to be an engineering educator reported:

> *I've done a lot of work with engineering research centers around the country that are typically NSF-funded. I clearly get the idea that this initiative [NCETE] really is the first time this has been done in the field of technology education—in other words, infusing engineering into technology education teaching and learning—so it is a newer concept. The Center is just trying to figure out who is connected with whom.*

Therefore, since its inception, NCETE has always faced the challenge of both forging a hybrid community, while simultaneously researching it. Other CLTs we've evaluated, such as CILS and ACCLAIM, have also faced this challenge. Yet, in the case of CILS, much of the work could build on the solid research foundations laid in science education and cognitive science. In ACCLAIM, the work could build on the solid research foundations laid in rural education and mathematics education.

While they have not typically been interwoven or integrated, research in engineering education and technology education do share an unfortunate similarity: that is, the relatively low status it has traditionally been afforded, relative to other STEM disciplines, such as science education.

In his introduction to the Council on Technology Teacher Education's (CTTE's) 57th yearbook, titled Engineering and Technology Education, William Wulf, a professor at the University of Virginia and President Emeritus of the National Academy of Engineering wrote:

Too often in the past, work on both engineering and technology education has lacked a scholarly approach and 'good weight' as a result. For our part at the NAE, several years ago we created the Center for the Advancement of Scholarship in Engineering Education (CASEE), with stress on the word 'scholarship', to address this issue because we felt it so important. One center at the NAE and one scholarly book on engineering and technology education won't wipe out impressions from decades of poor scholarship, but it's a start (p. xvi).

In their essay Research Frontiers—An Emerging Research Agenda (2008), authors Johnson, Burghardt, and Daugherty provide an overview of the challenges that research in technology education has historically faced:

Within technology education, concerns about the quality and focus of research have been raised for years (Foster, 1992; Johnson, 1993; McCrory, 1987; Passmore, 1987; Sanders, 1987). More recently, Zuga (1997) examined research that was published in the main technology education journals and dissertation abstracts from 1987 through 1993. Zuga found that half of the 220 studies she reviewer were primarily descriptive and focused on curriculum. Zuga outlined four areas missing from technology education research: a) constructivism; b) integration of other subjects; c) inclusion of all students; and d) cognition (p. 241).

According to Zuga, constructivist, problem-based instruction and the integration of other subjects are both fundamental to technology education, yet few of the published research studies had examined either of these two aspects (Johnson et al., 2008). Furthermore, almost none of the studies she reviewed focused on students or their learning; specifically, no studies explored issues such as gender, ethnicity, or physical or mental challenges that face students. She sharply concluded that research in technology education focused "on descriptions of status and curriculum development points to researchers who are narrow, inwardly-focused, and oblivious to the goals of their own field" (Zuga, p. 213, in Johnson et al., 2008).

A few years later, Petrina conducted a mixed-method meta-study to review research published in the Journal of Technology Education (JTE) from 1989 to 1997. Similar to Zuga's findings, Petrina found that out of 96 articles, 62% were descriptive, a scant 35% focused on human subjects, and very few examined issues of class, ecology, gender, labor,

race, and sexuality. He concluded that those who had been reviewing research in the field concluded it to be a "malfunctioning practice" (Petrina, p. 28 in Johnson et al, 2008).

Two of our external reviewers made similar comments, regarding the history of research in technology education and the challenges NCETE faced, in creating a research program.

The Center was born at a time when technology education, as a field, was feeling a crisis: technology education was not being taken seriously enough in K-12 education, but neither did technology education, as a field, have a research history that could be used to convince the powers that be (whoever they are) of the importance of technology education or to show how best to carry it out.

My understanding is that NCETE was set up to help educate the next generation of technology education leadership (i.e., university faculty and researchers) and to generate research findings that would help in making arguments for the importance of technology education and would provide guidelines for carrying it out well in K-12.

It is important to keep these comments in mind when reviewing the work of the National Center for Engineering and Technology Education, since many reviewers have argued that it has not yet achieved the scholarly quality of the mathematics or science education research communities. Throughout this report, we present different perspectives, and sometimes very conflicting views on the quality of the research products NCETE has created. We believe that the unstable or nonexistent foundation in technology education research is in part to blame for these disparate views. Two of our external reviewers commented in similar ways:

People in the profession historically do a very good job at building curriculum, but they don't do a very good job in conducting research or building leadership.

I think given the nature of the field and the nature of where we are in the field, the Center has done well. Keep in mind that technology wasn't taken up as the main driver within our profession until say 1985. That is not all that long ago when you think about the long history of science, math, and the rest of them. Now, engineering has only come into the venue in the last few years and so, it is even newer. Given the circumstances and where we are with all of that, the Center has done a good job.

When we asked a respected engineering educator, "what are some of the issues that you think face researchers in the field of tech education?" he said:

> *A lot of the challenge is trying to develop a research agenda that is relevant… at the end of the day, a lot of people don't even know where to start. It has to do with the history of our field and research has never been our strong forte and so therefore, how do you even begin to hone and refine and determine what really needs to be done in research? That is something that has to be grappled with. It would be incredible if through the work of the Center, they were really able to set out the research agenda for people over the next 10 years but a lot of people don't even know where to start.*

In the end, most reviewers and participants who commented to us on the Center's research products concede that NCETE has actually made substantial strides in supporting researchers who are likely to make contributions to the field of technology education in the future. Much of NCETE's potential impact won't be seen for several years, as new faculty address and increase the standards for rigorous research.

Research initiatives of NCETE

Well aware of the challenges that face researchers in the field of technology education and even engineering education, the Center designed its research initiative around several components: funding research, supporting research, and disseminating and sharing it.

As noted in the introduction to this report, CLTs were not originally conceived as research centers, but took on the goal of conducting research as the initiative matured. Centers responded to this shifting expectation by attempting to create opportunities for Center participants to engage with research in multiple ways. NCETE established numerous venues for faculty and students to interact around the research. For example: the Center organized and sponsored a research symposium for faculty and students from campuses, including some outside of NCETE to share their research ideas and methods; the Center created a "seed grant" program that encouraged NCETE faculty and students to apply for research funding to conduct studies that were aligned with the Centers' mission; NCETE hosted special sessions at national conferences such as the International Technology Education Association (ITEA), which is now named the International Technology and Engineering Educators Association (ITEEA), where faculty and students presented sessions and posters; and Center students were invited to attend meetings in Washington DC to meet with NSF program officers.

We reviewed five different key research initiatives that NCETE undertook to bolster the research foundation in technology education.

Doctoral program. NCETE provided funding for doctoral students to complete their dissertations, once their committees had approved the topic area and research plans. The participating institutions were: University of Minnesota, University of Illinois at Champaign-Urbana, Utah State University, and University of Georgia. Each of these four universities offered a slightly different doctoral degree and program.

Seed grant program ("Center Studies"). NCETE funds studies to explore various aspects of curriculum, teaching practices, and professional development for infusing engineering into high school settings. The studies were completed by teams of NCETE faculty and students. Seventeen Center studies (or seed grants) have been completed.

Faculty research ("Research Results"). NCETE faculty often collaborated with each other and with students to produce publications reporting results of various research studies they have been engaged in over the years. Many of these were funded through other grants but involved NCETE participants.

Research symposia. NCETE organized and held a doctoral student conference at the University of Minnesota on May 22, 2008. The theme of the student conference was "Research in Engineering and Technology Education." NCETE Fellows as well as doctoral students and their faculty advisors from Tufts, Ohio State, Virginia Tech, Colorado State, and Purdue were invited and presented papers.

Pre-ITEA conferences. Each year, prior to the annual meeting of the International Technology Education Association, NCETE hosted a meeting for those students and faculty involved in the Center's research and professional development efforts.

Perspectives on NCETE Research—Accomplishments

NCETE has generated and amassed quite an impressive portfolio of research reports, representing a variety of interests within and outside of the Center. As of July 2010, the work of NCETE has produced or contributed to the following research products: 66 publications, of which many are peer-reviewed; over 125 conference presentations at professional conferences and poster sessions; 9 dissertations (ultimately, 13 will be produced); 18 reports on studies supported by NCETE (including seed grant projects and the research of post-doctoral fellows); and conference proceedings from a research symposium held in Minnesota in May of 2008.

Providing a foundation

The majority of the external expert reviewers of NCETE's research portfolio agreed that the body of research that NCETE has created provides a basis on which to have future conversations regarding integrating engineering education and technology education. For example, two separate reviewers made similar comments regarding the Center's research portfolio:

In looking at the publications of NCETE and recent developments in technology education, it is clear that the Center and its publications have been instrumental in furthering the discussion and acceptance of engineering education within the technology education community. This has resulted in an ongoing conversation among technology educators, the recent change in name of the International Technology Education Association to the International Technology and Engineering Education Association, and an increase in publishing activity by a handful of the NCETE member faculty.

The work of this research portfolio has laid an important new research base within the field and assured that the findings and methods of this research are communicated in a broad context and to a large audience. Several of the publications focused on issues of diversity and seeking to learn to broaden opportunities, and enable the participation of underrepresented minorities in engineering and related fields. The overall impact on the scholarly production of the field as a whole has been greatly impacted by the productivity of the Center's participants. The knowledge generated within these manuscripts and conference proceedings will be referenced and used to build on for years to come.

Increased collaboration in research

A major accomplishment of NCETE's research efforts is that they have created a context for connecting professionals from different institutions and different fields (e.g. technology education from a variety of campuses, and technology and engineering educators from around the country). An external reviewer of the Center's research portfolio reported:

> *The center appears to be encouraging more collaboration in research and writing than has been evident in technology education historically. At least, advisors and students appear to be publishing together in a number of articles and there are two articles written by faculty teams of authors.*

In an interview, a seed grant recipient commented on collaboration as well:

> *By having this opportunity, we have been able to build a better network. That is always my wish. It's not just meeting people once and saying' Hi and Bye' but how can we collaborate to understand each other's interests?*

And another of the external experts who reviewed the research portfolio wrote:

> *The dissertation committees reflect a broad range of faculty from education, technology education, and engineering. This intra and inter-disciplinary cooperation helps to build and strengthen a field of study.*

These collaborations were often useful and productive, leading to additional funding, and have cultivated relationships that will be fruitful in the future as others try to infuse engineering design principles into technology education.

> *What the Center has been able to do by these universities working collaboratively is they have begun to re-energize the field in regards to moving forward with some very good pieces around the research agenda. Their strength is that they have been able to bring together a group of very good professionals that have collectively worked together to achieve a better goal than they could have achieved individually.*

This "re-energizing" of the field through collaboration was noted by another expert from the field as an important element of NCETE's work:

> *The Center is also re-energizing and re-introducing young faculty into university programs. We were getting to a point that we were getting a little bit stale, because we didn't have a lot of younger people coming into the field to take over some of these university teaching positions and as people retired, there was just*
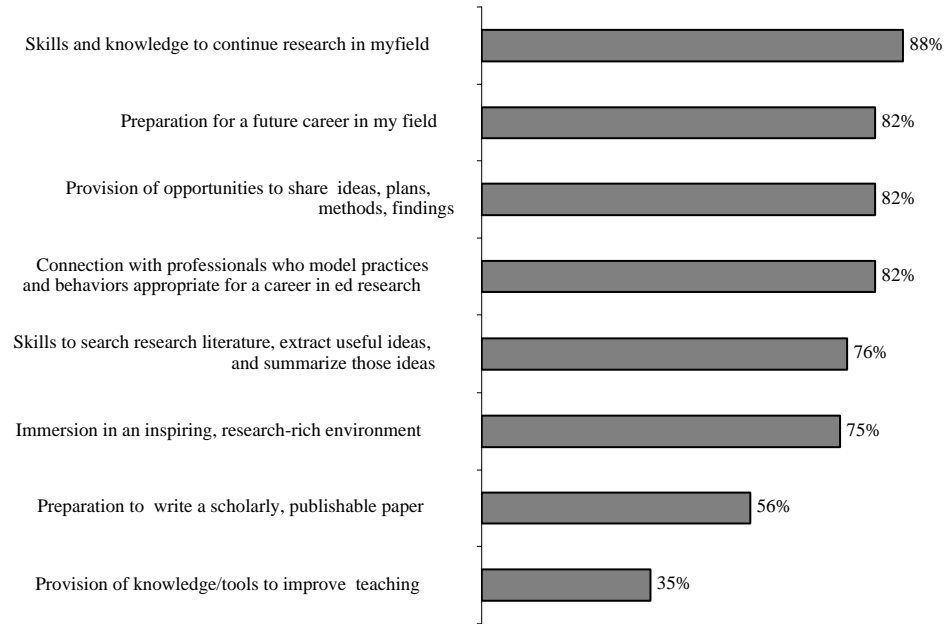
no one on the horizon to take the job. The Center has developed those people.
All of that is good.

Increased capacity for research among doctoral students

Given the relatively low starting place for NCETE's research in technology education, it is undeniable that the Center increased the capacity of its faculty and students (and perhaps collaborators) to design and conduct research. While the products do not always live up to the standards set in other fields, they have moved substantially forward from where research in technology education has been. NCETE has built the *capacity* of the Center participants to do research but also the *potential* to secure a future vision for research in the field, creating momentum among individuals in research universities who are dedicated to refining and furthering the research agenda of the field.

As one example of how the Center has increased the capacity of its students to design and conduct research, in March of 2009, Inverness conducted a survey of all NCETE doctoral students from both cohorts. With regard to the extent that their research experiences in the NCETE doctoral program was preparing them for continuing as researchers in the field, the majority (88%) of students said that the Center was equipping them with the necessary skills and knowledge to continue to conduct research in their field.
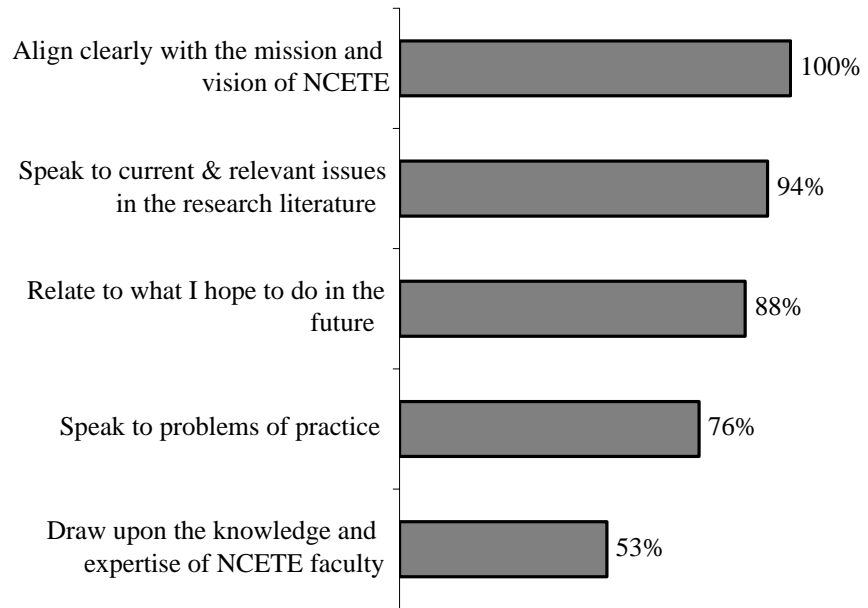
Percentage of NCETE doctoral fellows who report that the doctoral program is achieving positive outcomes related to their preparation to conduct research

Outcome	Percentage
Skills and knowledge to continue research in myfield	88%
Preparation for a future career in my field	82%
Provision of opportunities to share ideas, plans, methods, findings	82%
Connection with professionals who model practices and behaviors appropriate for a career in ed research	82%
Skills to search research literature, extract useful ideas, and summarize those ideas	76%
Immersion in an inspiring, research-rich environment	75%
Preparation to write a scholarly, publishable paper	56%
Provision of knowledge/tools to improve teaching	35%

Percentages represent ratings of 4 or 5 on a 5-point scale, where 1 = "disagree strongly" and 5 = "agree strongly."

Also in 2009, NCETE doctoral students had been pressed to consider how their dissertation research fit within the needs and knowledge of the Center and the field at large, and how it might help them in the future. All of the survey respondents replied that their dissertation research aligned clearly with the mission of the Center and the vast majority (94%) believed that their research would speak to the current and relevant issues in the research literature.

Percentage of NCETE doctoral fellows who think that their dissertation research will have positive outcomes

Category	Percentage
Align clearly with the mission and vision of NCETE	100%
Speak to current & relevant issues in the research literature	94%
Relate to what I hope to do in the future	88%
Speak to problems of practice	76%
Draw upon the knowledge and expertise of NCETE faculty	53%

Percentages represent ratings of 4 or 5 on a 5-point scale, where 1 = "disagree strongly" and 5 = "agree strongly."

Again in spring 2010, a second (shorter) survey was sent to 17 NCETE doctoral fellows, both graduates and fellows still in the program. The purpose of the survey was to gather fellows' summative reflections on the program, and their sense of the extent to which the program prepared them to work in the engineering and technology education field. Of the 17 fellows, 13 completed the survey.

We asked the NCETE doctoral fellows to rate the extent to which a series of research components was available to them, and to rate the quality of those components. The majority of fellows believe that there were high-quality opportunities for them to learn about research, and felt supported to do so. Fewer (but still the majority) felt that they were prepared to conduct research on their own once they graduated from the program.

	Extent to which this component was available to me % (n=13)			Quality of this component % (n=13)		
	Not at all/to a limited extent	To some extent	To a large/great extent	Very poor/poor	Mixed/ medium	Good/ excellent
Opportunity to learn about and conduct research	8	0	92	0	15	84
Support for conducting your own research while in the program	15	0	85	8	8	84
Preparation for conducting independent research once you graduated from the program (i.e. in your current role)	8	15	77	8	31	61

The doctoral fellows were also generally satisfied with the research component of the NCETE program. Of the 13 respondents, 85% reported that they were satisfied or very satisfied. The remaining 15% were "somewhat satisfied." The fellows had the following comments about the research component:

We had/have extraordinary opportunities to meet and work with some of the most influential and best researchers in the field.

Seed grants and the opportunity to apply for dissertation funding have provided many fellows with a solid research foundation.

Now from the vantage point of being an assistant professor at a research-intensive university, I am grateful for all of the preparation in research provided via NCETE and my doctoral program.

The Center exposed us to the various areas in engineering and technology education where more research is necessary to build the capacity of engineering and technology educators to teach design.

One event that was particularly useful for the doctoral fellows was the research symposium. The Center organized and held a doctoral student conference at the University of Minnesota on May 22, 2008. The theme of the student conference was "Research in Engineering and Technology Education." NCETE Fellows as well as doctoral students and their faculty advisors from Tufts, Ohio State, Virginia Tech, Colorado State, and Purdue were invited and presented papers. After reviewing the proceedings from that research symposium, specifically those from the Conference on Graduate Student Research in Engineering and Technology Education, one external expert reviewer wrote:

This conference, organized by the Center to highlight and bring together graduate students from around the country to report on their research progress is notable. Many of the conference participants have completed and published their dissertations. This is an excellent metric to see; when work-in-progress support yields young professionals who complete their doctoral degree and enter the profession.

Increased capacity for research among NCETE faculty

NCETE created and increased the capacity of students across the Center for designing and conducting research, yet it also increased the capacity of faculty to design and conduct research.

Three Center faculty members who received seed grants said of their experience:

I was always… not afraid of the unknown, but the unknown was unknown and so I didn't even know how to get started with the research proposal and I think my experience with NCETE did help me understand what the process was like, even though the learning curve is still huge. I think it helped me gain the confidence to try this research proposal that I am sending in.

The seed grant taught me a lot about how to write a proposal.

I think the approach that the Center took—going out and getting external reviews, even on the seed grants—it really added gravitas to the research. These could have been treated in a way where the leadership gets together and just kind of processes the paperwork and doles out the money. Instead, there was a degree of professionalism and seriousness to it—these weren't just handed out. You had

to compete for them and they expected quality and they were heavy-duty reviews and to come out of that with really positive reviews, is how it should be. It was a little more like NSF's process than it was just carving up a little bit of money out to the Center. I thought that was good.

Perspectives on NCETE Research—Challenges

Along with the positive outcomes and accomplishments achieved through NCETE's research initiative, there were also mixed reviews, particularly from the external experts in the field who we asked to review the Center's research portfolio. We argue that the variable nature of external experts' opinions on the quality of NCETE's research portfolio is in part attributable to its nascent status as a field that engages in rigorous research. In other words, they have made huge strides given where the field was six years ago. However, many reviewers do not believe the research within technology education is yet on par with that of science education or mathematics education.

In *Engineering and Technology Education* (2008), Johnson, Berghardt, & Daugherty recall Shavelson and Towne's 2002 statement that "to be ethically conducted and produce valid results, scientific efforts must be guided by fundamental principles that are agreed upon by the community of researchers within a discipline". According to the authors, the guiding principles that should underlie all scientific inquiry, including educational research consist of:

- Posing significant questions that can be investigated empirically

- Linking research to relevant theory

- Using methods that permit direct investigation of the question

- Providing a coherent and explicit chain of reasoning

- Replicating and generalizing across studies, and

- Disclosing research to encourage professional scrutiny and critique

(*Shavelson & Towne, pg. 52 in Johnson et al, 2008*).

As standards that have long-been accepted in science and mathematics education research, these were also the standards several external expert reviewers had in mind while reviewing the NCETE research portfolio.

In addition, we asked reviewers to comment on the contents of the research efforts along four key dimensions, which we will use to summarize their feedback in this section: 1) quality of the research; 2) relevance or importance of the research questions; 3) soundness of the conclusions and interpretations (analysis that led to the interpretations); and 4) coherence of the overall research agenda and coherence of the studies.

Quality of the research

While one reviewer thought the quality of the research portfolio overall was "sound and acceptably met methodological standards for social science research," the majority of reviewers had concerns regarding the quality of research products they reviewed:

> *In terms of quality of the research, I find the portfolio somewhat uneven. For example, several of the methodological weaknesses in the research on K-12 engineering education documented in the 2009 Academies report are apparent in the portfolio (e.g., small sample sizes that make it difficult to generalize results, reliance on self-reported, as opposed to observed behavior, and a mismatch between the assessment tool and behavior being assessed). The use of Delphi panels was sometimes not appropriate, in my opinion.*

Two reviewers commented on the literature reviews of some of the studies, particularly the doctoral dissertations:

> *The literature reviews of all studies are fairly extensive and of varied quality. What is not as clear in some of the studies is how the literature review has shaped the design of the research or the instruments.*

> *The literature reviews in some of these theses are quite interesting, even in some of the theses that I think were very weak. However, most lit reviews are all over the place—everything the student knows about some topic but without leading readers to know why the research question is important and where it fits into the general scheme of what we need to know to promote learning from design experiences.*

> *While in some of the reports, theoretical frameworks are included as part of the literature search, it is often not clear how these frameworks have informed the design of the study or how the results of the study further inform or challenge the framework. In general, the documents provide much more of a description than set forth a new way of looking at a problem space.*

Finally, a reviewer questioned the overall ability of NCETE participants to conduct quality research:

My overall impression of the research portfolio is that the NCETE leadership has had great difficulty moving themselves and their students towards carrying out deep and meaningful research that will result in substantial progress in technology education. I see confusion about what makes for an interesting research question, approaches to carrying out research, and, what a high-quality research endeavor entails. The theses, journal articles, and reports show me a leadership that wants to be doing high quality, productive, and important research but that hasn't yet made the transition into knowing how to do that.

Relevance of research questions

One reviewer articulated that what makes for quality research goes beyond the relevance or importance of the research questions being addressed:

I conclude that the research questions addressed in the NCETE portfolio do address some important and relevant issues along the technology education— engineering education continuum. However, simply addressing issues that are important and relevant is not the same as conducting quality research. Factors for judging quality research might include such things as the importance of the research question but also how the research takes account of and builds on what is already known, the appropriateness of the study methodology, and the investigator's skill at executing the methodology and making sense of the results.

Another reviewer felt that the research questions were not relevant or current enough to influence future research and practice—that they were not the most important questions for the field right now:

Many of the research questions are about topics that have been bantered about for years. After reading this complement of articles, it's difficult to think of one study that informs how I would do my work. There simply are not data or studies that are situated where the action is occurring.

One reviewer suggested looking to other disciplines for methods and tools and using some of the knowledge generated by these other disciplines, in order to push the boundaries of what is known in technology education:

Related to this, the articles and community seem to be fairly insular. This is a community that cites each other's work. Rarely does the literature, or theoretical framework, or studies reach beyond the technology education community to learn from or borrow methods or other interesting research tools from other disciplines. There is little precedent of looking toward the outside (to science education, to

math education, to sociology, to science studies etc.) and using the knowledge generated by these other disciplines to suggest new areas of research to push the boundaries of what is currently known.

Similarly, one reviewer wishes to see more innovative and current research questions and rigorous mixed-method studies:

Perceptions and thoughts are not adequate to ground a discipline. What is desperately needed are well-designed actual studies in real classrooms. This is a glaring need in the field—at present the field seems to be a very small number of people hypothesizing and reflecting about theoretical ideas. It's time to get down and dirty—get into the classrooms, ask really interesting and difficult questions, gather a lot of data from teachers and students, and undertake very detailed and careful analysis, using a number of highly respected qualitative and quantitative techniques.

Soundness of the methods, analysis, interpretations, and conclusions

Again, referring to the lack of a solid research tradition in technology education, one reviewer commented that while most of the methods were still descriptive, the portfolio did include more quasi-experimental designs than have been typically observed in technology education research:

The research based manuscripts often used descriptive and qualitative methods, however it is obvious that within the Center's journal publication portfolio, the number of quantitative quasi-experimental designs reported was proportionally higher than normally found in journals within this field.

Other reviewers were not so willing to overlook weaknesses in the research methods and analyses (across research products), simply because of the history of the field:

Perhaps the biggest challenges in the Center's dissertation research are the methods that are used—they are limited and generally weak. Descriptive or "theoretical" studies are in the majority. The sample sizes and analytic techniques used for these studies are often very rudimentary so it's hard to see a clear evidentiary trail between data and result. Very, very rarely does a study triangulate a finding or use more than one source of data and there are almost no mixed methods studies.

No one tried to observe engineers in practice as a qualitative researcher would have done or ask engineers about their work as the vocational and career educators would have done.

Reviewers called into question the soundness of some conclusions, given the methodologies as described:

Across the seed grant study reports, the analysis and reporting of results needs to be more carefully constructed. The methods used in the studies are often underreported. In general, more detailed methods could bolster the findings from the studies. Much more description about what was done, and many more steps that prove to the reader that very careful analysis of the data, resulting in codes, that were analyzed is needed. The reader should be able to see how the findings come from the raw data. Overall, perhaps because of the nature of the funding, the samples of students and of data collection are small. Deeper studies will help to generate stronger claims. Finally, the findings and language in some cases need to be more tentative and more carefully worded.

The comparison studies are, in general, disappointing as they tend to simply be evaluations of results without the analysis needed for us to learn what is responsible for the differences (which is essential in making decisions about new directions).

Coherence of the overall research agenda and coherence of the studies

Two external expert reviewers felt that the portfolio as a whole was coherent and balanced:

A good representative balance of theoretical, conceptual, professional, and research related manuscripts are contained within the journal and conference proceedings publication portfolio.

The Center's journal publications were clearly focused on the study of engineering design as it relates to curriculum, defining the core content of engineering design, assessment, professional development, and thinking and reasoning in engineering design. The importance of these topics is critical to the field of engineering and technology education as it evolves from a curriculum of human productive practice towards a more disciplined and analytical field of engineering. The issues raised and studies conducted represent a coherent and articulate base from which to build on within the field.

Other reviewers felt that as a whole, the portfolio's coherence and cohesiveness—and overall impact—was not clear:

I could not determine on my own if the Center's work was guided by a vision or strategy that influenced the choice of research questions, the selection of fellows, and the overall plan for research. I am sure there was such a vision laid out in the original proposal (and I did read the proposal abstract available at the NSF website), but it was not apparent from my review of the published research or from looking at the center's own website.

Unfortunately, given the small number of published articles available, as a group they are no more than paint splatters on a canvas, as they are not coordinated in any way. The studies leave a lot of disconnected white space in between forays into what engineering design might be. The researchers have sought either previous curriculum work or expert opinion and have not attempted to get into the field and observe and study what it is that engineers do and how that might help them to construct a body of knowledge for engineering education curriculum.

Doctoral fellows also questioned the extent to which the Center created a cohesive research agenda. On our spring 2009 survey, one commented:

I think the idea of a cohesive research agenda was a great one; however each of the doctoral advisors varied in their ability to have their students adhere to developing dissertations that targeted aspects of the Center's research agenda. In addition, across the partner institutions the quality and quantity of research varied greatly. Meetings could have been geared more toward enhancing individuals' research skills. It is apparent that this is something our field is weak in, and talking about it over and over does nothing; but developing specific skills can perhaps.

Contributions: Reaching new audiences and broadening dialog?

There is some concern across the external expert reviewers and the doctoral students that the Center may not be broadening the dialog regarding integrating engineering design principles into technology education, by including individuals outside of the field of technology education. One reviewer noticed some positive examples of the Center's efforts in broadening its audience:

Some work of the Center, related to understanding professional development of teachers of K-12 engineering and identifying the core concepts of secondary K-12 engineering, has informed both the recent Academies report on K-12 engineering as well as a more recent study at the National Academy of Engineering.

But this same reviewer also commented that most of NCETE's publications stay within the technology education field:

Is there evidence NCETE is speaking only to "the choir," or is there evidence of trying to reach new audiences and broaden dialog about issues that cut across STEM disciplines? What is the evidence for reaching out to the K-12 mathematics and science education communities? This issue of broadening communication and collaboration to other parts of the STEM community would seem to be an important objective for a national center devoted to subjects that are only marginally part of the "core" of K-12. It appears, however, that a significant majority of the published articles in the portfolio are in journals that target the technology education community.

Another reviewer commented similarly:

The NCETE group has published in a fairly narrow range of journals that are almost exclusively targeted at the technology education community. Very rarely have they produced work that might be of interest to other closely related STEM fields (like engineering education, or science education). Thus, if the goal is to create a larger awareness of and linkages between science and technology education, these do not yet seem to be present.

And again:

Most were published as either book chapters in a Council for Technology Teacher Education Yearbook edited by two Center members, journals within the field of technology education, and practitioner level journals within the same field. Few were published outside the field in related engineering education, educational journals, or journals that help inform the greater science, technology, engineering, and mathematics (STEM) community.

Of concern to this reviewer is the breadth of dissemination of this work to external audiences. Few, if any of the Center's scholarly publications and conference proceedings were directed towards science and mathematics educational partners. Little evidence is provided that the Center went outside the technology education community to share its results. It is important that future work involve collaboration with other STEM fields and build even stronger cooperation with the K-12 engineering community which would help to form a larger accessible base with both political and educational synergy.

Out of the 17 articles I read, one is in a science education journal and two are in engineering education publications. The dissertations are in a general education database, but with their titles and descriptors there is little hope that the dissertations will be identified by educators outside of technology and engineering education. The web reports could suffer the same fate. In addition, the book that they have published is primarily circulated within the technology teacher education community, so that it might not move its view of engineering education into the greater educational community. Having offered a different discussion of what the content for engineering education might be it may go

nowhere unless the information gets into mainstream educational publications and specifically science and math publications.

One doctoral fellow described his concern regarding the Center's dissemination efforts during our interviews in late 2009. He is concerned that too few doctoral fellows are publishing at all:

I was kind of blown away when I was trying to make the point that I thought that our impact with our Center was going to be forthcoming because a lot of the dissertation work and a lot of research hadn't been published yet. I said, 'Raise your hand if you have something in press'. I was amazed at how few people had something in press. So, that concerns me. It is one thing to do the research, it is another to disseminate the information. That is critical in an R-1 institution, but even in these regional institutions, you do need to publish.

A different doctoral fellow commented on a survey we administered in March of 2009 that he would like to see the Center's research efforts be packaged appropriately and disseminated to decision-makers:

I believe the NCETE environment is research-rich and knowledge is being created and distributed, though not as effectively as possible. I don't entirely fault the NCETE for this as I feel a much larger initiative would be needed to create and disseminate knowledge to a broad audience outside the Center and even the field of Technology Education. Important research is getting done but is not relevant/digestible by decision makers such as politicians at the state and federal level, school superintendents, principals and teachers who could eventually make the technology education field irrelevant.

Inverness' Perspective on the Research of NCETE

Some of the challenges described above are not surprising—they have been apparent since Inverness was contracted to serve as the external evaluators for NCETE in October of 2006. In March of 2007, we presented findings from our preliminary work of observing meetings and conducting in-depth interviews with all of the cohort 1 doctoral students. At that time, we reported our concern that the doctoral fellows did not seem to be solid in their understanding of and commitment to the domain that the Center was created to improve:

The doctoral fellows are not confident in their understanding of the domain the Center is supposed to be improving; particularly, the intellectual landscape of this domain.

At that time, we expressed the challenges as: Students have a range of understandings of the "intellectual landscape of the field."

- Some students perceive they have experienced inequitable opportunities to participate in research that would help them understand the field

- Students do not agree on what "the field" consists of, and several perceive a lack of agreement among Center faculty on this issue

- Students do not agree on their understandings of the major purpose of the Center

- Students perceive a lack of agreement across the Center about the meaning of "infusing engineering design into technology education"

- Lack of clarity on the intellectual landscape stems, to some degree, from lack of clarity regarding Center expectations for students, and/or what future opportunities exist for students

Later that year, in September of 2007, we made suggestions regarding sharing conceptual frameworks across the center and from other fields, in addition to hosting one or more research seminars or workshops that might help clarify the intellectual landscape of the field for those who would eventually be conducting research (as well as those faculty who were currently conducting research):

> *We wonder also whether the conceptual frameworks, instruments, findings, etc. that are developed for conducting the landscape studies can be made available to Center participants. These "deliverables" are important as they build the capacity of those in the field who are currently or will in the future conduct research. In the final two years of the Center, an investment in one or two seminars or workshops where research plans and findings are shared, discussed, critiqued, and refined could both enhance the quality of the work itself and provide an opportunity to continue to build community among Center participants. These meetings could also include practitioners—teachers and professional developers, for example, who are engaged in the research work or who are knowledgeable about the challenges the field faces. In addition, these meetings could involve leaders from outside of the field but related to it—math, engineering, science—to provide expert perspectives on the emerging theories and findings.*

In June of 2008, we recognized again the fact that NCETE was trying to build a hybrid field while simultaneously researching it:

> *The major challenge for this Center is that it is attempting to establish a national Center in a very nascent domain—engineering-infused K-12 technology education. The field of technology education does not have a strong research base,*

nor does it have a strong record of professional development that infuses engineering design into technology education… it appears that at the end of the funding period, there may not be a coherent set of studies or findings that the Center can point to as its intellectual legacy.

Again in 2009, we wrote:

It is not obvious that the Center will have a thorough understanding of the landscape of the field by the end of the grant period. By "landscape," we mean the policies, instructional practices, research, improvement strategies, professional development practices, and curricula that are associated with this domain. While some of the graduate students' dissertations and the seed grant studies will shed some light on a few aspects of the landscape, it is not clear that the Center will have a full picture of what is happening in field, though they will have made progress to be sure.

We are still not certain to what extent the Center's research portfolio addressed the intellectual landscape of the field. Early on, what seemed to constrain the limits of their imaginations was that they were still struggling with the purpose of infusing engineering design principles into technology education. Was it to increase the pipeline of engineering students or was it to encourage technological literacy for all?

In addition, we're not sure that Center faculty and students ever really settled on a definition of engineering design principles, much less what it means to infuse them into technology education. In point of fact, one NCETE faculty member admitted (in September of 2009):

When we talk about engineering, bringing engineering into technology education… I think this question still is not answered: what does that really mean?

These issues seemed to be interpreted differently across the Center and this was evident in the core courses, the professional development work, and the research. All of these issues contributed to the delay of pulling together a coherent research agenda. Liles, Johnson, Meade, & Underdown (1995) described a research agenda as:

The framework that determines the boundaries for scientific inquiry that addresses the fundamental questions of a discipline. It provides the means of grounding theory with practice… An effective research agenda is one that stands the test of time as researchers and practitioners exchange problems and research results to move the discipline forward (in Johnson et al, 2008).

To date, technology education has not agreed upon such a framework.

However, it must be said that the Center leadership has made great efforts to address the challenges they knew were present, as well as those that others identified. They sought to articulate a research agenda and mission that doctoral fellows' dissertations must address. They organized and hosted a research symposium that received excellent reviews for its attempts to bring in researchers from other disciplines. They provided "seed grant" opportunities for researchers within the Center to hone their research skills and address aspects of the research agenda that had not yet been addressed. All of these were substantial and positive responses.

As we have seen and heard, progress has been made, particularly in building the capacity for individual students and faculty to do research. It will be interesting to observe the course of events at Purdue University, where three NCETE doctoral fellows are now part of the professoriate and are focused on integrated STEM. One of these fellows told us:

> *We want to become the leader in graduate technology education with a focus on STEM—that clearly is a goal of everybody that is in our program and that is what we are shooting for. We are trying to recruit more masters' students and specifically we are trying to target Ph.D.s because Minnesota is no longer graduating Ph.D.s in that particular field and we feel there is opportunity there. We know that some of the other faculty members are getting ready to retire and programs are phasing out. We have a great opportunity, but we need to start carving out a research agenda that has a wider scope than just what traditional technology education and engineering design allows you.*

As we have stated throughout this report, NCETE was building a hybrid field while researching it, and the two fields brought together through the Center did not have solid research traditions of their own to begin with. The nature, quality, and depth of research a CLT can produce is in part, inherently a function of the research history of the disciplines it is working within. Furthermore, NCETE, like other CLTs, were not initially funded to conduct research and were therefore unclear regarding the nature and extent of the research they were meant to conduct— much less how to foster and support that research.

While the Center was solid in its goal to develop a supportive doctoral program, the entire vision for creating a research-rich milieu was unclear. Also, the faculty involved with the Center did not have a uniform or typical approach to engaging in and conducting research; therefore, there were not strong existing research groups that could subsume and mentor NCETE doctoral fellows. It may have helped the

Center's research efforts to encourage and support research and writing groups across or even within the campuses. Of course, NCETE's widely distributed nature posed a challenge to this sort of effort as well.

In a sense, NCETE can be described as a bootstrapping effort. That is, it had to *build* itself upon a foundation that it had to first create for itself—there was not an existing foundation for this work. Do we believe that the Center made progress in creating a stronger foundation for the field to continue to develop itself? Yes.

Closing

In summary, NCETE's research efforts resulted in some strong accomplishments and revealed (and in some cases, reinforced long-standing) challenges facing researchers in the technology education field. Both of these should be considered powerful learning opportunities.

Several reviewers noted the impressive progress NCETE has made, given the short time it has been in existence:

> *I recognize how short a time five years is to grow a meaningful research effort, especially on a set of topics that have been largely outside the mainstream of education research. I believe it is premature to try to determine the impact of NCETE's research. The time scale for meaningful education change of any significance is probably best measured in decades, not years.*

> *This presentation, poster session, and workshop portfolio when examined very carefully contains some of the most in-depth study, work, and dissemination of scholarship and research in the field of technology education. Never in the recent history of this young field of study has so much been written and disseminated.*

> *The overall intellectual merit of the journal and conference proceeding publications in this cross-sectional review is excellent for the time the Center has been in existence. The writing, discovery, and discourse within the breadth of the journal portfolio are of high quality and have raised the standards within the field.*

The Center increased the capacity of faculty and doctoral fellows to conduct research to begin with, and the research portfolio consists of strong evidence of increased collaboration among faculty from different universities and even some between technology educators and engineering educators. While challenges continue to face NCETE, in terms of its research agenda, this review has identified some clear

recommendations for future research efforts, which is extremely valuable. The Center has created momentum within and outside of the field to improve research in STEM.

In addition, now that the International Technology Education Association (ITEA) has changed its name to the International Technology and Engineering Educators Association (ITEEA), it is time to further the work of the Center in a modified "NCETE 2.0". How is ITEEA defining "engineering education" and its relationship with technology education? What will this look like in practice? What are the implications of the name change for future research agendas? Inverness suggests that a small task force group of individuals (who will think deeply and hard) form out of the original NCETE, to first take stock of the work the Center has accomplished to date and next to solicit in-depth input from researchers in the rest of the STEM fields—the science, math, and engineering education fields—as well as experts in methodological approaches (even outside of the STEM fields) regarding a future research agenda and approach. We suggest a working meeting where sub-groups could identify appropriate, relevant, and current research questions, as well as vet rigorous appropriate methodologies. Such a workshop would, in a sense, replicate the work that our external expert reviewers completed—identify strengths and weaknesses in the work to date, identify areas to fruitfully build upon, identify future directions, and brainstorm project ideas, and funding and dissemination opportunities.

Recommendations for future research efforts:

- Research questions should be current and not a rehashing or simple reformulation of previous research questions

- Attempt to identify appropriate content for engineering and technology education, K-12

- Methods should move away from descriptive studies that rely on self-report instead of observable data, to involve more mixed-method, empirical studies

- Attention should be paid to all guidelines for quality research:

  - Posing significant questions that can be investigated empirically

  - Linking research to relevant theory

  - Using methods that permit direct investigation of the question

- Providing a coherent and explicit chain of reasoning

- Replicating and generalizing across studies, and

- Disclosing research to encourage professional scrutiny and critique

- Employ larger samples sizes

- Identify clear pathways from data to interpretation to conclusions

- Include more engineering educators, along with math and science educators and education researchers

- Disseminate the Center's research at conferences and in peer-reviewed journals in engineering education, math education, and science education (i.e. outside of the technology education field)

- Package and disseminate research to decision-makers

While our external expert reviewers had many critiques of the work they reviewed in NCETE's research portfolio, all of them had summary comments that were appreciative of the Center's efforts to date and optimistic about the future of research in technology education. We end with a sampling of those comments:

They have laid a lot of groundwork that will lead to a lot of innovative things.

In a field that lacks solid leadership, the Center must be commended for not only showing research and scholarship leadership, but also for communicating new knowledge and direction for the field in general.

Although most of their publications have been descriptive of the landscape and descriptive in nature, more recent publications have begun to focus on trying to identify the content of engineering education, a step that had been identified as essential via several conferences and studies that have been conducted. These efforts at identification of content are in the initial stages and there does not appear to be enough work on this topic to generate agreement on content among the center participants. However, this is important work that needs to be continued because this group may include the only professionals who are actively seeking to provide engineering education information to the academic community.

NCETE efforts to promote engineering education have been noted by the larger community and they are making inroads in the teacher educator and ITEA communities regarding engineering design, as evidenced by the association name change.

Over the past two decades, no effort within the field of technology education has yielded such a robust unified body of knowledge focused on infusing engineering into the K-12 classroom. The work of this Center has important implications for the movement of the field of technology education into incorporating the strengths of engineering in its curriculum. This work is aligning with national goals for education and in particular STEM education.

In the end, the Center has provided a significant service to technology education by bringing teacher educators together and influencing their beliefs, by adding to the need to change the name of the professional association, by identifying the landscape of K-12 engineering education in the United States, by radically altering the discussion of science and mathematics as the appropriate content for engineering education, and by pointing to the need to identify an engineering education curriculum.

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Appendices

A. Doctoral Fellow interview protocol

NCETE Doctoral Student Structured Interview Protocol
March 2007

Hello, my name is _____. I am calling from Inverness Research Associates on behalf of NCETE. As you know, we are the external evaluators for this NSF Center.

We are conducting phone interviews with all of the doctoral students, following up on our January focus group interview, to learn more about your experiences and perspectives as an NCETE doc student. Our purpose for collecting this information is to gain a deeper understanding of your experiences, to inform and guide the Center's future work, and to inform and build the capacity of the field. Your feedback will be invaluable for guiding NCETE's work with Cohort 2.

We will use information from these interviews in our reports anonymously – that is, your name and other identifying information will not be directly attributed to any statement you make.

*We would also like to compensate you for your time today with a gift certificate at Amazon.com for **$75.00**.*

Name:	Interview Date:
University:	Year in program:
Phone #:	Date began program:
Address:	Interviewer:

****

For a rough overview, first I'm going to ask you questions about your coursework, then about your experiences with your advisor(s). Third I'll ask a set of questions about research, and finally we'll talk about your sense of NCETE overall.

I. COURSES

Since there are several studies of the core courses underway, we will only ask you some general questions at this time about courses.

1. How well do you feel your coursework so far has **prepared you for a career in your field**?

```
1_____2_____3_____4_____5
Not at all        somewhat        very well
```

Comments:

2. How well do you feel your coursework so far has **prepared you for conducting independent research**?

```
1_____2_____3_____4_____5
Not at all        somewhat         very well
```

Comments:

3. To what extent do you feel your coursework so far **supports/connects to the larger mission of NCETE**?

```
1_____2_____3_____4_____5
not connected    somewhat              very
at all           connected             connected
```

Comments:

4. What, if anything, is **missing** from your course of study?

5. Is there anything you would like to add about your coursework?

II. ADVISING/ADVISORS

Now I'd like to ask you some questions about your advisor and your experiences with advising in your program.

6.   Who is your **primary advisor**?

Has this person always been your advisor? Yes_____   No _____

If no, from whom did you switch, and why?

7.   Have you been seeking advice from anyone else? Yes_____ No_____

Who?

What is their relationship to NCETE?

8.   How often do you **"meet" with your advisor**?

☐ never
☐ rarely
☐ once/month
☐ once week/more

How do you meet?

☐ in person
☐ by phone
☐ email
☐ other

Comments:

9.   What kinds of things do you **discuss with your advisor**?

☐ logistics
☐ courses
☐ research
☐ internships
☐ comprehensive exams
☐ other

Comments:

10. To what extent does your advisor give you **feedback on your written work**?

```
1_____2_____3_____4_____5
Not at all        some            a great deal
```

Coursework?

```
1_____2_____3_____4_____5
Not at all        some            a great deal
```

Research?

```
1_____2_____3_____4_____5
Not at all        some            a great deal
```

Comments:

11. How **useful is the feedback** you receive?

```
1_____2_____3_____4_____5
not        somewhat          very
useful          useful          useful
```

Comments:

12. To what extent do you believe your advisor is engaged in the work of the Center

```
1_____2_____3_____4_____5
Not at all        some            a great deal
```

Comments:

13. Overall, **how well supported** do you feel by your advisor?

```
1_____2_____3_____4_____5
Not at all        somewhat        very
```


14. In what **ways, if any, do you feel supported**?

15. In what **ways do you wish you had more support**?

16. Do you have **other committee members** in mind for your dissertation research? Yes_____ No _____

If yes, **who** are they, **where** are they, and **why** have you chosen them?

17. Have you had significant **contact with any other faculty** (inside or outside of NCETE)? Yes_____ No _____

    If Yes, who, and what is the context and content of your contact?

18. Is there anything you would like to add about advising in your program?

III.   KNOWLEDGE

Now I'd like to ask you a few questions about your experience with the knowledge production and sharing within the Center

19. First, we want you to describe **your perspective on the intellectual landscape of the field**. By this we mean the key research, critical questions, findings, efforts facing the field. (If needed, prompt about technology education's relationship to engineering design.)

20. Please rate **your confidence level** in terms of the extent to which you believe your perspective is shared across the Center.

    1_____ 2_____ 3_____ 4_____ 5
    low   medium   high

    What about your advisor, specifically?

    Comments:

21. Are you engaged in ANY kind of **research project** right now?

    Yes_____ No_____

    If yes, please **describe the project** (who is the lead, how is it supported, what are the questions, methods, etc.)

22. How well would you say the **research relates to the larger mission** of NCETE?

    1_____ 2_____ 3_____ 4_____ 5
    Does not   somewhat   Relates
    Relate at all   related   very well

23.   In what **ways/how is it related**?

24. What are your **current ideas for your own dissertation research**? (probe for questions, general domain, methods, sites, what they know about existing research in this domain, what they hope to learn from it, timeline, etc.)

25. How does your **research idea build on your experience**, either inside or before your program?

26. Does your research **interest connect with the interests of your faculty/committee**? In what ways?

27. To what extent do you think your **research interests connect with the concerns and issues of practitioners**?

      1————————2———————3———————————4————————5
      not at all   somewhat   A lot

   Comments:

28. Becoming a researcher is a process that may involve **apprenticeship**. Apprenticeship entails the opportunity to work along side master craftspeople, with increasing responsibilities and appropriate guidance. Do you feel that you have had/will have a well-designed apprenticeship experience?

29. **Sink or swim**? This phrase refers to an approach of learning to swim where the child is simply thrown in the water and has to learn to swim. Would you characterize your own experience this way? Why or why not?

30. Who do you think you will **learn from**? Who do you think you will be **influencing** in your career?

31. To what extent do you feel you have a **realistic understanding of future opportunities** available in the field?

      1————————2———————3———————————4————————5
      not at all   somewhat   A great extent

- If rating is <u>high</u>: What are some examples of opportunities?

- If rating is <u>low</u>: Why is that? Do you feel unprepared for future opportunities, or do you feel you do not have a firm understanding of future opportunities?

32. Is there anything you'd like to add about **research**?

IV. NCETE COMMUNITY

In this section, I will ask you questions about your connection with the larger CLT project, etc.

33. Overall how **connected do you feel to a scholarly community through NCETE**?

1	2	3	4	5
very disconnected		somewhat connected		very connected

Comments:

34. What, if anything, does your **advisor do to bring you in/make you feel part of a scholarly community** (e.g. encourage participation in conferences, introduce to colleagues/researchers, invite student to co-author papers, etc.)?

35. How **connected do you feel to a "doctoral program"** at your university?

1	2	3	4	5
very disconnected		somewhat connected		very connected

If somewhat or very, what are some of the **things that help you feel connected**? (meeting with other students, sharing papers, sharing reading for courses, going to conferences together, co-authoring papers, etc.)

If very disconnected or poorly connected, **what is missing** that would help you feel connected?

36. Some NCETE fellows are in departments like human resources. How do you think your program fits into the larger university? How do you think it is viewed or received by the larger university community?

37. How **connected do you feel to other NCETE doctoral students**?

1	2	3	4	5
very disconnected		somewhat connected		very connected

Comments:

38. What kinds of **work/activities are you involved in that support your connection to the field**? (eg. RAship, TAship, internship, etc.)

39. How **satisfied** are you with the work/activities you are involved in?

```
    1        2         3        4         5
  very              somewhat           very
satisfied           satisfied        satisfied
```

    Comments:

40. To what extent is the Center providing you **shared experiences** outside of the core courses?

```
    1        2         3        4         5
 not at all          somewhat         A great extent
```

41. What **professional organizations** do you belong to? Please describe the **nature of your activities** related to these organizations.

42. What **research conferences** have you attended since becoming a doctoral student? What has been the **nature of your role** at these research conferences?

43. What other **strands of work within NCETE** are you involved in?

    TTE_____

    Research_____

    Other_____

    Describe the **ways you have connected** with these other strands.

44. Have you **offered feedback to the project leaders** about any aspect of your experience so far? Yes_____ No_____

    If yes, what **kind of feedback** have you offered?

45. How would you rate the **overall quality of your own communication** with the leaders of your program?

```
    1        2         3        4         5
  poor              adequate          excellent
```

    Comments:

46. How would you rate the **overall quality of communication** among the leaders of the Center?

```
 1      2        3        4         5
poor            adequate          excellent
```

47. How would you rate your overall satisfaction with how **finances** have been handled in your program?

```
 1      2        3        4         5
not at all    somewhat          Very satisfied
satisfied     satisfied
```

Comments:

48. How would you rate your overall satisfaction with how **logistical issues** have been handled in your program?

```
 1      2        3        4         5
not at all    somewhat          Very satisfied
satisfied     satisfied
```

Comments:

49. How would you rate your **overall satisfaction** with your program?

```
 1      2        3        4         5
not at all    somewhat          Very satisfied
satisfied     satisfied
```

Comments:

50. What would you say are the **greatest strengths** of your program?

51. What would you say are the **biggest issues/concerns** of your program?

52. Is there anything you would like to add about NCETE?

THANK YOU!!!

B. Faculty interview protocol

BACKGROUND and GENERAL CLT

1. What is your university or department **involvement** in NCETE? What is the particular role or specialty of your institution within NCETE?

2. What is your **current role** in the NCETE? How much time and effort do you spend on NCETE work? Do you play any leadership roles in the Center or in tech ed in general?

3. What are **the incentives for your participation** in NCETE? What are the **barriers** to participation? What are the **institutional messages** (overt and implicit) that you as a faculty member are getting from administrators and other faculty vis-à-vis the importance of NCETE and the advisability of your own involvement in the work of the Center?

4. Are you engaged in **research** related to the NCETE? What is important about the NCETE for research in this domain? Where are the opportunities for research in this domain?

5. Outside of teaching and research, in what **other ways are you involved** with NCETE? In what ways would you like to be more involved?

GRADUATE STUDENTS

6. How well **do you know** the NCETE doctoral students in Cohort 1 and 2? What is your **impression of them**? How do they **compare** to past students you have known/advised/taught who were not a part of NCETE?

7. How **are you working with graduate students at your institution in general**? (different roles: teaching, advising, committee work, leadership, etc.) What about NCETE doctoral students specifically?

    Master's Advisors:
    a. How many master's students have you advised in Tech Ed?
    b. To what extent and in what ways have masters students you have advised participated in NCETE?
    c. How well prepared do you feel the masters students are for assuming leadership positions in this field? Explain why.
    d. What role do you envision masters students playing in the field in the future (eg. are they in schools, districts, at universities, other leadership roles – we want to determine if they see masters students as leaders in the field)

PROFESSIONAL DEVELOPMENT

8. Have you been or are you now involved in any of the professional development efforts of the Center? What is your role?

9. What is your impression of the evolution of this work?

10. What contribution do you envision this strand could make to the Center? To the field at large?

11. How, if at all, is developing high school teachers related to developing leaders in the field?

12. What remains to be done in professional development in tech ed?

13. What are the major challenges facing this strand of work for the Center? For the field?

TEACHING

14. If you are currently or have recently taught a **course** for NCETE doctoral or masters students:

    - **Describe** the course(s)
    - What are your **goals** for the students in the course?
    - How does the course **fit in with the overall doctoral/masters experience**?
    - How do you see the course **fitting in with the overall Center mission**?
    - In what ways, if at all, did the course prepare students to become leaders in the field?
    - How does the course **fit into the rest of your teaching/research agenda**?

15. How, if at all, has teaching in **influenced your teaching** of other courses?

16. What **advice** would you give to another instructor teaching a course for the graduate students in NCETE?

17. How, if at all, has teaching in NCETE **influenced your ideas for future research or scholarship?**

RESEARCH

18. What do you know about the **research agenda** of the CENTER? Is there a **synergy** of efforts?

19. Who are the Center's **critical competitors** in the research arena?

20. To what extent do you feel the Center's research:
   a.   **Builds on past work** in the field; **adds value** to both the field and researcher's current work
   b.   Encompasses **new and important questions** of the field
   c.   Addresses issues of **practice**
   d.   Brings **new energy** to the field, is generative
   e.   Is of **high quality**

21. Are you planning on participating in the **Research Conference** in May? In what capacity?

SUMMARY

22. How, if at all, has participating in NCETE **affected you** professionally? **Added value** to your work? Has anything happened that would **otherwise not have happened** without the Center? What **new work** are you better prepared to engage in as a result of your involvement with NCETE?

23. What are some ways you feel you have **contributed to** NCETE?

24. At this point in time, what would you say the legacy of NCETE will be?

25. When the NSF funding comes to a close, do you anticipate continuing any center-related work?

26. If you had the resources you needed to continue some center-related work, what aspect, if any, would you choose to continue and why?

27. Do you have any **closing or final thoughts** that would be helpful to the leaders of the CENTER or for funders considering the impacts of the CENTER?

 THANK YOU!!!

C. Seed grant recipient interview protocol

Intro: We are interested in hearing more about the seed grant program: what the process was like, how the recipients experienced the program; and how, if at all, the program influenced the capacity of people to do research in the field of technology education.

As always, this interview is confidential and your comments will remain anonymous in any reports we write. Do you have any questions before we start?

1) How did you first learn about the seed grant opportunity (general announcement or one-on-one communication)?

2) Why did you choose to pursue a seed grant? What were you hoping to get out of the experience?

3) How would you describe your confidence to conduct research, prior to applying for the seed grant?

4) How, if at all, did the Center prepare you for the process of applying for the seed grant?

5) How, if at all, did the Center support you during the process of applying for the seed grant?

6) Did you collaborate with anyone on writing the proposal or conducting the research for your seed grant? If so, tell us a little about what that collaboration looked like and how the Center supported or did not support that collaboration.

7) How would you describe your confidence to conduct research, after having gone through the seed grant experience? How, if at all, did the process influence your capacity to conduct research?

8) What did you learn as a result of the entire seed grant proposal writing process and the research process that was of most value to you?

9) Are you aware of what research other seed grant recipients conducted? How familiar, if at all, are you with others' methodology and findings?

10) How, if at all, do you think the seed grant opportunity and process impacted the Center as a whole?

11) How effective does you think the seed grant process was as a strategy to influence the field of technology education at large? What might have been done differently?

THANK YOU!!!

D. Experts in the field interview protocol

NCETE External Expert Interview Protocol
September 2009

You've been recommended as a reference for NCETE. The reason you've been recommended is you have a broad knowledge in the field in which NCETE is working, and you also have some familiarity with the Center.

Key focal points for the conversation include:

The Domain NCETE Has Chosen

One of the premises of Centers is that they've identified a sub-domain of STEM education that needs investment for its improvement. So, for example, with engineering and technology education, there is an assumption that by studying and addressing issues related to infusing engineering design into technology education, we can make progress toward addressing or improving significant problems or situations in education. In other words, it's worthy of investment. This is a question of the importance of the domain.

1. Is this an important domain NCETE has chosen to focus on (ETE)? What are the issues that matter to practitioners? To researchers?

2. Was this Center well-positioned in that domain to make progress? In what ways? (probe for people involved, reputation, university partners, etc)

3. What are the critical areas of need in the domain, going forward? Has the Center addressed those needs at all?

Knowledge Generation and Knowledge Utilization (a Center is supposed to do both):

4. From what you understand of the kinds of research projects that the Center is engaged in and the kind of research they're promoting, is this Center likely to be significant in contributing to the knowledge base in the field?

5. To what extent and how has the Center succeeded in collecting, disseminating and consuming research? Of all the research in the field, has this Center played a role in helping to digest, translate and make the Center useful to researchers, practitioners, policy makers and others?

6. To what extent and how does the Center have the potential to make progress in this field, vis-à-vis, important questions, knowledge generation and utilization, that would address important issues that are faced by policy makers, practitioners and researchers?

7. Anything else you would like to add about the Center's research focus?

Leadership – Generation and Support of *Leadership*

8. I'd like you to now talk about the need for leadership or expertise in this domain and the degree to which you think the Center made progress in generating leadership among faculty members, researchers, graduate students, post docs, and practitioners. To what degree do you think the Center has produced people with expertise, knowledge, and leadership skills that will be important to this domain?

9. To what extent and how do you think the Center has made progress in empowering or enhancing existing leaders? Has the center drawn upon the skills of existing leaders in the field, put them to use, connect them? Examples.

Summary Questions

10. Overall, how has the Center performed in terms of building/contributing to the improvement of the domain of tech ed? How has the Center positioned itself to be a significant player, and to add value to the work of this field?

11. What are this Center's strengths?

12. What are this Center's weaknesses?

13. Major concerns?

14. Other summary thoughts?

THANK YOU!!!

E. Email invitation for expert review of research

Dear Colleague,

My name is -- and I am a researcher with Inverness Research. Our group is serving as the external evaluators for the National Center for Engineering and Technology Education (NCETE), an NSF-funded Center for Learning and Teaching.

As part of our summative evaluation of the Center, we are seeking your help as an expert in the field of engineering and/or technology education. We would like to offer you an opportunity to review NCETE-supported research products, in exchange for a small honorarium. We are hoping to complete these reviews by mid-April. We offer a range of options for you to choose from. Below is a description of each level of task.

Portfolio Review ($2000 honorarium): This task entails reviewing the <u>entire</u> selection of research products in the NCETE portfolio, reading several pieces, and writing a 3-4 page summary that considers (at least) the following:

- Your overall impression of the portfolio as a whole
- Importance/relevance of the research questions being addressed
- Originality of the research topics/foci
- Quality of the writing
- Overall potential contribution to the field
- What it suggests to you for the future

Dissertation Review ($1500 honorarium): This task entails reviewing at least three dissertations that interest you and summarizing your reflections in 3-4 pages with the following in mind:

- Your overall impression of the dissertations
- Importance/relevance of the research question being addressed
- Originality of the research topic/focus
- Soundness/appropriateness of the research design/methods
- Strength of the interpretations/data supports conclusions
- Quality of the writing
- Overall potential contribution to the field

Journal Article Review ($1000 honorarium): This task involves choosing and reading 6 NCETE-supported articles that interest you and summarizing your reflections in 3-4 pages with the following in mind:

- Your overall impression of the journal articles
- Importance/relevance of the research questions being addressed
- Originality of the research topic/foci
- Soundness/appropriateness of the research design/methods
- Strength of the interpretations/data supports conclusions
- Quality of the writing
- Overall potential contribution to the field

Papers of Your Choice Review ($800 honorarium): Here we are asking you to choose any 3 NCETE research products (from the website) that interest you, and reviewing them for quality and contribution to the field, and writing up 1-2 pages of your reflections.

For any task that you choose, we are hoping that you can apply your expertise and experience in reviewing the quality and value of this work. To make sure we have at least one person performing each level of task, please indicate how (if at all) you are interested in participating, by giving each option a rating from 1-4.
1 = I would very much like to do this
2 = I would like to do this
3 = I am willing to do this
4 = I do not want to do this

Options:
Portfolio Review ($2000). Your rating:
Dissertation Review ($1500). Your rating:
Journal Article Review ($1000). Your rating:
Review 2-3 articles of interest ($800). Your rating:

If you agree to participate, we will send you the documents (or links to the documents). Please reply to this email and indicate whether or not you would like to participate.   If you would prefer to be interviewed over the phone in lieu of writing your reflections, we can arrange this.

Many thanks,

Michelle Phillips and Jenifer Helms for the Inverness Research NCETE evaluation team