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Year Two Annual Report: Activities, Findings and Evaluators’ Reports

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Major Research and Education Activities: 2005-06

Research Activities

A major challenge in the work of the National Center for Engineering and Technology Education has been the need to strengthen the research climate across the institutional settings. A number of activities have been directed at that effort: internal funding of small student and faculty research projects; presentations by researchers at Center meetings; providing a research focus for the required core courses in cognitive science, design, problem solving, and creativity; and the evolution of the research framework for the Center.

The internal research program has been successful in providing relatively non-threatening experiences with proposal preparation, review, negotiation, and the conduct of small research projects. Six proposals were funded for exploratory research projects in 2005-2006. As these projects are completed, the researchers have shared their findings with their Center colleagues and at professional conferences. The Research Committee has completed its review of the second internal competition and the successful proposals are being negotiated as this report is being prepared in early June 2006. The internal research program has provided opportunities for students and faculty to develop their research capabilities to investigate new areas. The program has also helped to introduce a collaborative, research-focused interchange among the Center faculty as they establish and monitor the program.

The most recent Center meeting included presentations by two researchers, Christine Cunningham and Janet Kolodner. Christine Cunningham reported the findings of her work on the recruitment of girls and women to engineering and technology. Janet Kolodner described her investigations of effective ways to implement design activities in the classroom.

Serious attention has been given to the introduction of the cadre of doctoral students to the research process throughout their work at the Center. Specifically, the core courses include comprehensive studies of the research literature in the respective fields, provide specific preparation in research related to the content of the course, and require the students to conduct small research projects and prepare scholarly reports of their work.

In the first NCETE core course, The Role of Cognition in Engineering and Technology Education, the Fellows were expected to be both consumers and producers of educational research. The majority of the course readings described empirical studies of cognition that focused on technical learning and thinking. Each student was expected to critically analyze a research study and present the major concepts from the article to the class. The Fellows were also expected to write and present a major paper that reviewed and synthesized the literature on a critical issue related to cognition in engineering and technology education. Each Fellow was also expected to conduct an analysis of expertise in a domain of his or her choice using the protocol analysis method. This method of research was introduced in class as a way to empirically capture the thought processes that are used as the research participant completes a task. The Fellows designed and conducted the research study and wrote a technical report that included a description of the problem being addressed, the methods used to collect and analyze data, and the results and conclusions. The Fellows also made formal presentations of their research study to the class.

In the second core course, Design Thinking in Engineering and Technology Education, the fellows continue to be consumers and producers of educational research. The course explored the concept that design is the primary conceptual anchor for technology education, drawing the subject ever more tightly toward engineering. As the doctoral students reviewed contemporary literature in design thinking, they were asked to identify the conceptual framework against which the study was set, the quality of the research problem, the design/methodological approach of the study, the findings and recommendations,
and study limitations. The students were expected to critically analyze a body of research and develop a journal-quality synthesis paper. The instructor has expressed his willingness to help the students develop their synthesis paper into a journal article at the conclusion of the course.

As the third and fourth core courses are provided to the doctoral cadre during 2006-2007, the research focus will continue. The research emphasis in the core courses will prepare the students for research in their specialty, building upon their course work in research methodology and statistics at their respective institutions.

In March 2005, early in the life of the project, Center faculty and a team of outside consultants developed a research framework to encompass the anticipated research thrust of the Center. The framework identifies three themes: (1) how and what students learn in technology education; (2) how best to prepare technology teachers; and (3) assessment and evaluation. While the research framework is comprehensive and provided a useful starting point for the research endeavors of the group, the panelists at the Reverse Site Visit in May 2006 recommended refocusing the research framework into a more precise agenda. Faculty and fellows have already started that work and will continue the refinement of the research agenda in the months immediately ahead.

**Doctoral Activities**

The Center faculty gave concerted attention to developing an effective recruitment program for the first cohort of fellows and went through a meticulous selection process to build a strong cadre of beginning doctoral students. An August 2005 orientation session for the fellows was held at the National Academy of Engineering in Washington DC to introduce the fellows to representatives of the National Academy, the professional associations, and faculty members from the collaborating institutions.

During their initial semester of study, the Fellows completed a core course together via distance delivery from the University of Illinois, as well as a schedule of other courses required at their respective institutions. During the second semester, the fellows completed a second core course delivered by a team of two professors at the University of Minnesota.

During the spring semester, three Fellows represented the Center at the CLT PI Conference, where they presented poster sessions. They also reported their impressions of the PI Conference to their cohort colleagues via an interactive video session of the second core course. The Fellows participated in the Center workshop in Baltimore, reporting to the entire group on the research they completed in the first core course, working in the NCETE booth in the ITEA trade show, and hosting the ITEA leadership at a reception early during the convention.

At the conclusion of the first year of doctoral study, the Fellows participated in the summer workshop at the University of Georgia. (All twelve Fellows were retained through the experiences of the first year.) At the summer workshop, the Fellows provided individual and small group reports of work completed in core courses one and two as well as reports of research completed under the internal research program. All participated in a focus group seeking to reconfigure the Center research agenda and reported their suggestions to the faculty later in the workshop. They also participated in community-building activities hosted by the faculty and Fellows at the University of Georgia.

Several of the Fellows are working with partner professional development programs during summer 2006. Their levels of involvement vary from observation to workshop facilitation to evaluation. In addition, several are taking graduate courses at their home institutions during the summer session.

Both internal and external evaluations of the first two core courses have been completed. These studies
have provided recommendations that will be useful in revising the courses before they are offered again in 2007. While there was no formal ethnographic study of the first year experiences of the graduate students, consideration is being given to the possibility of such a study in the years ahead.

**Professional Development Activities**

The long-term goal of the professional development program is the identification of effective practices for professional development in engineering and technology education. In order to move toward that goal, each professional development institution identified short-term goals for the current year, shared those goals with the group, and then implemented activities to accomplish the goals in the local setting.

Faculty from each institution provided an in-depth report of their success in meeting their goals at the summer workshop at the University of Georgia. Also at that meeting, the faculty from the professional development institutions responded to questions raised at the Reverse Site Visit by developing a preliminary draft of the conceptual base for professional development and a preliminary list of criteria for assessing effective practices in professional development. These products represent important progress toward the evolution of a Center model for professional development and will provide a basis for further refinement during the year ahead.
Findings: 2005-06

This section contains findings from the activities of year two as well as a summary of internal evaluation activities. The external evaluation report from WestEd is included as a separate file uploaded through FastLane.

Year Two Findings

Research is at a relatively immature state in engineering and technology education, particularly in comparison with mathematics education and science education, both of which have decades-long traditions of disciplined inquiry to guide professional practice. We have discovered that fostering a research attitude in engineering and technology education is especially difficult, because the action orientation of the field tends to preclude reflective investigations. The Center continues to address this issue in an attempt to assist Fellows and faculty in the development of habits of disciplined inquiry. We have also found that many of the doctoral students were initially ill-prepared to deal with the theoretical constructs in pedagogy and in design that were an integral part of their doctoral programs. Their lack of understanding of the value of research-based knowledge sometimes appears as an anti-intellectual bias that interferes with the development of research competence. Faculty involved in teaching the first two core courses worked patiently with the doctoral students to help them begin to establish their identities as researchers in engineering and technology education. We sense that the doctoral students made great strides toward understanding the importance of research in their first year and we are optimistic they will continue to grow in this understanding.

The cohort has proven invaluable to the individual Fellows and to the groups of Fellows at each of the institutions. Fellows from different institutions are able to work together on tasks that facilitate mutual interests and clusters of fellows at the institutions have developed strong working relationships. The value of diversity is well demonstrated among the cohort. Their professional backgrounds in design, engineering, technology, and education at a wide range of institutions strengthen their development as a community of scholars engaged in the building of a new discipline.

It is important for the Center to devise an evaluation process to capture the experiences of the doctoral students and the evolution of their research identities, individually and as a cohort. Individual student logs, web logs, engineering journals, institutional and inter-institutional seminars, and collaborative research activities offer promise for strengthening the evaluation design.

The place of engineering and technology education in the high schools is somewhat tenuous in many parts of the country. The central themes of the field and the boundaries of the area of study are indistinct at this time in its development. As the Center participates in the effort to establish engineering and technology education as a critical area for high school students to study, it faces major hurdles because of the lack of a supporting infrastructure in most states. One of the most significant hurdles is the limited availability of instructional materials for high school students. This problem is further complicated by the fact that there is little professional development material available, as well. The teacher education programs in the Center have attempted to address this dearth of instructional materials in different ways, with widely varying levels of success.

Attracting motivated teachers and helping them resolve conflicts between the demands of their jobs, their personal lives, and Center professional development activities has become a more significant problem than the Center anticipated. It was difficult to attract the targeted numbers of technology education teachers during the second year of the project. Our original concept of designing professional development activities to serve local audiences may be flawed. It may be that teachers would be more attracted to a Center program with more of a national focus and higher national visibility.
Reflections on Reverse Site Visit Feedback

The Reverse Site Visit presentation by the Center team at NSF May 1, 2006 generated a generally positive response from the CLT program officer, who noted our success in incorporating engineering into technology education, the progress of the cohort of Fellows toward becoming a leadership cadre in the field, and the research emphasis accomplished in the doctoral program. We were, however, asked to focus and prioritize our mission and goals, to align the research framework more closely with the revised Center goals, and to strengthen the plans and protocols for the evaluation of the work of the Center.

The Management Team has reviewed the responses to the Reverse Site Visit and has discussed possible avenues of response to each of the areas of concern. Several efforts to frame Center responses are under way as this report is prepared in early June 2006. A Management Team meeting is scheduled July 7 in Chicago for face-to-face discussion and decision making on revisions in mission and goals and to identify needed changes in plans for future Center activities. The internal evaluator and the PI are drafting a request for proposals for a strengthened evaluation plan and protocol for the third year of the Center’s work. Preliminary inquiries have identified four evaluation groups that indicate an interest in receiving the RFP. Work on the refinement of the research framework was initiated at the summer workshop at the University of Georgia and will be continued by the Management Team and the Research Committee. It is expected that additional meetings of the Management Team will occur during the summer as work continues on the development of the response describing the focused goals, the revised research framework, and the revised evaluation plan. This written response will be submitted to NSF by August 30, 2006.
On-going

- Evaluation consulting in weekly NCETE staff meetings and as needed.
- Analysis of internal communication and project artifacts

December, 2005

- Developed and disseminated NCETE Professional Cohort Logic Model
- Developed and administered NCETE Core Course #1 – Cognitive Science in Engineering and Technology Education Evaluation Online Survey
- Review and comment on National Center for Engineering and Technology Education: Professional Develop Workshop Reflective Analysis

January, 2006

- Analyzed and reported on NCETE Core Course #1 – Cognitive Science in Engineering and Technology Education Evaluation

February, 2006

- Review And Comment On TTE Evaluation Documents And Evaluation Of The National Center For Engineering And Technology Education: Student Survey

March, 2006

- Developed Core Course 2 Midterm Course Survey
- Reviewed revised project goals statement

April, 2006

- Administered, analyzed, and submitted report on Core Course 2 Midterm evaluation

May, 2006

- Review external evaluator plans for summer workshop activities
- Draft UGA workshop survey
Evaluation of the National Center for Engineering and Technology Education

Year Two Report

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June, 2006
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Introduction

WestEd is a nonprofit research, development, and service agency. Our goal is to enhance and increase education and human development within schools, families, and communities. WestEd, under contract with the National Center for Engineering and Technology Education (NCETE or Center), is conducting the external evaluation to assess the development, implementation, and impact of NCETE’s activities. The goals of the Center are:

- to develop a new cadre of leaders who are engaged in research, teacher preparation, and professional development with the knowledge and skill to integrate engineering into technology education;
- to conduct research in how students learn engineering and technological aspects; how students learn design and problem solving, assessment and evaluation strategies; and how best to prepare technology teachers;
- to refocus technology teacher education (TTE) to prepare increasing numbers of new teachers, representing the diversity of the nation, who can infuse engineering principles, predictive analytic methods, and design into the K-12 schools;
- to design and deliver professional development for practicing K-12 teachers to learn to infuse engineering principles, predictive analytic methods, and design into the K-12 schools; and
- to develop methods for encouraging a diverse array of K-12 students to choose STEM careers.

Structure of the Report

In this report we provide a review of NCETE, how the Center is working toward achieving Center for Learning and Teaching (CLT) goals, and our evaluation activities and recommendations. The first section provides a brief overview of year two Center activities and our evaluation activities. The next section analyzes how Center activities are achieving CLT goals. The following section includes formative recommendations made during year two and changes or modifications the Center made as a result of our recommendations. Additionally, we provide a comprehensive list of recommendations for how the Center may want to proceed in their continued work for year three and beyond. This report concludes with our planned evaluation activities for year three.
Background

WestEd’s evaluation plan is designed to assess annually the Center’s impact and effectiveness, as well as its contribution to engineering and technology education research. Through cooperation with Center partners, WestEd is assessing if the Center’s work is fulfilling CLT’s focuses of advancing the preparation of STEM educators and establishing a meaningful partnership among stakeholders. Our formative evaluation serves to inform Center leaders of partnership development and interactions, benchmarks on product development, and service activities and structures that warrant additional development, hence facilitating NCETE effectiveness. This section outlines WestEd’s evaluation activities during the second year of the grant.

WestEd researchers attended all three Center meetings during year two: the fall meeting in Los Angeles, CA (October 2005), the spring meeting in Baltimore, MD (March 2006), and the summer meeting in Athens, GA (May 2006). Attendance at these meetings allowed us to collect valuable information about the activities and ongoing progress of the Center, as well as plans for future work. This year, we also conducted our first site visit. Part of WestEd’s evaluation plan involves conducting site visits to one of the four regional NCETE cells1. The first site visit was conducted in the southern regional cell of North Carolina A&T State University (NCA&T) and the University of Georgia (UGA) on March 28-30, 2006. The southern region was chosen as the first site visit location by the NCETE management team. During the site visits, WestEd collected data to answer specific evaluation questions (Appendix A).

Outside of these in-person meetings, numerous informal conference calls and emails facilitated communication. Conference calls were held primarily with the two principal investigators. The discussion focused on planning for data collection and announcements during meetings, as well as providing formative feedback on our findings.

Our data collection, conducted in early summer 2006, included individual interviews with the five members of the management team, focus groups with the five TTE teams, focus groups with the four graduate teams, interviews with individuals who were awarded research grants, and a focus group with the NCETE cohort one doctoral fellows. We used the interviews and focus groups to assess the extent to which Center and individual goals were met during year two, gather information about the role and impact of the different members of the Center, and collect

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1 The Center regional cells are represented by the West (California State University, Los Angeles; Utah State University; Brigham Young University), the South (North Carolina A&T State University; University of Georgia), the Midwest (University of Illinois at Urbana-Champaign; Illinois State University), and the North (University of Minnesota; University of Wisconsin - Stout).
information about the accomplishments and challenges the Center members experienced during year two.

**How Center Activities Fulfill CLT Goals**

In this section, we will review NCETE and its activities and how they fulfill CLT goals. Prior to assessing the extent to which each individual Center activity is achieved, we first clarify how each component contributes to the Center’s vision and goals. We will clarify how NCETE is intended to function as a national mechanism advancing a unified agenda. Then, we will review the three major branches of the Center – the graduate program, the technology teacher education program, and the research program – and how they individually and collaboratively address the three CLT goals. Finally, we will focus on overall Center progress for year two.

The advantage of a national center is three-fold: first, a national center is able to draw from the experience and ideas of professionals from all over the nation; second, endeavors can be undertaken that stem from a united belief system and are guided by an established plan of action; and finally, services and activities can be simultaneously implemented, eventually allowing the center to gain insight from each partner and refine its processes. This cyclical process must occur in order for improvement to occur:

Organizations that improve do so because they create and nurture agreement on what is worth achieving, and they set in motion the internal processes by which people progressively learn how to do what they need to do in order to achieve what is worthwhile. …Improvement occurs through organized social learning…. Experimentation and discovery can be harnessed to social learning by connecting people with new ideas to each other in an environment in which ideas are subject to scrutiny, measured against the collective purposes of the organization, and tested by history of what has already been learned and is known (Elmore, 2000, p. 25).

NCETE is in a position to embrace this cycle, which can ultimately help the Center become a strong, influential hub with a reputation for achieving its goals and providing a quality industry service (Figure 1).
Housed in the NCETE logic model above are the Center activities, which make up the bulk of NCETE’s utility. These activities are conducted by the three branches of the Center – the graduate program, the technology teacher education program, and the research program. Each branch is responsible for specific activities; however, many activities must work together in order to be successful both as an activity and in achieving NCETE goals. Figure 2 (below) demonstrates this interaction. The solid arrows exhibit the Center’s current interface. The dashed arrows describe interaction we propose, based on the evidence presented in this report, should be incorporated by NCETE.
Figure 2
NCETE Activities and Goals

NCETE Branches

- GRADUATE TTE
- RESEARCH

Activities

- Doctoral Students
  - Recruitment
  - Activities and responsibilities
  - Retention
- Core Course
  - Development
  - Delivery and refinement
- Professional Development
  - Development
  - Recruitment
  - Delivery and refinement
- Pre-service TTE Engineering Course
- RFP Funding Process
  - Research agenda
- Research Dissemination
  - Publications, website, conference presentations

NCETE Goals

1. Develop a new cadre of leaders
2. Conduct research
3. Refocus TTE to prepare new teachers
4. Design and deliver PD for practicing teachers
5. Encourage diverse K-12 students to choose STEM careers

CLT Goals

1. Renew and diversify the cadre of leaders in STEM education
2. Increase the number of K-16 educators capable of delivering high-quality STEM instruction and assessment
3. Conduct research into STEM education and issues of national import
We will begin clarifying the activities of each branch and how they interact with one another. Next, we will describe how specific activities help to achieve certain NCETE goals. Finally, we explain how the NCETE goals fulfill the CLT goals.

The first column of the figure outlines the three branches of the Center, which are the graduate program, the TTE program, and the research program. The primary activities of each branch are listed in the second column. The graduate program’s two primary areas of focus are the doctoral students; including recruitment, activities and responsibilities, and retention; and the development, delivery and refinement of the core courses. The TTE program’s primary activities are the professional development program, which includes program development, recruitment, delivery, and refinement. The TTE program is also developing a pre-service TTE engineering course. The research program is responsible for the RFP funding process, a process for funding research aligned with the Center’s research agenda by using a request for proposals (RFP) process. The research program also includes disseminating Center-sponsored research.

Within the graduate program, the doctoral students contribute to both the TTE professional development program and the pre-service engineering course because they are involved in the development and delivery of educational content. The doctoral students also contribute to research dissemination because they have begun to present their research at industry conferences. The dashed line connecting the core courses to the RFP funding process demonstrates a suggestion made by the fellows to embed the RFP process into their coursework both to help them advance their proposal-writing skills, and to provide them a chance to incubate and develop their research projects into potential research proposals.

In the TTE program, the first link is from the TTE program to the doctoral students. This link exists because some institutions housed in the TTE program also actively recruit candidates for the graduate fellowship program. There is also a link from professional development to research dissemination. Eventually, findings resulting from the professional development models and input received from the teacher participators on the practical implementation of what they learned will culminate in either the dissemination of a replicable professional development model or guide on how to effectively conduct NCETE-sponsored professional development with TTE teachers.

The research RFP funding process is linked to TTE professional development and the pre-service TTE engineering course because the Center’s research agenda includes how and what students learn in technology education, how best to prepare technology teachers, and assessment and evaluation, or how to gauge what students have learned. All three areas contribute directly to improving TTE instruction and professional development for technology education teachers.

The Center activities are directed at achieving the five Center goals. The fellowship program directly leads to the first goal, to develop a new cadre of leaders who are engaged in
research, teacher preparation, and professional development with the knowledge and skill to integrate engineering into technology education. The RFP funding process directly addresses the second Center goal, to conduct research in how students learn engineering and technological aspects; how students learn design and problem solving, assessment and evaluation strategies; and how best to prepare technology teachers. The TTE professional development program and the pre-service TTE engineering course work to fulfill the third goal, to refocus technology teacher education (TTE) to prepare increasing numbers of new teachers, representing the diversity of the nation, who can infuse engineering principles, predictive analytic methods, and design into the 9-12 schools. TTE professional development will tackle the fourth goal, to design and deliver professional development for practicing 9-12 teachers to learn to infuse engineering principles, predictive analytic methods, and design into the 9-12 schools. And finally, there is the fifth Center goal, to develop methods for encouraging a diverse array of 9-12 students to choose STEM careers. This final goal was not addressed by any of the Center activities. Our suggestion, which is represented by a dashed line in Figure 2, is to broaden the research agenda to encompass and attend to this goal.

The final column in Figure 2 lists the CLT goals. One or more of the NCETE goals addresses each CLT goal. However, we also have suggestions of how additional supports can be achieved. The first CLT goal, to renew and diversify the cadre of leaders in STEM education, is addressed by the first NCETE goal. We also suggest that the TTE program empower in- and pre-service teachers with leadership training and direction so they may also serve to fulfill both Center and CLT goals among peers in their own schools and districts. The second CLT goal, to increase the number of K-16 educators capable of delivering high-quality STEM instruction and assessment, is addressed by the second, third and fourth NCETE goals, which involve preparing technology teacher educators. The third CLT goal, to conduct research into STEM education and issues of national import, is fulfilled by the second NCETE goal, which will advance the research agenda, as well as the first NCETE goal, as the new cadre of leaders will be encouraged to embark upon careers in research. Finally, we suggest aligning the fifth NCETE goal with the all three CLT goals so that younger generations are inspired to pursue STEM leadership, instruction, and research.

Figure 2 illustrates how NCETE will eventually achieve its desired outcomes and their intended implications. The figure also serves as a reference for determining where Center processes are breaking down, and what these problems will ultimately affect. We will use Figure 2 as a guide throughout our analysis of the three Center branches of activity.
Graduate Program

In this section, we describe and evaluate the activities and progress of the NCETE graduate program. The section begins with a look at the doctoral students, including the retention efforts for cohort one, fellow activities and responsibilities, and recruitment planning for cohort two. This section also discusses the core courses, including the delivery and refinement of the first two core courses and the development of core courses three and four.

Doctoral Students

The NCETE graduate program introduced a number of activities in its second year in an effort to renew and diversify the cadre of leaders in STEM education. During the year, the graduate program focused their efforts on retention of cohort one doctoral students by making great efforts to build rapport and a sense of belonging among the fellows. In addition, center partners arranged for fellow involvement in teaching, the TTE program, Center research and dissemination, and graduate course planning. The graduate program activities also included planning for the recruitment of cohort two fellows.

Throughout year two, Center members helped ensure the retention of cohort one by building and strengthening rapport among the fellows, and employing activities to include the fellows and instill a sense of belonging to NCETE. First, an inaugural event for the fellows was held at the National Academy of Science (NAE) in Washington, D.C. to introduce them to each other and to NAE and National Science Foundation (NSF) personnel. The fellows also met face-to-face during the NCETE spring meeting in Baltimore, MD (March 2006) and during the summer workshop in Athens, GA (May 2006). According to the fellows, such opportunities to interact face-to-face are of great importance. To help maintain communication outside of these face-to-face meetings, the lead for the graduate program established a virtual discussion board solely for the fellows, allowing them to communicate openly with each other without the presence of the instructors. The fellows are also in constant communication via email and telephone.

During our focus group, a number of fellows commented on how individual university efforts to make them feel “special” strengthened their sense of belonging to the program. Including the fellows in planning meetings made them believe their expertise, interests, and feedback are appreciated. Having office space and access to the professors, on a professional and social level also gave the fellows a sense of collegiality with their mentors. Socially, a number of center partners invited fellows to their homes for dinner, and one partner took the fellows at his institution on an outing to a local lake.
Although some fellows were able to give multiple examples of these efforts, other fellows voiced concerns regarding equal treatment at all institutions. Students from different campuses have had different graduate experiences, and a couple of which did not include the aforementioned efforts. The graduate lead may want to meet with Center partners at each graduate institution to brainstorm pragmatic yet effective methods so all the fellows may feel appreciated.

As part of their fellowship responsibilities, a number of the fellows taught courses at their respective universities. Some of the courses taught by fellows include a master’s level engineering design course; a lab-based power, energy, and technology course; and a technology and ethics course. While the content of many of the courses the fellows taught pertained to engineering in technology education, not all related to the Center. We recommend that, if possible, the fellows teach a course related to Center aims to further address the goal of developing new leaders who will prepare teachers to infuse engineering principles and design into K-12 schools. For example, WestEd staff observed part of a pre-service course co-taught by two fellows. The course, Creative Activities for Teachers, is designed as a course for elementary education students. It is a technology education course that incorporates the engineering design process into problem-solving activities. This course is a clear link from the fellowship program to the TTE pre-service engineering course development.

The graduate program also involved fellows in TTE professional development sessions (Figure 2). Fellows from three of the four graduate institutions taught some of the TTE sessions, provided content expertise to TTE institutions, and plan to participate in summer professional development workshops. At one TTE site, fellows were asked to translate what they learned in their core courses to practitioners. They presented this information by providing a hands-on experience to the TTE professional development session participants. Fellows have been involved in plans to develop, implement, and assess the summer workshops, including helping with engineering design challenges.

NCETE plans for the doctoral students to become a group of leaders engaged in teacher preparation and professional development with the knowledge and skill to integrate engineering into technology education. Therefore, the fellowship program should mandate involvement in TTE sessions to further engage the fellows in the teacher preparation and professional development side of integrating engineering into technology education.

The development of the fellows’ identities as researchers through their research assistantships, core courses, and involvement in the request for proposals (RFP) process also promoted the Center’s research agenda (Figure 2). One fellow was awarded a research grant in the first-year RFP process. In the second year, three fellows submitted proposals. In addition, this past year, the research team actively encouraged the fellows to participate in the research
conducted at the TTE institutions. For example, in year three, one fellow will participate in the evaluation of professional development activities at a TTE partner institution. Other fellows will participate in a study examining outcomes of professional development. The fellows were also actively involved in conducting research in their core courses, which included literature reviews, designing studies, soliciting participants, and presenting the findings.

To improve their experience submitting research proposals, the fellows believed the RFP application process should be embedded into one of the core courses. Fellows could develop proposals in class using the same models used in their coursework. Creating connections between core courses and the RFP process will benefit the fellows by providing valuable feedback that will result in stronger, more focused, and more numerous proposals.

Fellows are also beginning to disseminate their research findings (Figure 2). Based on the quality of the core course research projects, Center members encouraged the fellows to present their findings at industry conferences. Three of the NCETE fellows presented results from their research studies developed in core course one. The poster presentations were given at the CLTNet Leadership Conference in Washington D.C. in February 2006. Other fellows also expressed interest in attending conferences and disseminating their research findings to colleagues in the field.

At the end of year two, Center partners began to think about recruitment efforts for the second cohort of fellows. Each institution was charged with spearheading its own recruitment efforts and the only guidance given was to “focus on diversity.” As their recruitment planning and efforts begin, NCETE must make an extra effort toward renewing and diversifying the cadre of leaders in STEM education. Cohort one has 12 fellows, five of whom come from underrepresented groups. Center members must continue to think creatively and work diligently toward increasing their recruitment of a diverse and quality second cohort. Recruitment planning conducted thus far includes discussions of advertising in industry magazines as well as on the NCETE website. In addition, the Center recruited at industry conferences such as the International Technology Education Association (ITEA) annual conference.

Because TTE institutions were involved with recruiting for cohort one, we recommend they continue fellow recruitment efforts for the second cohort. This expanded search will increase the potential for a larger pool of candidates for cohort two. We also recommend the graduate program lead follow up with each NCETE institution regarding recruitment efforts especially focusing on recruiting qualified, diverse candidates. This will not only allow the lead to gauge recruitment progress, but it will also enable him to share recruitment ideas across institutions and connect potential candidates from TTE institutions with graduate institutions.
Core Courses

During year two, the fellows completed core courses one and two. In this section, we describe the core courses and their distance delivery mechanisms, address plans and suggestions for the refinement of these courses, and discuss the development of core courses three and four.

The graduate program began its work with the first cohort with the delivery of core course one, *The Role of Cognition in Engineering and Technology Education*. It was facilitated by faculty at one institution and delivered to the other three PhD campuses via the distance learning system, Elluminate. Elluminate provides a virtual classroom with audio capabilities for real-time instruction and interaction, which allows the professor to facilitate classroom discussions. Technical difficulties at the beginning of the course were quickly resolved, and the students expressed no concerns with Elluminate. All participants were positive about the distance learning aspect of the course; however, graduate program instructors hoped to use a program that incorporated visual capabilities to enhance the distance learning experience for the fellows.

Core course two, *Design Thinking in Engineering and Technology Education*, was also completed in year two. This course was facilitated by faculty at a second institution and delivered to the other three PhD campuses via another distance learning system, Breeze. Breeze has both the audio and visual capabilities graduate program leaders desired. The screen is divided into images of the students and faculty from all four campuses, PowerPoint slides, and a chat room. A camera is positioned at each institution to capture the groups of students seated together. All participants believed this tool worked better than Elluminate, and the program plans to continue to use it for the third core course.

After completing the core courses, the fellows identified areas for improvement. For example, the fellows stated that some topics covered in core course one were repetitive, specifically involving the articles they were assigned to read. Fellows from one institution commented that the content of core course one is the same as the content of another course available at that campus. In addition, some students did not see the connection between this course and the goal of infusing engineering into technology education. The fellows also acknowledged that they possess varying levels of academic research experience and believed more research training within core course one is necessary. The professor of core course one will address these concerns for cohort two. The revised course will include material about research methods, along with smaller scale research projects to address concerns regarding prior research experience.

Fellow insight and our own observations resulted in a number of points of constructive feedback regarding core course two. The fellows thought the transition between core course one and core course two was unclear. In addition, they believed the differences in teaching style
between the two instructors who co-taught core course two disrupted the flow of the course. WestEd staff observed one session of core course two and believe the core course agenda was ambitious for the allotted time. During the session, the instructor moved through the agenda at a rapid pace in order to complete everything on the schedule, including student presentations. Student participation was limited to these mandatory presentations of journal articles and research projects, and discussion was limited. Unfortunately, when a student initiated discussion, it was not pursued by the instructor. Student discussion time should be an essential piece of each core course session to provide a forum to build community and express student insight.

Overall, fellows said that the primary focus of the courses was on philosophizing and not direct application. They admitted that even after taking the two core courses, they still did not understand the engineering design process. They also hoped their NCETE courses would address the practical classroom implementation of what they were studying, including what teachers need to know to implement engineering into their technology education courses. In their view, core course content should be kept focused on topics involving the Center itself, including the history of the field, its development, and future goals of the field. The fellows also commented that they would like more feedback on their work and would like to see it provided in a timely manner. They wanted professors at each site to be available to assist the fellows by providing this additional feedback and guidance with their classroom assignments and research projects.

Development of core courses three and four took place during year two. The PhD institution responsible for core course three held weekly planning meetings to discuss the course syllabus, materials, and planned course activities. The faculty at this institution included the fellows from their university in the planning meetings. The fellows contributed their views on what they think they, as well as other fellows, will take away from the course. These fellows noted that this inclusion helped them develop a vested interest in core course three. Core course four development will result from feedback from the reverse site visit and outcomes of core course three. Center partners may want to consider the benefits of including fellows in planning for core course four.

During year two, the graduate program retained the entire cohort of diverse first year fellows, delivered two core courses, encouraged fellow involvement in TTE professional development, and empowered the fellows to pursue research aligned with the Center’s research agenda. The fellows reported a feeling of satisfaction with the fellowship program. These activities all work toward fulfilling the NCETE goal of developing a new cadre of leaders engaged in research, teacher preparation, and professional development with the knowledge and skill to integrate engineering into technology education. However, some fellows are experiencing dissonance with choosing between becoming researchers or practitioners and expressed concern that the future direction of the program may conflict with personal goals. For example, one
fellow said, “I’m not here just to be a researcher. I want to put these things into practice. That’s the reason why I got into this program, is to practice what I’m learning.” Center leaders and the graduate team partners should address these concerns immediately, before fellows become frustrated with their graduate studies and the NCETE fellowship program. Further, at least one respondent worried that a total focus on research would limit recruitment, “It won’t lend to the goal of recruiting if everyone is sitting at an R1 institution writing papers only people from other R1 institutions will quote from.” As long as this concern is addressed and the graduate team continues to accomplish their goals and refine their activities, NCETE will continue to advance the CLT goals of renewing and diversifying the cadre of leaders in STEM education and conducting research into STEM education and issues of national import.

Technology Teacher Education Program

In this section, we present a description and evaluation of the general activities of the technology teacher education (TTE) program, concluding with how the TTE program worked towards achieving the CLT goal of increasing the number of K-16 educators capable of delivering high-quality STEM instruction and assessment. The primary activities of the TTE program during year two were to conduct professional development for TTE educators and to develop a pre-service TTE engineering course.

Professional Development

In this section, we discuss the professional development activities conducted by the TTE institutions in year two. The bulk of the effort was aimed at in-service teacher professional development sessions, though some institutions allowed their pre-service teachers to attend. Regarding the in-service sessions, we first will examine recruitment efforts, which emphasized diversity. We then discuss planned changes to the program based on our site visit findings as well as an additional suggested change not yet formally addressed by Center partners. Following, we review best practices from the year two in-service professional development sessions. To end this section, we discuss how the TTE professional development group is contributing to the research program agenda.

A variety of strategies were employed by the five institutions to recruit diverse participants for cohort two. The various methods included recruiting through professional associations, directly recruiting alumni of each university’s TTE program, asking cohort one participants to recommend colleagues, publicizing the program at industry conferences, and posting summaries and applications in journals. NCETE TTE institutions also employed a few
incentives to aid in recruitment, as well as promote retention of in-service participants. The TTE group arranged to compensate districts for substitutes so participants could leave their classrooms during the day to attend workshops. At some TTE institutions, participants received certificates of continuing education to use towards license renewal, while others received graduate credit.

The TTE program’s year two recruitment strategies were abundant; however they did not result in increased diversity compared with the year one cohort. During years one and two, the TTE program delivered professional development to 115 teachers, 21% of whom were female and 15% represented ethnic minorities (5% were female, ethnic minorities). However in year two, the percentages of female, ethnic minority, and female ethnic minority participants all decrease (see Table 1). The most significant difference between the demographics of year one and year two was in the population of African American females (five participants in year one and zero in year two).

Table 1

<table>
<thead>
<tr>
<th>TTE Program Demographics for Underrepresented Populations</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Participants</td>
<td>42</td>
<td>73</td>
<td>115</td>
</tr>
<tr>
<td>Number &amp; Percentage of Female Participants</td>
<td>13 (31%)</td>
<td>11 (15%)</td>
<td>24 (21%)</td>
</tr>
<tr>
<td>Number &amp; Percentage of Ethnic Minority Participants</td>
<td>8 (19%)</td>
<td>9 (12%)</td>
<td>17 (15%)</td>
</tr>
<tr>
<td>Number &amp; Percentage of Ethnic Minority Female Participants</td>
<td>5 (12%)</td>
<td>1 (1%)</td>
<td>6 (5%)</td>
</tr>
</tbody>
</table>

In order to continue working toward the NCETE goal of infusing engineering into technology education to a diverse body of in-service teachers, the TTE program needs to make a greater appeal to underrepresented populations in recruitment. New recruitment strategies are planned for year three. For example, some institutions plan to identify scholarships or additional funds for participants and plan to reserve some scholarships specifically for students from underrepresented populations. Institutions also plan to mass mail recruitment materials that publicize the minimum requirements for participation to reach even more potential participants then currently. Work with guidance counselors through the university admissions offices and
with local school district administration is also planned. In recruiting the third cohort, TTE partners must do more than simply employ additional strategies; they must put special emphasis on diversifying both the candidate pool and the cohort. Without this emphasis, the demographic statistics describing the third cohort may reflect the same, or even lower, numbers than the second cohort.

Based on our data collection during the site visit, the TTE faculty plans to make a few changes to their current professional development activities. During our site visit, we discovered that the professional development schedule was not ideal for many of the teachers because they did not like being absent from their classes. Although the Center provides funding for substitutes, the teachers would prefer teaching their own classes. As one participant stated, “It’s hard to get productivity from the students with substitutes.” Teacher participants suggested changing the schedule so workshops take place after school, in the evening, on weekends, or exclusively in the summer. According to the TTE lead, scheduling will be taken into consideration for year three.

During the site visit, we also conducted interviews with cohort one participants. These participants requested follow-up with their fellow cohort members and the faculty who conducted the professional development. The teachers wanted to share experiences with teachers from their cohort, as well as verify that they are implementing the material correctly.

Faculty at some of the TTE institutions made classroom visits during year two to observe implementation and student response, and other TTE institutions are also planning to conduct follow-up meetings and classroom visits with cohort one participants. To ensure proper implementation and encourage institutionalization, we recommend all TTE institutions maintain regular communication with past TTE cohort members (Birman, Desimone, Porter, & Garet, 2000).

The TTE program also plans to include more planning time for their teachers during the professional development sessions. Cohort two participants expressed concern with the time it would take to develop lessons from the professional development material. They specified a number of constraints, such as scheduling, materials, and student academic level, which needed to be considered when planning lessons. Teachers added that more guidance in delivering the lessons would help ensure effective teaching and improved student understanding. We suggest that TTE partners plan for increased discussion time on implementation and lesson preparation tailored to the engineering design process. Not only would this increase the teachers’ comfort levels, but it would also promote institutionalization. In order for in-service teachers to permanently infuse the engineering design process into their existing technology education curricula, the TTE partners must transition from providing example plans to empowering these teachers to create their own lesson plans (Fullan, 2001). Once teachers are able to create their own lesson plans, they will be able to deliver the material with confidence.
Throughout our year two data collection efforts, we identified a number of “best practices,” as identified by prior research, the TTE program currently employs. These best practices include cross-discipline collaboration, the involvement of NCETE fellows in the TTE professional development program, and improved interaction with each and among cohorts. An additional practice we would like to see continued is TTE’s internal program assessment.

The TTE program worked steadily during year two to prepare in-service teachers to infuse engineering into technology education. All the TTE teams reported that in year two, they felt more comfortable with their work and had a better grasp of the engineering content compared with year one. This past year, TTE partners consulted with academic and practicing engineers to help reinforce the engineering design process in their curricula and better explain how it differs from current technological design processes. This collaboration and clarification allowed TTE partners to identify the appropriate engineering-related content to include in their professional development courses. TTE partners should continue to collaborate with their peers from other disciplines to further improve the NCETE professional development program.

Our second identified best practice involves cross-center collaboration. Some TTE institutions included the doctoral fellows in their professional development sessions. The fellows created and presented lesson plans based on their coursework that focused on constraints, predictive analysis, and optimization. The fellows were enthusiastic about their participation in a Center initiative and enjoyed the experience and the ability to share what they learned in a core course with others.

The third best practice we identified involves the interaction between TTE leads and past cohort members, as well as between the cohorts. As mentioned above, one TTE institution already conducted classroom observations with their cohort one participants. The in-service teachers found this interaction to be extremely helpful in refining and reinforcing their lesson delivery. Regarding cross-cohort interaction, one TTE institution created a mentoring program by having cohort one and cohort two participants work closely together during the professional development sessions. The first cohort participants were excited about sharing their experiences and the second cohort found the practical insight helpful for their lesson planning. We recommended above that all TTE institutions schedule opportunities to observe their cohort one teachers. We also recommend that all TTE institutions create mentoring opportunities, or at the very least, bring the two cohorts together to share ideas on classroom implementation (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). These meetings can initiate a network of teachers who can capitalize on each other’s experiences. This network could also serve to encourage teachers to implement the professional development material in their classes.

The final best practice we identified was the TTE program’s internal program assessment. The ongoing assessment of TTE participants through anonymous surveys at the end
of each workshop and at the conclusion of the entire professional development experience served as an important reflective tool for the program. For example, teachers commented that some of their students had difficulty with the math content. TTE partners plan to respond by incorporating additional planning time so teachers can customize their lessons to include instruction that addresses students’ academic needs.

The surveys also provide positive feedback of practices participants think should continue. They saw value in a portfolio system to house the information and project work provided during the workshops. One teacher added that she intends to use the portfolio as a reference when she begins classroom implementation.

The TTE lead also plans to conduct an internal evaluation of the different professional development models from the five institutions and tease out which elements of each have been successful, thereby identifying and capturing best practices to be disseminated across the other sites. It will be important that these best practices are formally identified and recognized by the Center and adopted at all five sites. Organizational knowledge creation will contribute to the success of the TTE program as it does in industry. Research shows:

...the most successful companies were not successful due to their manufacturing prowess or human resource practices and the like, but rather because of their skills and expertise at organizational knowledge creation. Organizational knowledge creation is, “…the capability of a company as a whole to create new knowledge, disseminate it throughout the organization, and embody it in products, services and systems” (Fullan, 2001, p. 270, see also Von Krogh, Ichijo, & Nonaka, 2000, p. 3).

Such creation of organizational knowledge creation is one way the TTE professional development group can contribute to the dissemination of NCETE-sponsored research (Figure 2). As the TTE partners work to advance the preparation of STEM educators, Center partners are in a solid position to conduct research into what technology education teachers need to know, how best to prepare them, and how to teach this material to high school level students. One of the research goals for the TTE program for year three is to collaborate with both cohorts during this summer’s professional development sessions to develop research-based curricular units. A few of the TTE sites are also planning to conduct observations of other established and effective TTE professional development programs and incorporate pertinent material into their program. Regardless of intention, some TTE partners are further along in planning formal research endeavors than others.

In the future, we recommend stronger, more significant use of the TTE group as a research mechanism, especially about student learning of technology and engineering concepts.
An assessment of cohort one, cohort two, and cohort three\(^2\) activities can lead to the development of an NCETE endorsed method of delivering professional development to high school level technology teachers. Each NCETE TTE institution should not only adopt this method, but the method can also be replicated at other institutions that provide TTE programs.

*Pre-service TTE Engineering Course*

Each TTE institution is currently creating a pre-service engineering course, which will be required early in their education and expose the pre-service teachers to the application of science, mathematics, and engineering concepts. The faculty at each TTE institution is reevaluating the coursework currently required of pre-service teachers and adjusting the curriculum by requiring more math and science as needed. After the pre-service engineering courses have been implemented, the TTE lead plans to conduct course evaluations to identify best practices within these separate courses. This additional instance of organizational knowledge creation will help the TTE team eventually create a uniform program sponsored by the Center to guide the undergraduate pre-service courses across the five sites. This program will establish symmetry across the five institutions.

During year two, the TTE program continued to work toward achieving both Center and CLT goals. The TTE professional development activities address the fourth Center goal of designing and delivering professional development for practicing teachers to learn to infuse engineering principles, predictive analytic methods, and design into the 9-12 schools. The TTE program’s efforts to create a pre-service TTE engineering course addresses the third Center goal of preparing new, diverse teachers to infuse engineering principles, predictive analytic methods, and design into the 9-12 schools. As illustrated in Figure 2, the Center must fulfill these two Center goals in order to attain the second CLT goal – to increase the number of K-16 educators capable of delivering high-quality STEM instruction and assessment. Embracing the ideals of organizational knowledge creation throughout the TTE program’s service development and delivery processes will facilitate success for this branch of the Center and for NCETE itself.

\(^2\) Should the TTE program’s focus change to prioritize a research agenda, it may be beneficial to discontinue recruiting new cohorts so focus can be placed on the first two cohorts and their classrooms as “test centers.” To continue expanding the TTE program by adding on more cohorts will make it difficult to focus on research and refining the NCETE professional development program.
Research Program

The Center completed a number of research activities in the second year of operations that advanced the attainment of the Center’s research goals. In this section, we provide a description of these research activities, concluding with how the research program worked towards achieving the CLT goal of conducting research into STEM education and issues of national import. The primary activities of the research program during year two involve the RFP funding process, which includes the Center’s research agenda, and research dissemination.

RFP Funding Process

In this section, we discuss the year two RFP process, including a description of the NCETE research agenda and a progress report on the funded projects, problems encountered this past year, and future endeavors of the research program, which address how the RFP funding process supports the TTE group’s professional development program.

The research team’s RFP process served as the primary method for fulfilling the Center’s research goal. There were no major changes to the RFP process in year two. The research program continued to fund only individuals associated with the nine NCETE partner institutions. NCETE’s year two research themes, which were the same as year one, revolve around advancing the preparation of STEM educators: (1) how and what students learn in technology education; (2) how best to prepare technology teachers; and (3) assessment and evaluation. The research team met during the summer workshop to select proposals from among the six that were submitted. They provided candid feedback on the proposals to improve the quality of the research studies. They plan to award three research proposals contingent upon the revisions. Two more may be funded if they are successfully revised. The research team is mailing award letters in June.

The research team also monitored the progress of the first-year research grantees this past year. In year one, the research team awarded six one-year grants to researchers whose proposals addressed the three research themes. For example, TTE researchers at one partner institution conducted a modified Delphi study to identify important engineering outcomes that should be included in technology education curriculum for grades 9-12. Researchers at another TTE partner institution collected data on female participants in a summer pre-engineering camp for middle school girls to better understand how young women think about technology and engineering. Doctoral researchers at one partner institution developed a process for identifying critical features of engineering design within technology education and creating a rubric for evaluating the integration of engineering design. Researchers at another PhD partner institution
conducted a study examining factors that attract and retain women in engineering careers and a study of the self-management of cognition.

Feedback on the progress of the research studies was solicited twice during the second year. Research grantees submitted formal progress reports in October 2005. Of the six proposals funded in the first year, three studies were completed and several are being prepared for publication. Some researchers experienced setbacks as soliciting participants and time management proved to be challenges, consequently extending the projects longer than originally intended. The research team is continuing to monitor the progress of these studies.

The research team encountered a few minor problems during the second year, indicating a need for policies to address them. For example, researchers from one funded study had trouble recruiting participants, resulting in a change to the study plan and money left over. The researchers resubmitted a proposal for using the extra money and the additional time needed to complete the study. The NCETE research program does not have a formal process in place for these types of issues. Research grantees and the NCETE research program would benefit from a formal protocol for research extensions with rules and procedures to account for potential issues of needing more money or having funds left over and applying them to an extension of a current study.

Our data collection also produced a critique of the RFP process. According to one funded researcher, the RFP process was discouraging for first time applicants. In the future, perhaps first time applicants should be encouraged to work closely with an experienced colleague to help hone their proposal-writing skills.

A recent change in Center organization placed greater emphasis on the research component of the Center. In planning the third year RFP process, the research team will narrow the research areas to better align with NSF goals. This change calls for more research involving the TTE professional development sessions and participants, requiring classroom research. The research will focus on identifying engineering concepts needed in the classroom, and attempt to design a model that will enable the TTE program to deliver and assess the effectiveness of teaching core engineering design principles. As research in these areas is completed, the TTE team will be able to directly benefit from the findings by incorporating the research into their professional development program and pre-service course.

Research Dissemination

The research team possesses a number of outlets through which they may disseminate Center-sponsored research reports, including publications, industry conferences, and the website. However, product development for the NCETE research team has been slow. According to the
research lead, several of the first year research projects are being prepared for publication, but none have yet been submitted to journals.

The fastest and most convenient method the research team can use to publicize research findings is the NCETE website. However, plans for using the NCETE website for disseminating findings were not completed because Center leaders are concerned that posting research findings on the website might preclude further publication. Although research dissemination was weak in year two, we understand that the reflection and revision process takes time. We support the research team’s emphasis on producing quality research reports as these resources will reflect upon the Center. Regardless, the research team should prioritize streamlining the dissemination process in year three so the benefits associated with the research can be realized. For example, the research team should seek ways to include incorporating the research findings into Center endeavors and creating Center products such as publications, rubrics, and surveys.

The research team is poised to achieve both the CLT and the Center research goals. The RFP process is focused on funding projects that conduct research in how students learn engineering and technological aspects; how students learn design and problem solving, assessment and evaluation strategies; and how best to prepare technology teachers. The research is being conducted, the important next step is what to do with this information.

**Overall Center Progress**

In order for the achievements of each Center branch and each activity to hold national significance, they must work together as a united organization. Otherwise these efforts merely become the work of nine individual institutions. A number of factors must be in place in order for any multi-year, multi-institution national center to function smoothly – center-ness, communication, and momentum.

**Center-ness**

The NCETE co-PIs and center partners made concerted efforts to strengthen the level of center-ness in NCETE. Center-ness in NCETE is crucial to ensure collaboration, consistency, and intended national effect. Without Center-ness, each partner’s work becomes introverted and self-serving, and the affected population will be limited to the scope of each regional academic institution. Each of the three program areas shows a strong sense of Center awareness. In this section, we describe evidence of center-ness from year two. We organize this description by first reviewing the graduate program, then the TTE program, and finally the research program. We end this section with a discussion of the Center leaders and their efforts at achieving center-ness.
The NCETE graduate program began year two with a strong emphasis on Center unity due to excitement generated by the first fellow cohort. Between the inaugural event in Washington, D.C. and the start of core course one, the graduate program embodied center-ness. The fellows recently completed the first year as NCETE fellows during which time they were often involved in Center-sponsored activities, such as the core courses, Center meetings, TTE activities, and planning for future coursework. These efforts help develop a vested interest in the Center. However, to help solidify the graduate program, the Center must set a clear definition of what being an NCETE fellow entails. The Center must also define what each PhD institution must do to properly house a branch of the NCETE fellowship program. Although coursework is going well and some fellows are involved in Center-sponsored activities, additional requirements should be determined. For example, NCETE should address teaching responsibilities, contributions to the TTE program, research contributions, and participation in core course planning meetings that make participation in the NCETE program well rounded. While each institution brings its individual strengths to the Center, it is important for the leadership to provide a clear and consistent message about the goals of NCETE and clearly define the role of an NCETE fellow and a host institution.

Center-ness in the TTE program was apparent during our site visit. WestEd researchers observed the NCETE name and logo on materials and presentations distributed by the TTE institution. NCETE sponsorship is visible to the TTE professional development participants, but it was not clear that the in-service teachers associated what they were learning with the Center. The TTE program lead’s desire to maintain the individuality of each institution’s program is understandable; however, this works against opportunities for organizational knowledge creation. In the future, and as the TTE program begins to develop the pre-service TTE engineering course, it should continue NCETE’s visual presence, but begin to establish a presence in the professional development content as well. Pre-service TTE programs should be tapped into as a source of future leadership to be developed by the Center, as well as a means to establish Center credibility among a future generation of technology educators who possess the knowledge to incorporate engineering principles into their pedagogy.

The best method the NCETE research program can employ to promote center-ness is to increase awareness of the center as a national source of research funding, as well as a source of the latest research in engineering and technology education. Researchers at each institution, including those not directly involved with the center, are continuing to apply for research funds to progress the Center’s research agenda. Response to the RFP solicitation is strong, indicating that the research grant is well publicized amongst the NCETE institutions and as a national funding source. The next step in increasing Center awareness is publicizing NCETE-endorsed research. Increased center-ness resulting from the research program will occur once Center
members can rally around published research reports sponsored by NCETE. The effect can be strengthened if Center leadership publicize the published reports among Center members through the website and by distributing a professionally printed copy of the article or report to each individual. As each funding cycle passes and Center-funded research is published and otherwise publicized, the Center will become more synonymous with significant research in the engineering and technology education field. As a result, the Center will be accepted and respected as an industry research resource.

There is a strong level of center-ness among the Center leadership team. They have instituted efforts such as NCETE apparel, Center-wide meetings, and attendance at industry conferences to instill center-ness throughout the partnership. From these efforts, partners are now taking the next step by involving the Center in other industry-related endeavors, such as the recently funded national symposium to develop an effective model for the professional development of K-12 engineering and technology education teachers, and university sponsored technology education conferences. However, Center leaders should think of additional ways to develop center-ness in NCETE, as well as to ensure each branch is prioritizing center-ness in its efforts. As long as Center partners have confidence in and a vested interest in NCETE, the Center will continue to grow as a decisive resource in the fields of technology education and engineering.

Communication

Communication throughout the Center remained strong during the second year of operations. Teleconferences and email remain the staple in informal communication and have proven effective in ensuring day-to-day activities are completed. All Center partners, including the fellows, employ these communication methods regularly to conduct business and exchange ideas. However, the most valuable communication comes through three annual center-wide face-to-face meetings. These meetings are crucial for enlightening all Center members on current and future activities, as well as for exchanging concerns and ideas.

The internal evaluation of meeting effectiveness produced key findings to further strengthen Center communication. One major finding, which shaped the structure of subsequent meetings, was that Center partners did not want to be broken up into separate sub-committee meetings during their annual meetings. They preferred to stay together to hear about the business of each branch. This allowed them to get a clear picture of what the Center was doing as a whole. Conducting this survey annually would be useful for continuing to improve Center communication and to conduct future planning. The face-to-face leadership team meetings
should also continue as they are an efficient method by which higher level decision-making can occur.

Communication breakdowns, if left unfixed, may hinder future program development in a few areas. First, many of the TTE members are enthusiastic about moving into pre-service education by developing a pre-service engineering course. As these courses are developed at the five institutions, TTE program leaders should communicate with one another to develop guidelines so institutions may systematically gauge the effectiveness of their courses, as well as consider how to improve the program in the future. In addition, one fellow reported that in response to discussions of the fellows pursuing solely research endeavors, TTE partners expressed their interest in maintaining a focus on preparing teachers and improving the practice of existing teachers. Fellows received both the message about the importance of research careers and the message about the importance of careers in teacher education. Such mixed messages add to the dissonance discussed earlier. After Center leadership incorporates NSF suggestions made at the reverse site visit and refines NCETE’s activities, they should develop a new mission statement with revised Center goals reflective of these changes. This mission statement should then be distributed and discussed with all Center partners, including the fellows.

The NCETE website is an ideal method to communicate Center accomplishments and announcements to the general public. Therefore it is important to maintain the site and keep the content as updated as possible. During our interviews, Center leaders admitted they have been too busy to maintain the website to the degree they would like. We recommend potentially passing the responsibility to another partner or fellow who has more time to devote to keeping the site updated.

Communication maintenance is crucial for Center progress. The internal evaluator may want to consider assessing where breakdowns occur and helping Center leadership create a point person to facilitate smooth communication across the board.

Momentum

NCETE is ending a year of tremendous momentum generated from the excitement built in year one and partially maintained by the enthusiasm produced by the first cohort of fellows. The partners all seemed motivated to fulfill their Center roles and perfect their processes. Graduate program partners are showing a high level of motivation in their planning process for the third core course. They are including graduate students in the planning process and incorporating colleagues located internationally into the curriculum. The drive of the Center partners to continue reevaluating and refining their activities (Figure 1) is what will make the Center strong in years to come.
As the Center embarks on its third year, it will be crucial to diligently involve all three areas, especially with some partners leaving, institutions on hiatus from delivering core courses, fellows beginning their second year of the program, and certain Center activities becoming routine. Center leadership should keep all members focused on constant development and maintain the drive for constant refinement and improvement, especially with the induction of the second cohort of fellows and as the feedback received from the 2006 reverse site visit is incorporated.

**Year Two Formative Recommendations**

The following section includes recommendations made during year two, and changes or modifications the Center made as a result of our recommendations. Our formative evaluation serves to inform Center leaders of partnership development and interactions, benchmarks on product development, and service activities and structures that warrant additional development, hence facilitating NCETE effectiveness.

During year one, WestEd recommended that the Center make a “big splash” with the doctoral fellows to publicize the Center and make the fellows feel special. The Center held an inaugural event for the fellows at the National Academy of Science in Washington, D.C. to introduce them to each other and to NAE and NSF personnel. The fellows were included in the spring meeting at ITEA in Baltimore, where NCETE sponsored a reception in their honor. Fellows also attended the NCETE summer workshop at the University of Georgia. In addition to Center efforts, individual university efforts to make the fellows feel special have proved valuable to their sense of belonging to the program.

The bulk of our formative recommendations can be found in our first site visit report (Appendix A). Center leaders addressed a number of our recommendations by the time we conducted our final data collection effort during the summer workshop. WestEd recommended the TTE program create a transition plan for providing lessons to the teachers and empowering teachers to create their own lesson plans that incorporate the engineering design process. Based on this recommendation, some TTE sites plan to include more lesson planning time for the summer professional development sessions. WestEd also recommended the cohort one and two participants be brought together to share ideas for implementing the material in their classes, starting a network of teachers who can capitalize on each other’s experiences and begin exploring mentoring opportunities. Some TTE institutions have since planned meetings for participants from cohorts one and two. Finally, based on teachers’ scheduling conflicts, we recommended that the TTE program schedule spring workshops at school sites and/or after
school at the university lab so teachers do not miss class. The TTE lead said he plans to take scheduling into consideration for cohort three.

Recommendations

In this section, we offer recommendations to support the success of NCETE. These recommendations are based on findings in this report. Additional recommendations resulting from our year two data collection efforts can be found in the Site Visit One report (Appendix A).

Graduate Program

• Allow student discussion time in each core course session to provide a forum to build community and express student insight.

• Continue to create opportunities for the fellows to interact face-to-face at events such as conferences and other NCETE meetings.

• Continue to include fellows in TTE sessions to further engage them in preparing teachers to integrate engineering into technology education.

• Fellows’ recommendations regarding the core courses:
  o Embed the RFP process into coursework to help fellows improve their proposal-writing skills and provide them a chance to incubate and develop their research projects into potential research proposals.
  o Consider the benefits of including fellows in planning for core course four.
  o Differentiate between content of NCETE courses versus content that can be acquired from other courses at the fellows’ respective universities. Content should be kept focused on Center goals including the history and development of the Center and its aims for the future.
  o Ensure professors at each graduate institution are available to assist fellows by providing feedback regarding coursework in a timely manner.

• Have fellows teach courses related to Center aims, rather than courses unrelated to NCETE.

• Hold a meeting of the graduate team and Center partners at each graduate institution to brainstorm pragmatic, yet effective methods to make all fellows feel “special” and appreciated.
• Follow up with all NCETE institutions regarding recruitment efforts, ensuring efforts are focused on recruiting qualified, diverse candidates.

• Define what being an NCETE fellow entails, including teaching responsibilities, contributions to the TTE program, research contributions, and participation in planning meetings.

• Provide a clear and consistent message about the goals of NCETE and set good examples of cross-institutional collaboration for the fellows.

• Communicate with fellows regarding feelings of dissonance about choosing between research and practice in their future endeavors, as well as changes in the direction of the NCETE program.

Technology Teacher Education Program

• Continue to conduct internal program assessment based on participant surveys.

• Continue to collaborate with peers from other disciplines to further improve the NCETE professional development program.

• Empower in- and pre-service teachers with leadership training and direction so they fulfill NCETE and CLT goals amongst peers in their own schools and districts.

• Make a greater appeal to underrepresented populations in future recruitment efforts.

• Maintain regular communication with past TTE cohorts.

• Transition the professional development programs from providing example lesson plans to empowering teachers to create their own lessons plans in order to institutionalize TTE program efforts.

• Create uniform guidelines for the in-service professional development sessions and the pre-service course that are representative of the Center to implement across the five sites, rather than offering different courses.

• Adopt a mentoring program, or have all TTE cohorts meet to share ideas on practical classroom implementation.
• If the TTE program is reorganized and used as a mechanism for conducting research, discontinue recruiting new cohorts so focus can be placed on the first two cohorts and their classrooms as “test centers.”

• Continue to identify best practices in TTE professional development and disseminate them to all five sites.

• Observe and test established TTE program models and incorporate pertinent material into NCETE’s professional development.

Research Program

• Prioritize streamlining the dissemination process in year three so the benefits associated with the research can be realized. For example, seek ways to include incorporating the research findings into Center endeavors and creating Center products such as publications, rubrics, and surveys.

• Broaden the research agenda to encompass the fifth NCETE goal – to develop methods for encouraging a diverse array of 9-12 students to choose STEM careers.

• Encourage first-time applicants to work closely with an experienced colleague to help demystify the RFP process and buffer against possibly discouraging revisions.

• Use the TTE program as a research mechanism.

• Create a formal protocol for research extensions with rules and procedures to account for potential issues such as needing more money, having funds left over, and granting extensions to current studies.

Overall Center Progress

• Maintain a visual NCETE presence (i.e., logo) and a content-imbedded presence (i.e., “NCETE-endorsed” label) in all instructional and professional development models sponsored by NCETE.

• Tap pre-service TTE programs as a source of future leadership to be developed by the Center, as well as a means to establish Center credibility among a future generation of technology educators.
• Continue to develop center-ness on a macro level (Center-wide) and a micro level (within the three branches).

• Publicize published research associated with the Center among Center members by highlighting the occasion on the website and distributing a professionally printed copy of the article or report to each individual.

• Continue to conduct internal evaluation efforts to strengthen communication practices.

• Maintain the website as an updated resource for academic and industry peers.

• Develop a new mission statement and goals that are reflective of changes to the Center. Discuss these changes with all Center partners, including the fellows.

• Continue to hold face-to-face leadership team meetings.

• Keep all members focused on constant development and maintain the drive for constant refinement and improvement.

• Align the fifth NCETE goal with the all three CLT goals so that younger generations are inspired to pursue STEM leadership, instruction, and research.

**Year Three Evaluation Activities**

In this section, we will detail our evaluation activities for year three. Our data collection conducted this past year will closely resemble our data collection activities planned for year three.

We plan to attend the Center management council meeting scheduled for July 2006, the October 2006 fall planning session at the University of Wisconsin – Stout, the March 2007 meeting in San Antonio, TX, and the 2007 summer conference scheduled for May, which will be co-hosted by the University of Illinois at Urbana-Champaign and Illinois State University.

Over the course of year three, we will communicate with the TTE group regarding its efforts to work with both in- and pre-service teachers. We will gather information from the TTE lead to gain insight into the overall progress of the TTE program and any developments in the program’s work scope. Our evaluation will also consist of additional interviews and surveys of TTE team members, workshop participants, and students at the five TTE institutions. Our first activity will be to survey the cohort two TTE workshop participants during their summer 2006 professional development week.
For our evaluation of the graduate program, we intend to collect qualitative data in the form of interviews and focus groups. Our data collection will assess the PhD fellows’ year two experiences in the PhD program, including their efforts outside the classroom, as well as their interest in pursuing careers in education and research. We will also be monitoring the development and delivery of core courses three and four. During year three, another primary activity we plan to examine is the recruitment of the second cohort of NCETE fellows.

Our second site visit will occur in year three. The NCETE management team will select one graduate institution and one TTE institution in the same regional area for our second site visit. During this visit we plan to conduct a number of qualitative activities including observing a NCETE graduate core course, interviewing the on-site fellows, observing a TTE workshop, and interviewing the workshop participants. During year three, we will also be conducting document reviews of the Center’s research contributions and progress in the field of STEM education.
References


Appendix
Evaluation of the National Center for Engineering and Technology Education

Site Visit 1 Report
Southern Region:
North Carolina A&T State University
University of Georgia

Naida Tushnet, Program Director
Jodie L.S. Hoffman, Project Director
Jaclyn Ziobrowski, Research Associate
Isabel Ochoa, Research Assistant

April, 2006
Introduction

WestEd is a nonprofit research, development, and service agency. Our goal is to enhance and increase education and human development within schools, families, and communities. WestEd, under contract with the National Center for Engineering and Technology Education (NCETE or Center), is conducting the external evaluation to assess the development, implementation, and impact of NCETE’s activities. The goals of the Center are as follows:

- to develop a new cadre of leaders who are engaged in research, teacher preparation, and professional development with the knowledge and skill to integrate engineering into technology education,
- to conduct research in how students learn engineering and technological aspects; how students learn design and problem solving, assessment and evaluation strategies; and how best to prepare technology teachers,
- to refocus technology teacher education (TTE) to prepare increasing numbers of new teachers, representing the diversity of the nation, who can infuse engineering principles, predictive analytic methods, and design into the K-12 schools,
- to design and deliver professional development for practicing K-12 teachers to learn to infuse engineering principles, predictive analytic methods, and design into the K-12 schools,
- to develop methods for encouraging a diverse array of K-12 students to choose STEM careers.

Structure of the Report

In this report, WestEd presents the results of Site Visit 1. The first section provides a background on WestEd’s evaluation plan and the regional breakdown of the Center. The next section provides summaries of the evaluation activities conducted during the site visit and our findings. Additionally, we provide a summary list of recommendations for how the Center might want to proceed in its continued work.

Evaluation Background

WestEd’s evaluation plan is designed to assess annually the Center’s impact and effectiveness, as well as its contribution to engineering and technology education research. Through cooperation with Center partners, WestEd will assess if the Center’s work is fulfilling CLT’s focuses of advancing the preparation of STEM educators and establishing a meaningful
partnership among stakeholders. Our formative evaluation serves to inform Center leaders of partnership development and interactions, benchmarks on product development, and service activities and structures that warrant additional development, hence facilitating NCETE effectiveness.

Part of WestEd’s evaluation plan are yearly site visits to one of the four regional NCETE cells. During the site visits, WestEd will collect data to answer specific evaluation questions (Table 1).

The Center regional cells are represented by the West (California State University, Los Angeles; Utah State University; Brigham Young University), the South (North Carolina A&T State University; University of Georgia), the Midwest (University of Illinois at Urbana-Champaign; Illinois State University), and the North (University of Minnesota; University of Wisconsin - Stout). Site Visit 1 was conducted in the southern regional cell of North Carolina A&T State University (NCA&T) and the University of Georgia (UGA) on March 28-30, 2006. The southern region was chosen as the first site visit location by the NCETE management team.
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<td>Observe TTE Professional Development at NCA&amp;T</td>
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<td>and specifically, what in NCETE’s work has affected participants’ knowledge of content and pedagogy relevant to engineering and technology education?</td>
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Evaluation Activities

In this section, we present summaries of the evaluation activities conducted during the site visit and our findings organized by Center Area. The evaluation activities conducted are based upon the programs being implemented in the institutions.

Technology Teacher Education

Summaries

Observe Year 2 TTE Professional Development Workshop at North Carolina A&T State University

WestEd staff observed a professional development workshop at NCA&T. Eleven people (9 male, 2 female) participated in the session. According to the facilitators, the goal was for participants to capitalize on their individual strengths while working in groups and to follow the engineering design process to optimize their solution to the mini design challenge.

The session began with a discussion between facilitators and participants on how the material from the previous workshop can be implemented in the classroom. Following the discussion, an engineering faculty member gave a brief lecture on the engineering design process. Participants were then put into groups based on their individual strengths and knowledge and given a mini design challenge.

The session observation began at 8:30am and concluded at 2pm. This workshop was the participants’ third spring session. After this meeting, participants will not meet again until the summer workshop.

Focus group with TTE Cohort 2 at North Carolina A&T State University

WestEd staff conducted a focus group with TTE Cohort 2 from NCA&T. The focus group consisted of 11 participants (9 male, 2 female) representing five school districts. All participants are technology educators. Some have prior experience in the field of engineering while others were trained specifically in technology education. Many of the participants were NCA&T graduates or had taken post-baccalaureate courses at NCA&T.

Observe high school technology classroom of TTE Cohort 1 participant
WestEd observed a high school technology course at Atkins Academic and Technology High School in Greensboro, NC, in order to see how the material from the TTE professional development was implemented. The course, Fundamentals of Technology, is delivered to ninth and tenth grade students. The educator for this course is a Cohort 1 participant.

WestEd staff observed 15 students (7 male, 8 female) during one class session (85 minutes). During the observation, students worked in groups on a circuit problem given by their instructor the week before. Students created decision matrices on the computer and then drew the circuit designs on paper. Some students plugged circuits into breadboards. Students documented their assignment using PowerPoint as part of their class portfolio. While the students were working, the teacher walked around the room and guided student learning and work. She assisted students with the application or materials they were using.

Interviews with TTE Cohort 1 participants

Interviews were conducted with two TTE Cohort 1 participants. One participant is a teacher at Atkins Technology High School and has a Bachelor of Science in technology education from NCA&T. The other participant teaches at Eastern Guildford High School and is in his second year of teaching. Prior to teaching, he worked as an engineer.

The teachers chose to participate in the professional development for a number of reasons: the desire to learn to integrate engineering, science, and mathematics into their technology programs, as well as to gain new activities to use in their classrooms.

Findings
Lesson Plans

Prior to the professional development observation, NCA&T faculty informed WestEd staff that the goal of the professional development is for the participants to take the engineering design process into their classrooms and apply it to their existing lessons. Based on focus group feedback, however, just a few participants were taking away the process. More were planning on taking back actual lessons.

Focus group participants asked for either more planning time to tailor the lessons to their classes or to be provided with the lessons to take back to their classrooms. When writing the lessons, the constraints of time, materials, and level of students in their classes should be taken into consideration. The teachers from Cohort 1 believed more assistance in using the lessons would help ensure effectiveness of delivery by the teacher and understanding by the students.
If the goal is to apply the engineering design process to their existing lesson plans, Center members must have a clearer plan to transition from providing example plans for teachers to empowering teachers to create their own lesson plans. Allowing more time for discussion between facilitators and participants on implementing the material presented at the workshop and discussing how to write lessons tailored to the engineering design process would ease these concerns. Institutionalization of TTE efforts would benefit from a clearer longitudinal plan of action.

Cohort Reunion and Interaction

According to the focus group participants, the most appealing aspect of the professional development was the opportunity to share and gain ideas from fellow educators for infusing engineering into technology education. Participants believed it would be helpful to see how individuals from Cohort 1 were implementing what they learned from the workshops. They would like the opportunity for both cohorts to meet to share ideas and experiences, especially with those teaching in schools with similar demographics. Cohort 1 participants also believed it would be useful to bring back their fellow colleagues to share ideas and experiences after they had time to implement what they learned in their classes.

Communication with School Districts

Focus group participants were content with the level of communication by NCA&T faculty with district and school administrators. This communication helped to inform administrators of the importance and benefits of the program and eased apprehension about allowing their staff to participate in the workshops. However, participants expressed concerns about availability of materials to use in the classroom, and some participants believed that more communication with administration by the NCA&T faculty could lead to more funding for technology education classes.

Scheduling

Cohort 2 participants expressed appreciation for having the majority of the sessions take place in the summer. The spring sessions were difficult to attend because participants did not like to miss their classes. Cohort 1 participants added that in the summer they could devote more time
and attention to the workshops than they could in the spring. Evening or weekend sessions during the spring may remedy the problem of teachers missing class to attend the workshops.

Session Culture

A climate of respect for participants’ contributions pervaded the professional development session. Participants showed no signs of hesitation in generating ideas and contributing to discussions. Participants were respectful of each other’s strengths and listened intently to each other’s ideas, creating a collaborative working environment both among participants and between facilitators and participants. Continuing this culture of respect and sharing is critical in a program that emphasizes people’s strengths and experiences.

NCETE Visibility

NCETE logos were visible on PowerPoint displays, handouts, and the facilitators’ shirts at the professional development session. The Center was mentioned often during the discussion portion of the session. As a result, participants saw a connection between the Center and the NCA&T professional development, an important part of building a national center.

Student Response

Two participants from Cohort 2 had already begun implementing the engineering design process in their classes prior to attending the professional development sessions, and the workshops helped them incorporate the engineering design process into current lesson plans. As a result, they believe there has been an increase in student interest, performance, and success in optimizing the solution.

Cohort 1 participants incorporated some aspects of the TTE professional development in their classes. One teacher used the PowerPoint slides from the professional development to help integrate engineering design into his technology classes. The other teacher requires her students to create an extensive classroom portfolio. She uses the portfolio she created in the workshops as an example portfolio and to share her own experiences with the design challenges. She noted that the advanced students seem to enjoy the activities and are challenged intellectually by the problems. However, some design challenges are too advanced for other students in her class.
Both teachers noted an increase in student engagement in their classes that they attribute in part to the materials from the workshop.

**Graduate Program**

*Summaries*

**Interview with University of Georgia NCETE Fellows**

WestEd staff conducted an interview with the University of Georgia NCETE Fellows. Their responses to the Fellows Focus Groups Protocol will be compiled with those of the entire PhD cohort during a focus group WestEd will conduct at the NCETE Summer Workshop. A summary of these responses will be included in the final Year 2 Report.

**Observe Core Course 2**

WestEd staff observed NCETE’s PhD Core Course 2, Design Thinking in Engineering and Technology Education, at the University of Georgia. The course is facilitated by faculty at the University of Minnesota and is delivered to the other three PhD campuses via the distance learning system, Breeze. Breeze has audio and visual capabilities to aid delivery. The screen is divided into images of the students and faculty from all 4 campuses, PowerPoint slides, and a chat room. A camera is positioned at each institution to capture the groups of students seated together. The observed class was the tenth session of this course.

The class began with the instructor giving an introduction and an agenda for the session. Students from each school then presented a review of a pre-selected article. Following the article reviews, students presented their class research projects using PowerPoint presentations.

**Observe Undergraduate pre-service course facilitated by NCETE Fellows**

At UGA, WestEd staff observed part of a pre-service course co-taught by the UGA Fellows. (This class observation was not included in WestEd’s original site visit agenda and was not observed according to a standard protocol.) The course, Creative Activities for Teachers, is designed as a pre-service course for elementary education students. This is a technology education course that incorporates the engineering design process into problem solving activities for these future teachers.
Findings

Student Discussion

The Core Course agenda was ambitious for the allotted time. The instructor moved through the agenda at a rapid pace in order to complete everything on the schedule, including student presentations. Student participation was limited to these mandatory presentations of journal articles and research projects, and limited discussion. Unfortunately, when a student initiated voluntary discussion, it was not pursued by the instructor due to time constraints. Occasionally, class communication was hindered due to the distance learning system. There is a slight lag time in the audio delivery, and, at times, more than one person would be talking yet only one person could be heard. Student discussion time should be an essential piece of each Core Course session to provide a forum to build community and express student thought.

Cross-institution collaboration

The Core Course student presentations provided many examples of collaborative work between students at their respective institutions. However, cross-institution collaboration was not common. For example, at the conclusion of the class, the instructor assigned articles for the following week to pairs of students, and for the most part, students chose to work with the students at their same institution. More mandatory cross-institution collaboration initiated by the instructors and facilitated through class projects would benefit the PhD students and the Center as a national community of scholars and researchers.

Link between the Fellows and the TTE program

The Center had difficulty establishing a direct link between the TTE professional development focus and the graduate program. The Center proposed research projects or other collaborations to help bridge this gap. In searching for a connection, the UGA pre-service course provides an excellent example of a link between these two NCETE concentrations. The pre-service teachers in this class are being exposed to the application of science and mathematics in class activities early in their education. With one of the goals of the Center to develop methods to generate interest in K-12 students to choose STEM careers and to prepare new teachers to infuse
engineering principles and design into K-12 schools, this class is exactly the kind of activity the Center needs to be actively pursuing at all campuses with an undergraduate education program.

Research

Summary

Interviews with Research Grantees at North Carolina A&T State University and the University of Georgia

WestEd staff conducted two interviews with research grantees at NCA&T and UGA. NCA&T researchers conducted a modified Delphi study to identify important engineering outcomes that should be included in 9-12 technology education curriculum. Researchers at UGA developed a process for identifying critical features of engineering design within technology education and creating a rubric for evaluating the integration of engineering design. This rubric is to be used by teachers and students as a reference for decision making and helping to set expectations.

Findings

Research Results

Results from both studies will be used to further examine and revise the TTE professional development conducted by all NCETE TTE campuses. The recycling of the research findings into Center activities is a positive step in the NCETE research agenda. By investing the findings into Center activities, the Research team is contributing to the production of quality research projects that adhere to NCETE research goals.

Research Protocol

Researchers from one of the studies encountered problems recruiting individuals to participate, resulting in a change to the study plan and money left over. The researchers now need to resubmit a proposal for how the extra money will be used and the additional length of time needed to complete the study. The NCETE research program does not have a formal process in place for these types of issues. Research grantees and the NCETE research program would benefit from a formal protocol for research extensions with rules and procedures to account for potential issues of needing more money or having funds left over.
Recommendations

In this section, we offer a summary of recommendations to support the success of NCETE. These recommendations are based on findings from Site Visit 1.

**Teacher Technology Education**

- The TTE program should create a transition plan for providing lessons to the teachers and empowering teachers to create their own lesson plans that incorporate the engineering design process.

- After the summer TTE sessions, bring Cohort 1 and 2 participants together to share ideas for implementing the material in their classes. This meeting can be the start of a network of teachers who can capitalize on each other’s experiences and begin exploring mentoring opportunities.

- Increase communication between school district administration and TTE faculty to build close partnerships and possibly help create more opportunities for funding in technology education classes.

- Schedule TTE spring workshops at school sites and/or after school at the university lab to avoid scheduling conflicts with teachers missing class to attend professional development.

**Graduate Program**

- Student discussion time should be an essential piece of each Core Course session to provide a forum to build community and express student thought.

- Build cross-institution collaboration into the Core Courses through class projects to develop a community of young scholars who can draw upon each other’s strengths and experiences.

- Pursuit of a defined link between the NCETE graduate program and TTE program should be a primary item on the Center’s agenda. Through the Fellows’ research projects, undergraduate TTE courses taught by PhD students, or other such collaborations, this link needs to become a well-defined aspect of the Center.

**Research**

- Create a formal protocol for research extensions with rules and procedures to account for potential issues of needing more money or having funds left over and applying them to an extension of a current study.