National Center for Engineering and Technology Education

Review of Leadership Capacity

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Introduction

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

Inverness has developed a particular perspective on leadership through our study of CLTs. Our point of view is not limited to the traditional notion of people with followers; rather, we see leaders as people who have the ability, propensity, and expertise to contribute to the improvement of the domain in which they are situated. For example, a leading teacher is not only teaching in the classroom, but has the ability to contribute to the improvement of teaching. A leading faculty member is a faculty member in a university who has the ability and predisposition to contribute to the improvement of their particular area of scholarship, and to support the development of graduate students and scholars new to the field. Graduate students in CLTs are studying problems and issues of the domain such that they gain the knowledge and expertise to launch a career in the improvement of the domain and therefore, have the potential to become leaders. One of the key outcomes of CLTs, therefore, is the development of a diverse group of people who can become part of "the improvement community"[1] for that domain. It is in this light that we explore NCETE's accomplishments with respect to the development of leadership.

In this document, we highlight the ways and extent to which NCETE has fostered leaders to shepherd the domain of engineering-infused technology education. We provide an overview of the Center's various efforts to develop leadership, as well as a range of perspectives on the efficacy of those initiatives. Finally, we review NCETE's approaches to and activities for developing leadership among its students, faculty, post-doctoral students, and the broader community. The primary

[1] St. John, M. and Stokes, L. (2008) Investing in the Improvement of Education: Lessons Learned from the National Writing Project. Available at: http://www.inverness-research.org/abstracts/ab2008-12_Rpt_NWP_ImprovementInfrastructure.html.

audiences for this document are Center leadership and potential funders of future leadership development projects.

Data sources and methods

Our data sources and collection methods for this report included:

1) Initial focus group interviews with both cohorts of doctoral students

2) Interviews (three) and surveys (two) of doctoral students, regarding the opportunities they had to develop their leadership capacities

3) Interviews with faculty members, regarding their own opportunities to develop their leadership capacity and how they encouraged leadership development among the doctoral students

4) Interviews with field experts that explored, in part, the extent and ways NCETE has built leadership capacity in the field

5) Interviews with Seed Grant recipients

6) Interviews with doctoral graduates with jobs

Overview of report

This report summarizes the various formal and informal efforts of the Center to build and support leadership in the domain. By "domain," here we are referring to the members of the field who work to infuse engineering design principles into technology education. In this report, we highlight a range of perspectives on the quality, cohesiveness, rigor, and contribution of the different leadership-development initiatives of NCETE, including the research strand of the Center. Perspectives include those of the doctoral fellows from both cohorts; doctoral fellows who have graduated and are currently employed; NCETE faculty advisors; seed grant recipients; faculty and students engaged in research at NCETE institutions; experts in the field we interviewed regarding the Center's work in this domain; and external expert reviewers we recruited to review the Center's research portfolio. After providing a review of perspectives on NCETE's efforts within leadership development, we offer our own perspectives on the Center's progress in creating and maintaining leadership capacity, and discuss potential future directions.

Leadership Development Initiatives of NCETE

In the following paragraphs, we underscore the key efforts the NCETE offered to build leadership among the Center participants, and throughout the technology education community. We focus on two major efforts:

- The doctoral programs at the University of Georgia, University of Illinois at Champaign-Urbana, University of Minnesota, and Utah State University, and leadership opportunities for doctoral fellows outside of the formal doctoral programs
- Faculty leadership opportunities

The Doctoral Programs

A total of 17 Doctoral students were admitted to four degree-granting universities participating in the Center over the life of the grant. Each university offered different programs for eligible students. From the NCETE website:

- **The University of Georgia** offers a PhD in Workforce Education, which prepares individuals for leadership, university teaching, and other roles in career and technical education.
- **The University of Illinois at Urbana-Champaign** offers a PhD in Human Resource Education, which prepares individuals for leadership roles and faculty positions that requires the use of the tools and concepts of inquiry and analysis in activities such as research, evaluation, and curriculum development.
- **The University of Minnesota** offers a PhD in Work and Human Resource Education, which prepares individuals for professional roles that emphasize conducting research.
- **Utah State University** offers a PhD in Curriculum and Instruction with an emphasis in engineering and technology education, which is primarily chosen by people who are seeking teaching/research positions in colleges and universities.

Over the years, we have interviewed and surveyed the doctoral students about their experiences at their home universities, the quality and value of Center-related courses, events, and other experiences, and their reflections on the extent and ways the Center has prepared them for leadership in the field. The following paragraphs summarize some of the key findings from our studies of the doctoral students.

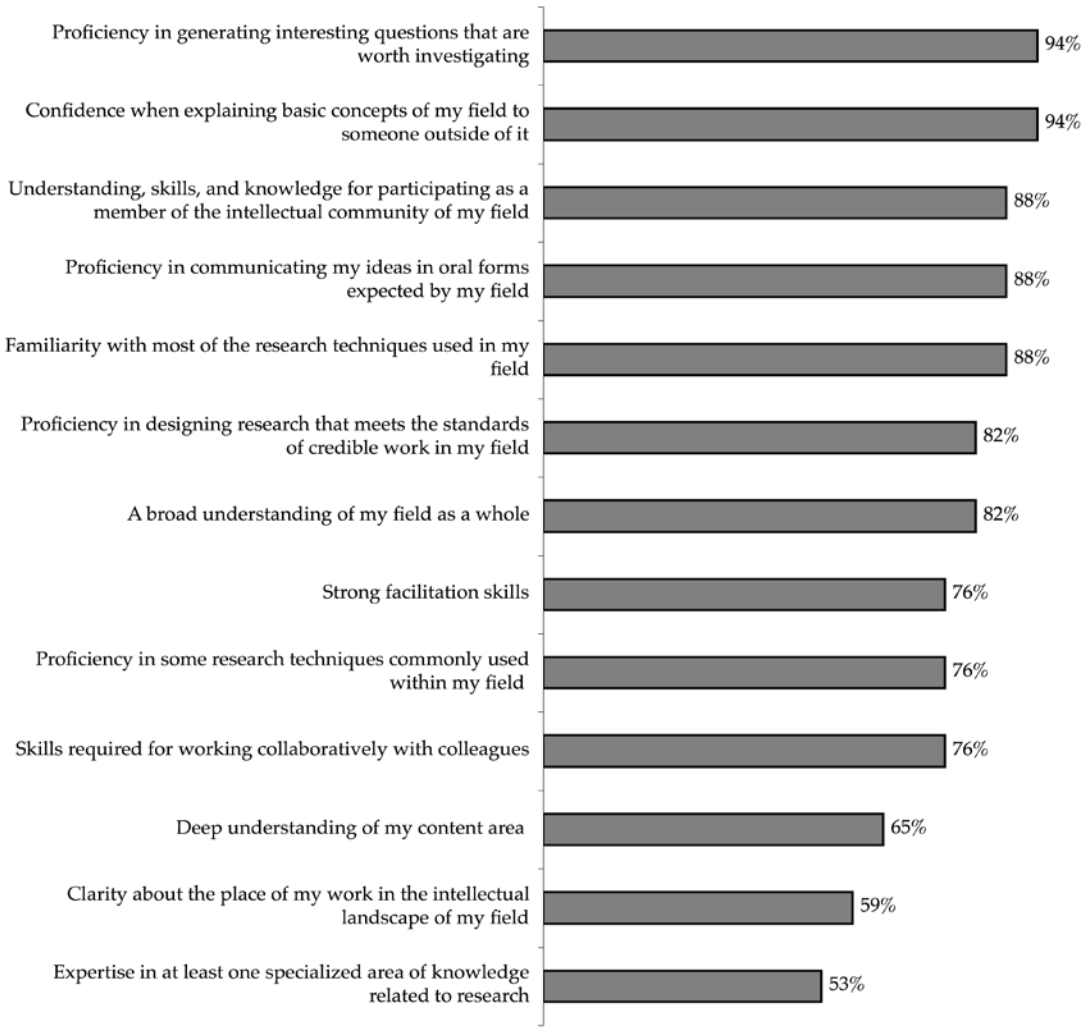
For the most part, the doctoral fellows believe NCETE prepared them to be effective leaders in the field. The vast majority of them reported that NCETE has equipped them to a large or very large extent with understandings in areas that prepare them to play a leadership role in the field, such as: confidence when explaining basic concepts of the field to someone outside of it; proficiency in generating interesting questions that are worth investigating; familiarity with most of the research techniques used in the field; proficiency in communicating ideas in oral forms expected by the field; understanding, skills, and knowledge for participating as a member of the intellectual community of the field; a broad understanding of the field as a whole; and proficiency in designing research that meets the standards of credible work in the field.

> *From a knowledge and skills perspective I feel prepared to eventually assume a leadership role in my field. I have made many good contacts in the field, and have discussed field issues at length with many of these people, which I think is an important gauge of how my ideas and skills fit into the field. I think I have a good understanding of methodological processes used in the field, and can understand, interpret, and synthesize literature with accuracy and confidence.*

The areas where NCETE doctoral fellows were less confident include having gained a deep understanding of their content area, clarity of the place of their work in the intellectual landscape, and expertise in one specialized area.[2]

[2] The differences between the cohorts regarding their perceived preparation for leadership roles are not strong, with slightly higher ratings given for most questions by the first cohort, but not significantly higher. One area—skills related to oral communication—may have been significantly stronger for the first cohort.

Percentage of NCETE doctoral fellows who believe that their doctoral program has equipped them with the understanding, skills, and knowledge to prepare them to play a leadership role in the field



From the March 2009 Survey. Percentages represent ratings of 4 or 5 on a scale where 1 = "not at all" and 5 = "to a very great extent."

In the summer of 2010, all NCETE Fellows – graduated or not – were surveyed for their final assessment of their graduate experience (13 Fellows responded to the survey). We asked the fellows to rate the extent to which various leadership components were available, and also to rate the quality of those components. Just over one-half of the Fellows reported that opportunities to learn about and lead while in the program were available to them, and that these opportunities were good or excellent. About the same number believed that the program prepared

them to be leaders in the field upon leaving the program, and that this preparation was good or excellent.

In the same 2010 survey, Fellows had the following comments about the leadership aspects of their graduate experience:

> *I saw that many of the leadership development opportunities we had were vastly superior to those available outside of NCETE and have since recognized the significant advantage and experience this gives me over many of my current colleagues.*

> *I came into my [current] position with numerous publications, conference proceedings, leadership roles on committees of professional associations, and co-PI positions on funded projects. I'd say that is pretty rare for a first year assistant professor. I credit NCETE with a lot, if not most, of those opportunities.*

> *Very good mentorship is provided.*

The cohort structure

NCETE sponsored two cohorts of doctoral students over the life of the grant. The cohort structure of the doctoral program was a significant positive contributor to the students' experience, and to their perceptions of themselves as becoming leaders in the field. In the 2009 survey, a few fellows commented on the value of the cohort:

> *Being part of a cohort invokes a sense of community and belonging that is needed to provide a collaborative environment for myself and other STEM stakeholders. Cohorts are also vital to capacity building because it serves as a vehicle for increased networking and idea sharing. I do not see any disadvantages with experiencing the program as part of a cohort.*

> *The cohort has provided a critical mass of people who are focused on a similar goal. This is rather unique in my experience since technology education, typically, is a small group of folks. This critical mass has provided a motivating factor in that we support each other. The small disadvantage is that not all fellows are/were ready for the substantial commitment and are struggling members of the team.*

My vocabulary lacks the words to quantify the importance of going through all phases of a doctoral program with at least a few others experiencing the same pain simultaneously. Not that the pain is always a bad thing. But there were times I seriously questioned my decision to pursue a PhD and having one other person feeling the same pain, to serve as a sounding board, helped pull me through. In addition, there is much to be gained from the expertise of fellow fellows. The initial pool of candidates that were sought from Technology Education and Engineering was well intended and helped spread a wealth of professional knowledge from within the cohort. I learned a great deal from these cohort members. The greatest disadvantage of a cohort is that if there are a few weak links in the chain, others end up carrying the weight for them. When quality people begin to shut down out of frustration, it weakens the cohort and has negative consequences for the intended goal/mission of NCETE.

Other program experiences

In addition to the cohort structure, NCETE provided other doctoral program experiences that were intended to build leadership, such as meetings where Fellows spent the day in Washington DC, visited NSF, and met and spoke with NSF program officers; research meetings, where Fellows were introduced to key researchers in the field, as well as new researchers outside the Center; NCETE Center meetings, where many students were invited to participate in Center-wide planning and business meetings; support with proposal writing for their dissertations, as well as other research opportunities; and seed grant opportunities. In general, the Center played a large role in providing students with opportunities to build their leadership confidence and skills.

Graduate fellow research opportunities

We call particular attention to the research opportunities that were intended to build leadership skills. Most of the students were given opportunities to participate in research outside of their dissertation work. Some students participated in research within their university departments, some students participated in NCETE sponsored research, and some students proposed and received seed grant money for research.

While early on in their experience, many students reported being somewhat dissatisfied with their preparation to conduct research, by 2009-10 most students felt the Center had prepared them well. In 2010, the majority of Fellows believed that there were high-quality opportunities for them to learn about research, and felt supported to do

so. Fewer (but still the majority) felt that they were prepared to conduct research on their own once they graduated the program.

Ultimately, the doctoral fellows were generally satisfied with the research component of the NCETE program. The fellows had the following final comments about the research component, which highlight both the positive and negative aspects of their experience with research:

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

> *I was given many opportunities to do my own research. However, the faculty did not include me on their research papers, projects, etc. I would have learned from being an "apprentice" rather than being thrown into the deep end of the pool.*

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

> *I think the research component was based on the individual institution and it may have been more beneficial to have minimal criteria to the exposure that was provided. Where as I did not have the opportunity to conduct much of my own research, other fellows did and looking back I believe that would have been helpful.*

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

> *NCETE exposed us to the various areas in engineering and technology education where more research is necessary, to build the capacity of engineering and technology educators to teach design.*

> *This question is difficult to answer. If the question is, 'how well did the PhD program, meaning the classes at my university, prepare me to conduct research', the answer would be it did an excellent job. However, if the question is specifically referring to how well did NCETE prepare me to conduct research, then I would say a somewhat satisfactory job. I believe the 4 NCETE classes*

were beneficial. However, at our university, we were not provided with research opportunities beyond our dissertation, like some of the other universities.

In interviews with graduated Fellows who were employed, several reported that the experiences they had in the Center were instrumental in helping them attain their current position, as well as preparing them to develop and embark on a research agenda in the field. (Please see the separate report: Review of NCETE's Research Initiative for more on the Fellows' research experiences.)

Facilitating collaborations

One critical component to developing leaders in a new field is facilitating connections with others. NCETE made a strong effort to connect graduate students to leaders in the field, from both inside and outside the Center, through supporting their participation in meetings and conferences, and convening invitational meetings sponsored by NCETE. These opportunities to build relationships and connections were consistently highlighted by the doctoral fellows as very important contributors to their growth as scholars.

As a Fellow for NCETE, I can honestly say that I was afforded many opportunities to share and collaboratively create knowledge that has helped spur my professional career. Working on various research projects at my respective university only enhanced this aspect of my matriculation.

NCETE has fostered relationships and connections within and across the engineering and technology education fields by hosting various events that brought together a variety of STEM stakeholders with similar goals concerning the improvement of teaching/learning within our schools. I have participated in these relationships by attending conferences, symposiums, and have been more actively involved with these relationships and connections through my doctoral research.

In our interviews with employed graduates, we asked them to comment on the extent to which the Center prepared them for collaborative opportunities in their current positions. While not all graduates were in situations that presented such opportunities, several commented on how the connections they made while part of the Center continue to be important influences in their careers, and have encouraged them to seek out new opportunities for collaboration.

My new colleague is from NCETE, and he is right next door and so obviously that relationship is strong. I talk to [another Center graduate] at least 2 or 3 times a month. I think I had a pretty good network started already, and so what I have tried to do is connect those folks up and help them, and I know they have helped me as well.

I think the exposure to other professionals within the field was very important from a couple of standpoints. Number one, knowing that there are people out there who are equally enthusiastic and striving toward ways of effectively educating kids [is important]. And understanding that there are good people out there that are more than willing to help, and also having an opportunity to collaborate with people at my own level, understanding that there is a change going on [in the field]. I am associated with people that I will probably be collaborating with for the rest of my career.

Working as closely as we did with the core courses and things, with the multiple instructors at multiple schools, it prepared me for the kinds of political hurdles and cultural hurdles that occur between people with different points of view. In the Center, you have the teaching institutions and the research institutions and they are working collaboratively, but they each have their unique mission that they are trying to accomplish. Similarly, I get to work with high schools, which have a different kind of mission than the colleges do. So, that was very helpful, I would say.

I think honestly being exposed to and interacting with other students on other campuses and people with such diverse backgrounds certainly helps a whole lot. Some of the dynamics that we had, like when we had to partner together across universities, I think that was a great thing. I know that we started that actually with a design course, but we did it with some of the other activities, in some of the other classes as well. That certainly did help [me learn how to collaborate].

Overall, as of summer 2010, most NCETE fellows were satisfied with the leadership component of the Center's doctoral program: 69% said they were satisfied or very satisfied. However, 15% said they were somewhat satisfied, and another 15% reported being dissatisfied. Over the years, we have observed that the Center was very responsive to the concerns and needs of the doctoral fellows. A handful of Fellows not

satisfied with some aspects of their program are to be expected in any doctoral program. The interviews with graduates revealed that while in retrospect they would have liked some aspects of the program to have been improved, overall they felt that their doctoral experience prepared them well for their current positions. Further, they reported that their experiences prepared them to support the effort to advance the field of technology education.

Faculty Leadership

There has been a range of faculty involved in the Center, who have participated in different ways (by conducting research, serving as professional development leaders, advising graduate students, etc.). Interviews with NCETE faculty and field experts external to the Center provide evidence of the ways NCETE added value to faculty members' professional trajectories and provided new opportunities for them to make contributions to the field.

Interviews with NCETE faculty regarding ways the Center has impacted their professional roles have revealed that for the most part, participating in the Center has been a positive experience. While key faculty admitted that creating and running the Center was more difficult than they anticipated, they also acknowledged that it has impacted them in terms of how they think about infusing engineering design principles into technology education, new research opportunities and approaches, and getting smarter about providing professional development in technology education. Faculty also discussed ways the Center connected them with peers across the country, which they identified as being among the greatest benefits of being involved in NCETE. Perhaps most importantly, the faculty agreed that the major contribution or legacy of the Center will be the next generation of leaders and scholars it is producing through the doctoral fellows, and the creation of a national community focused on infusing engineering principles into technology education.

Ultimately, faculty believed that the Center provided an opportunity for national collaboration and the potential to unify and bring attention to those attempting to integrate engineering design principles into technology education.

> *I think the Center has real potential for advancing an agenda. To help be in a leadership role and make that happen [is a good opportunity]. The Center has as much potential for having influence of anything I've seen in a long time. And externally, having resources to do the work is an incentive.*

All along, one of the major values of the Center was being able to connect with peers at other institutions on a regular basis. Without the Center, that just doesn't happen. You see these people at conferences once a year or once every two years. That's a huge benefit-professional collaborations and opportunities to collaborate even further… The bottom line is that I hope the Center gives us some visibility in the field and offers us some collaboration opportunities like Ken Welty's work with NAE… That is huge. That would not have happened without the Center.

Internally, all along, I believed in what the Center stood for. And being able to move forward with this initiative to look at engineering design as a central piece and component of technology ed as a field. Whether it's working with the leadership team or developing some proposals, or helping students to get onboard with their research…

I am very committed to the field generally. Well before the Center came into being, I was involved on the national scene … and being involved in the journals and so forth, and so NCETE was a continuation of that motivation to be a contributor to the field. And the fact that we were trying to create a next generation of professors who could give leadership to the field was exciting and of course the fact that a good crowd of people nationally who will come together over this thing was exciting. There are some good people in NCETE, and when we bring us all together, out of that, you get a good excitement from it.

Faculty research opportunities

One of the potential benefits of participating in an NSF-sponsored Center for Learning and Teaching is the opportunity to conduct collaborative research. While this was not necessarily a frequent occurrence in NCETE, for those who did engage in working with others on research projects, it was a very rewarding experience. As one faculty member put it:

…There is magic that happens, between bringing together these disparate personalities and these disparate technical competencies. All of a sudden, it clicks and I think so far, that professionally, is what I would say I have learned from this, how great it is. Research doesn't have to be holed up in your office, whacking away on the computer.

Toward the end of the grant period, a few faculty members participated in seed grant-funded research, and several were in the process of proposing new research projects to the National Science Foundation. One in particular reported that his experience in NCETE was instrumental in supporting his efforts to submit a DRK-12 proposal:

> *I don't spend a lot of time engaging in research projects and in fact, just this month, I am submitting my very first proposal to the NSF for research. I think being involved with the NCETE and hearing about the research and what others were doing gave me confidence and piqued my interest to try writing a research proposal, a big major one. To be honest, I was always not afraid of the unknown, but the unknown was unknown and so I didn't even know how to get started with the research proposal. I think my experience with NCETE did help me understand what the process was like, even though the learning curve is still huge. I think it helped me gain the confidence to try this research proposal that I am sending in.*

In summary, over the past several years of observing the NCETE faculty in project leadership meetings, talking with them in interviews, and listening to conference presentations and other meeting presentations, we have seen a steady growth in sophistication and depth of conversation about the challenges they face in their efforts to promote a new perspective on technology education. The opportunities for national collaboration, the development of the doctoral program across the four universities, and the opportunities for conducting new research have, in our view, grown and contributed to building leadership capacity among these faculty members that will ultimately benefit the field.

Perspectives from the field

As part of our evaluation work, we consulted external experts, to gather their impressions of the Center and its potential to impact the field. One area that the experts agree is currently lacking in the field and is an area in which the Center could potentially contribute, is future leadership: the number of people engaged in the field is declining, and there is a critical need for fresh perspectives and energy. A few of our external experts commented:

> *I think [building leadership capacity] is probably one of the components where they really did the best, in terms of trying to identify and mentor people, to give them opportunities and give them exposure. In my meanderings at professional conferences and so on, there has been a definite presence of some of those. I can't pretend to say I know all of them, but there are definitely some of them that I have seen out and about and I know that was something that the leadership*

team gave a lot of thought to, that exposure and engagement and give them real responsibilities and expectations. I think they did a good job with that.

What the center has been able to do by these universities working collaboratively… is re-energize and re-introduce young faculty into these university programs because we were getting to a point where we were getting a little bit stale, because we didn't have a lot of younger people coming into the field to take over some of these university teaching positions. As people retired, there was just no one on the horizon to take the job. All of that is good. That is why I think that they have the potential to make a good impact. I understand that students takes classes based on their own university, but they also do some distance learning classes and that gives the student the ability to interface with faculty from all over the country, and that really does help to bring a more collaborative brain around it, because you aren't limited to the ideas that you are exposed to on the campus you attend.

I think they do have the potential to make progress, but I think their potential completely hinges upon a larger group of students being engaged, because I think to an extent, their numbers have been few because frankly, as a field, we have very few people that are pursuing Ph.D.'s. The more we can up those numbers, and get more people in the think-tank so to speak, the more momentum and more action can happen.

I would say [one NCETE graduate in particular] certainly has the potential for a great career ahead of her. I think there will be forces bringing engineering into the K-12 world and it is important that technology ed be part of that. There are forces in play beyond technology education to work in that arena. So, and to the extent that there are people like [this NCETE graduate] who are young, energetic and not bound by tradition, I think that is all to the good, because what technology education from an industrial arts perspective is, is not what it should be going forward, even though aspects of that are important. I think they need to examine where they want to be in 5 years, 10 years, and see how you get there.

One expert expressed the concern that the Center may not be able to go far enough to supply the needed human capital to move the field forward:

> *I think there has been such a decline in the number of people going into technology ed, that even if the Center is very, very successful, I am not sure that there is a critical mass out there to implement all of the good things that the center will have accomplished in terms of its goals, whether it is conducting research, the impact of that research on the profession, or whether it is building leadership within the profession. I think it comes down to the number of people that will be out there promoting the profession and promoting, after the Center goes away, if you will, promoting the ideals of the Center. People in the profession historically do a very good job at building curriculum, but they don't do a very good job in conducting research or building leadership.*

> *I think the Center could have made more of an impact, a collateral impact, on other professionals in the field, but it is hard to say. I know they had various meetings where they brought in people and it would have been nice to see more, and sometimes you see the same people over and over again at the meetings, some of them, and not necessarily the people that need further involvement. They get invited because they are the big names that get invited, but maybe it would have made them better to bring in somebody who is earlier in their career.*

Many of the above comments refer to the Center's efforts to train doctoral students and prepare new leaders for future work in the field. While many of our experts did not feel they were sufficiently knowledgeable to comment on details of the Center's doctoral programs or other leadership development activities, they were clear that there is a real need in technology education for fresh perspectives and new leadership.

Summary

There are renewed efforts in the field to address engineering design as a central aspect of technology education (e.g., International Technology and Engineering Educators Association, or ITEEA). NCETE made efforts to develop skills and knowledge in the doctoral fellows and Center faculty to further this mission. There was an important role for the Center community and its relationship-building function in fostering leadership growth, for both Center participants and others. Evidence suggests the Center made headway in developing leaders, and provided

one high profile university program in particular - Purdue - with new faculty who are committed to the vision.

It is important to consider the fact that the field of technology education does not have the strong research and leadership history that mathematics or science education—or even engineering education—has. Indeed, hundreds if not thousands of scholars have engaged in research and development in science and math education. Therefore, as technology education is a smaller and newer field, the Center has made a large proportional contribution, relative to the scale and existing strengths on which the Center was able to build.

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