AC 2010-1963: DESIGN AND ASSESSMENT OF PROFESSIONAL EDUCATIONAL DEVELOPMENT PROGRAMMING FOR GRADUATE STUDENTS AT A RESEARCH EXTENSIVE UNIVERSITY

Sunni Newton, Georgia Institute of Technology

Sunni H. Newton is currently in her 4th year of Georgia Tech's PhD program in industrial organizational psychology, with a minor in quantitative psychology. She attended Georgia Tech as an undergraduate, double-majoring in psychology and management. She worked for several years as a graduate research assistant in a psychology lab where she helped conduct studies on adult learning. She currently works as a graduate research assistant in Georgia Tech's Center for the Enhancement of Teaching and Learning (CETL) where she assists with assessment and data analysis for ongoing CETL projects. Her masters thesis involved an investigation of caffeine and cognitive fatigue. Her current research involves the topics of workaholism and overwork.

Lydia Soleil, Georgia Institute of Technology

Dr. Lydia Soleil is the Assistant Director for TA Programs and Graduate Student Development in the Center for the Enhancement of Teaching and Learning at the Georgia Institute of Technology (Georgia Tech). Previously, she was at the University of California, Irvine working with graduate students in various capacities: Associate Director of the Teaching, Learning and Technology Center, First Year Initiatives (undergraduate and graduate) Coordinator for Student Housing, and Graduate Student Career Consultant in the Career Center. Dr. Soleil's current work involves the design and coordination of all aspects of the higher education portion of the Tech to Teaching program which prepares graduate students for academic careers. She also supports all aspects of Teaching Assistant (TA) professional development for the entire Georgia Tech campus. Dr. Soleil received her B.S. in Biotechnology from Worcester Polytechnic Institute and her Ph.D. in Physiology from the University of California, Davis.

Tristan Utschig, Georgia Institute of Technology

Dr. Tristan T. Utschig is a Senior Academic Professional in the Center for the Enhancement of Teaching and Learning and is Assistant Director for the Scholarship and Assessment of Teaching and Learning at the Georgia Institute of Technology. Formerly, he was Associate Professor of Engineering Physics at Lewis-Clark State College. Dr. Utschig has regularly published and presented work on a variety of topics including assessment instruments and methodologies, using technology in the classroom, faculty development in instructional design, teaching diversity, and peer coaching. Dr. Utschig completed his PhD in Nuclear Engineering at the University of Wisconsin – Madison. His technical expertise involves analysis of thermal systems for fusion reactor designs.

Donna Llewellyn, Georgia Institute of Technology

Dr. Donna C. Llewellyn is the Director of the Center for the Enhancement of Teaching and Learning (CETL) at Georgia Tech. Donna received her B.A. in Mathematics from Swarthmore College, her M.S. in Operations Research from Stanford University, and her Ph.D. in Operations Research from Cornell University. After working as a faculty member in the School of Industrial and Systems Engineering at Georgia Tech, she changed career paths to lead CETL where she works with faculty, instructors, and graduate students to help them teach effectively so that our students can learn.

Design and Assessment of Professional Educational Development Programming for Graduate Students at a Research Extensive University

Abstract

This paper describes the design and assessment of a new professional development program for graduate students at a research extensive university, The Georgia Institute of Technology. The program addresses two needs that have been identified by the graduate student government at Georgia Tech – more explicit training to teach effectively, and career advice for those wanting an academic career. This program, *Tech to Teaching*, is funded by NSF and is designed to link existing STEM (Science, Technology, Engineering, and Mathematics) education projects at Georgia Tech to produce a collective result that is greater than the sum of its parts. The grant also promotes collaboration within Georgia Tech and with nearby institutions in order to give graduate students the skills and experience they need to successfully transition to a faculty member position.

There is both a formal structured certificate program and less structured a la carte options. There are two tiers of the certificate program. The first tier includes a graduate level course on the fundamentals of teaching and learning and a teaching practicum whereby graduate students work with a mentor and take on some of the duties of teaching a course, such as preparing and delivering several lectures, helping write assignments and exams, etc. For the second tier, graduate students take a graduate level course in course design and then take full responsibility for teaching a course, either at Georgia Tech or a nearby college, with the support of a mentor. A la carte options include workshops focused on the academic job search and career options, academic communication skills, and teaching topics as well as graduate courses in academic communication. Individual career, teaching and communication consultations are also available. Student perceptions about the program's pilot offerings have been assessed via student course/instructor opinion surveys, a student focus group, and workshop feedback forms. Additionally, course syllabi and workshop content have been analyzed for alignment with project goals. Finally, participation rates in the program are being tracked via course enrollment and workshop attendance numbers.

Overall, this program, which mainly targets the teaching-related aspect of a faculty career in higher education for graduate students, was eagerly received and highly rated across all program elements at Georgia Tech. Additionally, other grant funded projects involving STEM education across the campus are being linked with elements of this project. This paper will explain the process that was used to develop the program, describe synergies being created from links to existing programs, and present assessment data from the first year of implementation. Specifically, value to the reader is provided in two distinct ways: 1) presentation of participation rates and assessment data will illustrate the potential for utilization of and appreciation for this type of programming, and 2) description of resources used, design steps taken, and program components implemented will provide a template for individuals at other institutions interested in setting up similar programs.

1. Introduction

The graduate level component of the *Tech to Teaching* project aims to create an infrastructure at Georgia Tech which encourages graduate students to gain the skills needed to obtain and be successful in a career in college teaching. The *Tech to Teaching* project has significant potential to impact engineering education at this university because approximately 56% of our graduate students are engineers[1], and 70% of our graduate students intend to pursue academic careers (please note that the 70% figure is based on data from a small subsample of our grad students, including both engineering and non-engineering). Other schools with significant engineering graduate student populations could also benefit from instituting such a program for the reasons elucidated below. While some graduates of engineering doctoral programs will likely end up at institutions similar in nature to the majority of institutions that produce doctoral engineering students, that is research universities, others will pursue careers at institutions whose missions place a heavier emphasis on teaching. Regardless of where their paths lead them post-graduation, the value of high quality teaching and communication skills is of critical importance in all academic career paths, and doctoral education best serves its graduate students by providing such skills as part of graduate education. It is also important that institutions educate graduate students about career options and the pathways to careers at schools other than research institutions so that they have the information and skills needed to choose, obtain, and be successful in the academic career that is the best match for their skills, interests and values.

Tech to Teaching imparts these skills and facilitates the progression toward a career in college teaching by providing new programming and by integrating existing teaching-related grants and projects. The goal is to make opportunities for this type of professional development well-known and readily accessible to graduate students. The audience for the graduate level component of *Tech to Teaching* is all graduate students with at least some level of interest in an academic (faculty) career. Students can participate in a wide range of *Tech to Teaching* activities as there is both a certificate program with two tiers, and also less structured a la carte options. A la carte workshops are offered on topics related to teaching skills, academic communication skills, academic career options, and the academic job search. There are also courses in academic communication and one-on-one consulting on all of the above topics. In the certificate program there are courses on teaching and learning and opportunities for two levels of mentored teaching experiences. Students are not required to commit to completing either tier of the certificate program. With both the certificate program and the a la carte options, students may participate in as few or as many activities as they wish. Descriptions of students' participation in and reactions to these activities during the first year of the *Tech to Teaching* project comprise the bulk of this paper; in general, demand for this type of programming among the graduate student body was clearly evident, and students who participated in *Tech to Teaching* activities were pleased with their experiences.

This paper offers several specific elements of value to the reader. First, a brief literature review provides a foundation for understanding the national context in which *Tech to Teaching* is situated as related to graduate student professional development. Second, the detailed descriptions of the program development process and specific program components (e.g., courses, workshops, mentoring and immersion experiences) could serve as a blueprint for institutions interested in implementing similar programming, or provide ideas about changes or enhancements that could be made to existing programs elsewhere. Third, the extent to which

there is an interested and receptive student audience for this type of programming (at least at institutions serving significant numbers of engineering graduate students) is demonstrated. Fourth, specific results from the assessment of the first year programming activities are presented.

2. Background and Context

2.1 Why do we need Tech to Teaching?

A survey conducted by the Georgia Tech Graduate Student Government Association (GSGA) in February 2008 provided some preliminary data which indicated that graduate students are interested in teaching careers and do not feel well prepared for them. These data should be treated as preliminary given that the response rate from doctoral students was about 6% (a total of 177 responses were received).

Of the doctoral students who responded, about 70% indicated that presently they are interested in pursuing an academic career. This is a large percentage when considered within the context of the Survey of Earned Doctorate results, which indicate that only 15% of engineering PhDs were employed in academia[2]. However, when looking specifically at the responses of 3rd year or later doctoral students, only 26% indicated that they have definite career goals that they are pursuing. When the same group was asked about their perceptions regarding the ease of finding a job, they indicated that they perceived that it would be more difficult to find a job in academia than in industry.

We looked specifically at the data for doctoral students in their third year and later who were asked to rate the impact of their graduate school experience on the development of various skills (152 such responses were received). The item "conducting independent research" received the highest rating, indicating that respondents felt that their graduate education had contributed to a moderate to great improvement in their research skills. However, Table 1 below shows that the other skills related to teaching and the job search (in general) were ranked *much* lower than research skills. Although the data in the Table 1 support the premise that Georgia Tech explicitly trains doctoral students to be researchers, it also highlights deficiencies in the development of skills related to teaching, professional communication and the job search[3].

Table 1: GSGA Survey Results

SKILL	**RATING**
Conduct independent research	3.57
Teach (small "seminar" or "problem-based" learning courses	2.00
Teach (large "lecture" course)	1.79
Teach (laboratory)	2.05
Assess performance outcomes from teaching, supervising, or leading	1.70
Prepare written credentials (CV, resume, cover letter)	2.14
Interviewing skills	1.86
Public speaking	2.78
SCALE: 1=no contribution, 2=limited skill improvement, 3=moderate skill improvement, and 4=great skill improvement	

2.2 What does the literature say about graduate student preparation for teaching and the academic job search?

Recent research indicates that there is a major deficiency in the preparation of graduate students for aspects of a faculty position other than research responsibilities. One of the major problems is the lack of skills and experience related to teaching responsibilities, which are a component of faculty positions at all types of institutions. This is particularly true in engineering fields where graduate students typically have much less teaching experience then their peers in the sciences, humanities, and social sciences; "that only a few graduate students have broad experience with teaching suggests that graduate programs are not adequately addressing a major component of faculty work[4]." New faculty members are often surprised by and uncomfortable with the number and breadth of courses they are expected to teach, and surveys of new faculty members and their chairpersons suggest that both groups agree that graduate programs did not sufficiently prepare their students for teaching at the college level[4].

The focus of science and engineering graduate programs is research; rather than following a well-rounded set of guidelines, it seems that the education they deliver is "largely a byproduct of policies that support research[5]." A report by The Committee on Science, Engineering, and Public Policy (COSEPUP) on how science and engineering doctoral students are educated has stressed the need to foster communication skills, specifically the ability to convey complex ideas to laypersons[5]. This report also recommends that, rather than relying solely on funded research projects, more graduate students should receive their funding from education/training grants. This could result in students' education being dictated less by the needs of research projects and more by a deliberate focus on developing competencies, such as teaching skills, in areas besides research[5]. This would help create graduate students who are better prepared for the multitude of demands, beyond those related to research, that are expected of a faculty member.

It is well documented that across all of graduate education, graduate students are not instructed on how to go about obtaining an academic position, and students are not satisfied by the information they receive from faculty members regarding job searches[4]. In many fields outside of engineering, this is related to the fact that these graduate students are trained by faculty at large research universities, but the majority of academic job opportunities exist at drastically different types of institutions such as smaller colleges, community colleges, etc[4]. Although this issue is not as prevalent in engineering, it is still true that a substantial number of engineering faculty jobs are at non-research universities.

In order to assess the distribution of engineering teaching job opportunities at different types of institutions, chemical engineering was selected as an illustrative example for the purposes of this paper. Other engineering fields can be expected to produce similar results. Based on information obtained from the 2007 ASEE database of chemical engineering programs across the country (~167) and the number of faculty jobs at each type (by general Carnegie classification), the breakdown of jobs at each institution type is as follows: ~ 75% of faculty positions are at Doctoral Extensive/Intensive institutions, ~14% are at Master's I/II institutions, 5% are at Bachelors and Engineering & Technology institutions and ~ 6% are in other settings not classified within the Carnegie system (e.g., Canadian universities, joint programs, etc.).

Therefore, 19 to 25% of the faculty positions for chemical engineering are at more teaching-focused institutions. Additionally, this data does not take into account faculty positions that would be open to chemical engineers but housed in general engineering programs at community or technical colleges and/or at some small colleges. Therefore, the fraction of positions at teaching-focused institutions calculated above is likely an underestimation[6,7]. Even research university faculty typically teach on a regular basis, making it imperative that graduate students gain these skills during their doctoral programs, rather than trying to master them while the tenure clock is ticking and they are establishing their research reputations. In addition, strong communication skills and the ability to teach others effectively will serve graduate students well even if they choose a career path outside of academia. In short, every graduate student can benefit from learning to be an efficient and effective teacher.

The model academic career path presented to graduate students (that is, becoming a faculty member at a research university) may well not be the one that they themselves follow[4], either by choice or due to the lack of available positions. In addition, students are infrequently informed about or encouraged to pursue any career paths other than that of a faculty member at a research university; even worse, graduate faculty members often belittle positions at non-research institutions, despite the fact that these institutions do offer a substantial percentage of the faculty positions available to engineering graduate students. Results from 1998 and 2001 surveys of graduate students who had participated in the Preparing Future Faculty program highlight this issue; one student illustrates faculty's negative attitudes towards non-research intensive jobs by stating, "if you get a job at a liberal arts school, that's your failure rather than your success[8]." Similarly, an engineering graduate student friend of one of the authors on this paper who obtained a job teaching night courses at a local technical college was unwilling to inform their advisor because of similar negative attitudes.

In order to assess the relative quantity of engineering teaching job opportunities, chemical engineering was again used as an illustrative example for the purposes of this paper. The number of positions at research institutions is often lower than the number of PhD holders seeking them. For example, according to the 2007 ASEE database of chemical engineering programs, there were 2,682 individuals employed (including full and part time, tenure track and tenured, non-tenure track, and non-tenured faculty) as faculty in chemical engineering programs[6]. Assuming that 75% of those positions are at research universities (as calculated above), that means there are 2,011 chemical engineering research university faculty members. However, 800 PhDs in chemical engineering were awarded in 2006[6]. Even if 10% of the research university faculty positions opened up in a single year (201 positions), there would be 4 new chemical engineering PhDs for each opening. Therefore it is imperative that graduate students have sufficient information about the broad range of jobs in which their training could be put to use, and that "...faculty do not consider their only successful students as those who are clones of themselves,[9]" as it is unrealistic to think that all PhD chemical engineers could get jobs as faculty at research universities. Nevertheless, data suggest that some graduate students reject opportunities at non-research universities because their advisors would consider such a career path to be a failure[4,10]. Graduate students who do not experience such negative attitudes (or choose to ignore them) and elect to pursue jobs at non-research universities rarely have the appropriate preparation for the diverse student population and heavy teaching load they will face[4].

2.3 What are some well documented models of graduate student preparation for teaching careers?

Implementation of courses and/or programs where graduate students learn more about teaching, teaching career options, and the academic job search is not unique to Georgia Tech. A recent study[11] gave a sense of the prevalence of Preparing Future Faculty (PFF) programs, teaching certificate programs (in which students can earn a certificate for completing some series of requirements), and teaching courses at the 288 research and doctoral granting institutions in the U.S.; all three were found to be quite common. Please see Table 2 for counts and percentages of both the number of schools for which data was obtained, and the number of schools reporting that they had each course/program type[11]. For each of the three categories, the rate was about 90%; please note that this figure is based on a limited data set of those schools for which data could be obtained. It is not clear if this data set is reflective of the full set of 288 U.S. research and doctoral granting institutions.

Table 2: Count of Schools with Teacher Preparation Programs & Courses

	# and % of schools for which data was obtained	# and % of schools reporting that they offer the course/program
Preparing Future Faculty program	80 (27.8%)	72 (90%)
Teaching certificate program	90 (31.3%)	81 (90%)
Teaching course(s)	83 (28.8%)	75 (90.4%)

Although this seemingly high number of available opportunities appears to contradict the idea that doctoral students are not getting adequate preparation for teaching careers, it is important to note that a very small percentage of grad students participate in such programs. One of the authors of this paper with experience with teaching certificate programs and courses at three separate universities estimates that less than 5% of the graduate students at any university participate in such opportunities, suggesting that these programs are a good first step but need to become integral to graduate education to really make a difference. In addition, the PFF program has collected some data that indicate that those who went through the PFF program have an easier transition to faculty life (see description of PFF below), but the differences between those who participate in teaching professional development in graduate school and those who don't is not well studied.

Certificate programs generally entail several workshops and/or coursework on the theory and mechanics of teaching, as well as an actual teaching component. Possession of such a certificate indicates a substantial investment of time and effort on the part of graduate students in developing their teaching skills, and should provide a substantial advantage for students seeking jobs, particularly those which place a strong emphasis on teaching.

There are at least two excellent examples of national level programs spanning across multiple institutions. The Preparing Future Faculty (PFF) program, started in the early 1990s, seeks to

prepare graduate students for academic life by exposing them to the "real lives" of faculty in a wide variety of academic settings (e.g., research university, comprehensive university, liberal arts college, historically black college or university)[8]. In addition to providing graduate students with this exposure to diverse institutions, the program seeks to provide forums in which graduate students and faculty can communicate about life at these various institutions, and also to increase the extent to which graduate programs embrace their role in facilitating the professional development of graduate students. Qualitative surveys conducted in 1998 and 2001 with 129 graduates of the PFF program suggested that the program impacted participants in the following ways[8]:

- "Legitimized" conversations about teaching
- Created an intellectual community feel that had been previously lacking from graduate school
- Led to more open conversations between students and faculty mentors regarding faculty life in different types of institutions
- Led to recognition that training solely in a narrowly focused research specialization will not serve most graduate students well when they enter the job market
- Helped students gain insight as to how academic institutions actually work
- Improved comfort level for navigating the job search process
- Made students aware of alternative career paths (both within and outside of academia), other than just faculty positions at research-intensive institutions
- Helped students understand the differences between the various types of institutions
- Gave students information about how best to present themselves, in terms of application materials, interviews, etc., in a manner tailored to the various types of institutions
- Provided an advantage over other new faculty in terms of knowing what to expect, having more teaching experience ("PFF eliminates first-time mistakes", p. 15), and more quickly and readily establishing a balance between research and teaching

A second national program with goals similar to *Tech to Teaching* is called the Delta Program, and one of the participating institutions for this program is the University of Wisconsin[12]. This program seeks to help current and future faculty succeed in science, engineering, and math higher education. Three core ideas comprise this larger goal; they include applying research methods to the teaching process, creating a community of graduate students, post-docs and faculty who interact in a series of collaborative activities and programs, and bringing together diverse views on the challenges of teaching and learning. Specific program components include courses on effective use of technology in teaching, teaching large classes, working in teams, diversity in the college classroom, instructional material development, and other teaching topics, internships, certificate programs, workshops, roundtable dinners, brown bag discussions, and faculty mentor training seminars.

3. Program Development & Description

3.1 Program Development

The higher education component of *Tech to Teaching* consists of both a formal structured two-tier teaching certificate program and less structured a la carte options which focus on teaching, academic communication skills, academic career options, and the academic job search. A review

of the design and content of Preparing Future Faculty programs, teaching certificate programs, and higher education teaching courses from institutions around the country was undertaken before beginning the design of the certificate program component of *Tech to Teaching* and its individual elements. Best practices within departments at Georgia Tech that already offered their graduate students a teaching practicum (which is a component of the teaching certificate) were also considered.

Thus, the development of the teaching certificate and a la carte components of *Tech to Teaching* combined many elements from other programs and capitalized on existing resources and programs to meet the specific needs of Georgia Tech graduate students using well established practices, but in a way that was sensitive to the current culture and circumstance. The integrated course design model from Fink's "Creating Significant Learning Experiences"[13] was used to plan the courses and is integrated throughout all of the courses. Concepts from "Learner-Centered Teaching" by MaryAnn Weimer[14]are also integrated into the courses.

Topics and content for the academic career options and academic job search panels and workshops were selected in several ways. First, offerings by peer institutions with similar rankings were studied[15]. Next, the Graduate Career Consortium annual conference and community provided ideas and insights. The courses and workshops on academic communication skills were developed prior to the *Tech to Teaching* programs by the Graduate Communicate Coordinator at Georgia Tech, and these offerings have been integrated into the *Tech to Teaching* marketing efforts as a la carte options that would benefit graduate students interested in academic careers.

3.2. Certificate Program Description

By building on and combining elements from several existing programs and adding some new elements, the *Tech to Teaching* certificate program addresses many of the missing aspects of graduate education described in the literature and uncovered by the GSGA survey results. An explicit series of courses combined with "scaffolded" teaching opportunities with teaching mentors give graduate students progressively more independent experiences, as recommended by Golde & Dore (2004),[16] and mirror the TA development model described by Nyguist & Wulff (1996)[17]. In this model, graduate students move from TA or senior learner, to Colleagues in Training, to Junior Colleagues...

In the *Tech to Teaching* certificate program, all teaching experiences are mentored, and graduate students are guided through the structure of a learning community with a deliberate curriculum as to how to be a good mentee and how to obtain the mentoring they are required to have in order to meet the requirements of the teaching experiences and to grow professionally in other areas of interest. There are several sources that advocate multiple mentors for graduate students [9, 18, 19, 20, 21, 22]. These resources and more can be found in the annual report for the *Tech to Teaching* project.[23]

There are two tiers (or levels) of the certificate program. The first level includes TA experience (at least two terms), a graduate level course on the fundamentals of teaching and learning, and a teaching practicum. For the second tier, graduate students take a graduate level course in course design and then take full responsibility for teaching a course, either at Georgia Tech or a nearby college, with the support of a mentor.

LEVEL A

In Step 1, called "Introductory experience," graduate students must serve for two terms as a college-level Teaching Assistant (TA) for a laboratory and/or recitation section (or demonstrate similar experience). In any case, we require that the TA position have some instructional responsibilities such as teaching a laboratory, recitation, or discussion section; we exclude assignments as a "grader" or equivalent with the sole responsibilities of grading and holding office hours.

Step 2 consists of a 2 credit foundational course called Foundations of Teaching & Learning (CETL 8802 TL). This highly interactive and practical course gives graduate students the opportunity to gain the knowledge and skills necessary to evaluate instructional design options and make informed decisions in order to implement principles of learner-centered teaching. Students in the course have the opportunity to: (1) design lesson plans; (2) use facilitating and lecturing skills in several teaching opportunities; (3) self-reflect on their implementation of those activities; and (4) give and receive peer feedback from the community of teachers in the course. Participants discuss, reflect on, critically analyze, and evaluate readings, lectures, and videos about teaching and learning concepts through the lens of the learner-centered approach. Individuals also synthesize their personal experiences and the course content into a statement of teaching philosophy that can be used on the academic job market. Topics include: the future of teaching and learning, principles of learner-centered teaching including social constructivism, feedback and facilitation skills, learning styles, learning outcomes, integrative lesson planning, assessment of learning, teaching methods, and reflective teaching.

Step 3 is a mentored Teaching Practicum. Students who participate in this step are enrolled in a 3 unit course that meets at least every other week as a learning community. Students work with a faculty mentor to gain an inside view of the practicalities of teaching. See Table A1 in the Appendix for a description of the practicum elements. Elements of the practicum fall into several categories: teaching responsibilities, mentoring interactions, learning community activities, and written assignments.

Georgia Tech also has a NSF-funded GK-12 program, called STEP Up! (Student and Teacher Enhancement Partnership), and in the summer of 2009, the traditional training course for this program was significantly revised to align more strongly with the needs of *Tech to Teaching*. In STEP Up!, twelve STEM graduate students receive training on teaching and then are placed in local high schools to work with the teachers and students there. The revised STEP Up! training course is considered to be an equivalency for the Fundamentals of Teaching and Learning course, as similar content is presented in addition to the more specialized content for the K-12 arena. Students who complete the STEP Up! program by working in a local high school during the academic year following the course are considered to have completed the equivalence of the practicum element (Step 3) of Level A of the *Tech to Teaching* certificate through the work they do in K-12 classrooms, although they are welcome to also do a "higher education" practicum. The K-12 component of *Tech to Teaching* is mentioned within the context of this paper, despite its focus on graduate students, because teaching at the high school level is a potential desired career path for undergraduate and graduate students alike.

LEVEL B

Step 4, which is the first step of Level B, is a 2-credit advanced teaching course, Course Design for Higher Education (CETL 8802 CD)**.** Individuals in the course have the guided experience of designing a college-level course for a context of their choosing (both topic and type of university). This task takes place within the community of learners, who both give and receive peer feedback at all steps of the design process. The community of learners follows D. Fink's process of integrated course design using a learner-centered paradigm. Participants learn about several different advanced pedagogies, such as problem based learning and peer facilitated learning. Products created in the course include: a full course syllabus including an overall course schedule, a detailed plan for the first 3 weeks of the course, a project, paper or other non-exam based assessment for the course with an accompanying rubric, and a (revised) teaching philosophy.

Step 5 of the *Tech to Teaching* certificate is a mentored teaching immersion where the graduate student serves as the sole instructor of record for a course with the guidance and support of a mentor. Students are also enrolled in a 1 unit course which is a learning community of peers who meet at least every other week. Requirements of the immersion fall into 4 categories: teaching responsibilities, learning community actitivities, assignments, and mentor interactions. Please see Table A2 in the Appendix for a description of the immersion requirements.

With both the practicum and the immersion, the expectation is clearly set that the mentees must take responsibility for managing the details of the interactions with the mentor. For example, graduate students are responsible for setting up meetings with the mentor, planning for and bringing an agenda to the meetings, and following up after meetings. We also make it clear that the mentee is responsible for seeking the level of mentoring they feel they require. For some students, mentors can expect a very complete draft of an item for feedback; other students may want instruction and advice before they begin and feedback along the way. Some students may check in between scheduled meetings and others may not. We also make these expectations clear to the mentors and ask that they support their mentees to the level the mentee requests.

In general the *Tech to Teaching* certificate program requires that students move through the steps in progression, but students can proceed at the pace and to the level that they desire. The program is meant to be flexible. For step one, tutoring or other teaching experience in the community or in the K-12 realm can be substituted for TA experience. Having been an undergraduate TA and/or a TA at other institution can also be substituted. For the practicum and immersion, they can be done either at Georgia Tech or at a nearby institution. We offer to help practicum students find a mentor for the practicum elsewhere and we have formal agreements for the immersion component with two local colleges that each have a very different culture and focus than Georgia Tech. In addition, for students who choose to do their practicum at Georgia Tech, it may be done in the student's home department, with a relevant department, or with the 1 credit freshman seminar course "GT 1000". Many departments have their own departmental teaching practicum and as long as the departments agree, students in those departments can choose to substitute the departmental practicum for the *Tech to Teaching* practicum or vice versa, or do a hybrid practicum, etc. Also, if a graduate student has already done their practicum,

been an instructor of record for a college course, or been a fellow in the STEP Up! program, some steps can be skipped and/or completed in a different order.

3.3 A La Carte Options Descriptions

A la carte options include workshops focused on the academic job search and career options, communication skills, and teaching topics as well as courses in academic communication. Individual career and teaching consultations are also available.

Workshops

Under the *Tech to Teaching* moniker, CETL offers 8 - 10 workshops each term for the general graduate student audience. Additionally, special additional workshops on particular topics are offered for Graduate Student Housing and for specific academic and student life departments (such as the Women's Resource Center) upon request. Workshops cover topics related to the academic job search (academic job search process, interviewing skills, job talks, teaching demonstrations, CVs and cover letters), teaching (motivating students, intercultural communication in teaching), research (presentations and poster design, literature reviews, and grant writing), and options for academic career paths (faculty and non-faculty academic career options panels, career options in high school teaching). These workshops are conducted by CETL personnel. The subset of workshops most relevant to *Tech to Teaching* objectives is described in detail below.

Workshop on Motivating Students:[23]

- Information delivered in this workshop includes:
    - Discussion of past experiences in which workshop participants had encountered a professor, instructor, or TA who was especially motivating
    - Educational theory on what contributes to student motivation or lack thereof
    - Common situations in which students often experience a lack of motivation, and steps teachers can take to overcome these situations
    - Overall techniques and strategies for increasing student motivation

Workshop on Career Options in High School Teaching: [23]

- Information delivered in this workshop includes: [23]
    - Steps on getting certified to teach K-12
    - Tips for locating K-12 jobs and getting hired
    - Discussion of what to consider in determining whether teaching K-12 is a good fit for participants
    - Comparisons between teaching K-12 and other career path options
    - How to locate and access pre-teaching advising and services

Non-faculty Academic Career Panel: [23]

- Panelists were invited to address some of the following questions, in addition to answering questions from attendees:
    - Please briefly describe your career path since graduating with your PhD, including how you got into your current field/job
    - What are your present responsibilities at work and what is a typical day like?
    - For many Ph.D.s, the only lifestyle they know is that of a graduate student, post-doc, or faulty member. What is different about your position and why did you make the choice you did?
    - How do people typically get hired into positions like yours?
    - What advice do you have for our audience regarding how they can gain skills while in graduate school (but maybe not as part of the required graduate school activities) that will make them more marketable for non-faculty jobs in academia?

Faculty Academic Career Panel: [23]

- Panelists were invited to address some of the following questions, in addition to answering questions from attendees:
    - How and why did you decide to be a faculty member at a Community College, State College, Research University, Liberal Arts College, etc.?
    - What percentage of your time do you spend on the following: teaching, research, university service, etc?
    - How many hours per week do you work? How does this typically change over time (before vs. after tenure)?
    - What are the 3 biggest advantages/rewards to your job?
    - What are 3 of the biggest challenges/disadvantages to your job?
    - What can graduate students do while still in graduate school to become more competitive for jobs in your line of work?

Additional workshops[23]

Two workshops were presented by CETL in collaboration with two faculty members from Chemical Engineering; these workshops were specifically for chemical engineering students. The topics were "Assessing Yourself and Preparing for a Faculty Position" and "Applying for and Obtaining a Faculty Position." Additionally, two workshops were presented through the Housing Department. These workshops were facilitated by CETL. These were on "The Academic Job Search" and "Teaching Philosophies and Portfolios."

Advising

Consulting on academic communication skills and teaching for TAs and Graduate Student Instructors (those who teach thier own course) has been provided to graduate students since 2006. This consulting continues and services have expanded to include consulting with those

seeking advice about their academic job search and/or wanting feedback and advice on job search materials.

3.4 Program Visibility Among and Use by Engineering grad students

There are multiple mechanisms in place by which graduate students can find out about *Tech to Teaching* activities, programs, courses, etc. CETL personnel have developed a website with information about workshop content and schedules, resources (e.g., handouts, PowerPoint slides, etc.) from previously offered workshops, links to online teaching resources, career timelines for Master's and Doctoral students, and a forum where students can have their questions about teaching answered by an experienced teaching assistant. A network of graduate program coordinators assists in distributing information about CETL activities, generally via e-mail lists, to graduate students within each degree program. CETL also has contacts at various student organizations (e.g., Graduate SGA) that assist in advertising CETL events via e-mail lists and on their organizations' websites. In addition, students attending any CETL event are usually provided with a schedule of other CETL events planned for that semester.

Based on an analysis of the majors of participants in CETL courses, workshops, and advising offered during Spring and Summer, 2009, it is clear that engineering students are taking advantage of the opportunities offered to them by *Tech to Teaching*; please see Table 3 for the percentage of students participating in each activity type who were from an engineering department. For courses and workshops, engineering students are participating at a rate commensurate with their status as comprising roughly 56% of the graduate student body at Georgia Tech. However, for advising/consulting, they participated at a lower rate than would be expected based on their prevalence in the graduate student body.

Table 3: Count and Percentage of Engineering Students Participating in Activities

Activity Type	**Count and Percentage of engineering students in each activity type**
Courses	16/28 (57%)
Workshops	65/119 (55%)
Advising	24/71 (34%)

4. Results

Assessment of student participation in and reactions to the components of *Tech to Teaching* programming was facilitated through analysis of attendance/enrollment figures, student grades, and course ratings/evaluations. These items will be discussed in turn for the courses, workshops, and advising that were offered during Spring and Summer, 2009.

4.1 Coursework

[Please note that the original proposal for *Tech to Teaching* included one 3-credit course, CETL 8803: Fundamentals of Teaching, Learning and Course Design. This was offered as a pilot in spring, 2009. However, it was determined that a single course was not sufficient to address all the issues needed for a strong student learning experience. Therefore, it was decided that the course should be broken into two components – one for the fundamentals of teaching and learning (with the first mentored teaching experience to follow), and one for course design (with the immersion teaching experience to follow).]

Two graduate level courses were offered through *Tech to Teaching* during Spring and Summer, 2009. The first of these was CETL 8803: Fundamentals of Teaching, Learning and Course Design (this course was offered in Spring, 2009; for more detailed information on this course, please see section 3.2 above, Certificate Program Description – Level A). Of the 14 students initially enrolled in this course, 13 students completed the course and 1 student withdrew. This course was offered as a pass-fail course; all 13 students who completed the course earned passing grades. Course evaluations were gathered through the Georgia Tech Course-Instructor Opinion Survey (CIOS), an online survey administered near the end of each semester. Eleven of the 13 students who completed this course responded to the CIOS. Ratings for this course were somewhat mixed. Overall, students were happy with the instructor, giving an interpolated median rating of 4.6 for the item "The instructor was an effective teacher." Students gave a high score to the course instructor on the item "Good job covering course objectives/content" (4.7), but provided a lower score for the course instructor on the item "Explained complex material clearly" (3.5). So this instructor delivered the appropriate information to the students, but there is room for improvement in how this instructor explains complex material to students. There is also an opportunity for improvement in the organization of the course, given that students gave a score of 3.4 on the item "Course seemed well planned and organized." Students in this course also viewed attending class as worthwhile (rating of 4.6), and felt that the instructor was approachable (rating of 4.6) and encouraged consultation with students (rating of 4.8)[23]. Given the high response rate for the survey, coupled with the relatively high scores on many of the survey items, it is reasonable to conclude that overall, students were satisfied with this course. The 100% passing rate also indicates that students performed at least moderately well in achieving the course objectives.

The second graduate level course offered through *Tech to Teaching* was the training program for Georgia Tech's STEP Up! program. As is sometimes the case with summer courses, the CIOS response rate for this course was quite low: only one of the fourteen students who completed this course responded to the CIOS. This student was pleased with nearly all aspects of the course, but it is unwise to draw conclusions from this data due to the extremely low response rate. Due to the low response rate for CIOS among this class, the participants' journal entries (which were written by all students in this class as part of their participation in the STEP Up! program) containing reflections on the summer training were analyzed. In general, participants felt that their time in training/meetings was well spent. They expressed a desire to have more time spent on micro-teaching and inquiry-based learning, as well as more time spent with previous program participants and teacher partners/coordinators[23]. Fourteen students completed this course; the course was offered as a pass-fail course, and all 14 students earned passing

grades.

4.2 Workshops

Nine workshops were offered during Spring, 2009; workshops are not typically offered through CETL during the summer. These workshops covered a broad range of topics and were well-attended (attendance for these workshops ranged from 8 to 41participants). Attendance figures and interpolated median responses to the item "I would recommend this workshop to other grad students/TAs/Post-dosc/etc." for each of the nine workshops are presented in Table 4.

Table 4: Spring, 2009 Graduate Workshops:

Title	# participants	"Recommend to others" rating
Phone Interviews	41	4.8
Motivating Students	16	4.3
Giving a Job Talk	36	4.7
Presentations and Poster Design	15	4.4
Academic Career Panel –faculty	35	4.5
Academic Career Panel – non-faculty	27	4.3
Intercultural Communication	13	4.5
CV Workshop	8	4.9
Career Options in HS (high school) Teaching	17	4.7

A summary of student evaluation scores for the subset of workshops most relevant to *Tech to Teaching* is presented in Table 5.

Table 5: Participant Ratings Summary for Workshops Relevant to *Tech to Teaching*

Motivating Students	**% responding "agree" or "strongly agree"**	**# students responding**	**Interpolated Median**
This workshop helped me understand what is motivating and demotivating to students.	100%	16	4.2
This workshop provided me with concrete strategies for motivating students.	100%	16	4.2
The activities/discussions I participated in aided my understanding of the concepts presented.	94%	16	4.2
The leader explained concepts clearly.	100%	16	4.5
This workshop met (or exceeded) my expectations.	94%	16	4.1
I would recommend this workshop to other graduate students/TAs/post-dosc/etc.	94%	16	4.3
Career Options in High School Teaching			
This workshop provided me with information useful for deciding if K-12 teaching might be a good career choice for me.	94%	16	4.5
I now have a basic understanding of how I could become certified in Georgia if I decided to teach K-12.	94%	16	4.6
This workshop helped me compare some of the pros and cons of teaching as an adjunct at a community college with teaching at the K-12 level.	94%	16	4.9
The activities/discussions I participated in aided my understanding of the concepts presented.	94%	16	4.4

The leader explained concepts clearly.	100%	16	4.8
This workshop met (or exceeded) my expectations.	94%	16	4.5
I would recommend this workshop to other grad students/TAs/post-docs/etc.	94%	16	4.7
Non-Faculty Academic Career Options Panel			
This panel provided me with more information about career options within academia.	100%	22	4.4
Overall, hearing about the panelists' perspectives was valuable.	100%	22	4.6
The question and answer portion of the panel was valuable.	95%	21	4.5
This panel met (or exceeded) my expectations.	96%	22	4.1
I would recommend this type of panel to other grad students/TAs/post-docs/etc.	91%	22	4.3
Faculty Academic Career Options Panel			
This panel provided me with more information about career options.	93%	27	4.5
Overall, hearing about the panelists' perspectives was valuable.	96%	27	4.7
The question and answer portion of the panel was valuable.	96%	27	4.8
This panel met (or exceeded) my expectations.	82%	27	4.1
I would recommend this type of panel to other grad students/TAs/post-docs/etc.	100%	27	4.5

Two additional mini-series of workshops were offered through the Chemical Engineering and Housing Departments. No evaluation data was collected for these workshops. There were approximately 20-30 attendees for each of the Chemical Engineering workshops (which were held during Spring, 2009), and there were approximately 10 attendees for each of the Housing workshops (which were held during Summer, 2009).

4.3 Advising

While no evaluation data is available for advising, counts of appointments were used to assess students' use of this service. Table 6 shows the advising activity between January and September, 2009. Increasing demand for graduate advising services has led to a two-week scheduling delay, prompting discussions concerning appropriate resource allocation. This dramatic and unexpectedly high student utilization of this resource indicates that the *Tech to Teaching* program is satisfying a significant need within the community of students seeking teaching positions in higher education[23].

Table 6: Graduate Advising Count for January – September, 2009

# of Students	# of Sessions
72	**126**

5. Conclusions

Taken as a whole, the information presented in this paper provides evidence that the newly developed *Tech to Teaching* program is both serving a need on Georgia Tech's campus and has been utilized and well-received by graduate students. This program clearly has the potential to make a strong impact on engineering education specifically, demonstrated by both the large number of engineering graduate students present on Georgia Tech's campus who have the option to take advantage of these opportunities, as well as the fact that in the first year of this program, engineering students participated in courses and workshops at a rate commensurate with the percentage of the graduate student body that they comprise. The multi-faceted structure of this program was designed in an effort to assist students along their career paths to higher education teaching, and also to ensure that students will experience success once they embark upon such careers. These aims are facilitated in myriad ways through the programming and services offered by *Tech to Teaching*: students can receive content on principles of teaching and learning, various teaching career path options, and tips for the academic job search during courses and workshops; students can gain real-world teaching experience by participating in practicum and immersion experiences; and students can receive one-on-one consultations regarding their academic job search or teaching skills from experienced advisors.

Results from the first year of the program, including enrollment/attendance figures, course grades, and evaluations/ratings, suggest that: 1) a considerable number of students were reached by the program in its first year, 2) the students who participated in the courses performed well and demonstrated proficiency with the course content, and 3) the students participating in

these programs were generally pleased with their experiences. It is the authors' intention that readers of this paper come away with an understanding of both the critical need for and positive student reception of this type of programming, as well as practical ideas for implementation of such programming at other institutions. The program has enjoyed success during its first year, and, supported by strong student demand and obvious potential for impacting a large number of students in positive and meaningful ways, the program is poised to increase in scope and number of students reached in the coming years.

Acknowledgement

This work was supported by the National Science Foundation under grant No. 0833434. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Appendix

Table A1: Description of Elements of Mentored Teaching Practicum

Teaching Responsibilities
Attendance at every class period of the mentor's course
Design and facilitation of 4 "class deliveries:" one 5-min introduction of self and research to the class, one 10 - 15 minute part of a class meeting, and two full class sessions.
Ownership and implementation of all teaching tasks associated with the two full class deliveries (ex: write exam questions on their class delivery topics)
Learning Community Activities
Observe two peers and give feedback
Be observed by two peers and receive feedback
Share and discuss faculty academic job discussions with other practicum participants
Assignments
Practicum contract with mentor
Pre-class delivery forms for all 4 class deliveries
Lesson plan and all accompanying files for the two full course deliveries
Be observed by CETL and get feedback
Administer, collect and analyze feedback from students after each of the two full-course deliveries
Analysis paper on two full class deliveries
Reflection paper on faculty academic job advice and impact on mentee
Teaching philosophy statement (revised)
Final report on practicum experience
Mentoring Interactions (Required)
Course syllabus overview
Mentee's personal practicum goals
Roles and responsibilities of each party (contract)
Teaching philosophies of both parties (at beginning and end of practicum)
Final grade assignment process
Life as a faculty member and academic job search advice (Must also interview a second faculty member from a different type of university/college)
Final evaluation of mentee by mentor
Mentoring Interactions (Suggested)
Joint analysis of most recent class period taught by faculty member
Classroom management tips
Homework assignment writing and grading hints
Managing TAs effectively
Designing lessons
Designing a syllabus
Building a rapport with students/motivating students
Engaging students through active learning
Diversity in the classroom

Time management strategies—balancing teaching, research, personal, social, etc.
Ethical issues and teaching – potential problem situations
Reviewing/interpreting student feedback for improvement

Table A2: Description of Elements of Mentored Teaching Immersion

Teaching Responsibilities
Instructor of record (or equivalent) for a college course with full course responsibility
Teach at 100% of the "lecture" class meetings of a college course
Ownership and implementation of all teaching and course management tasks associated with the course, including assigning final grades
Learning Community Activities
Observe two peers teaching and give feedback
Be observed by two peers and receive feedback
Assignments
Immersion contract with mentor
Course syllabus and schedule
Pre-class delivery forms for 2 class deliveries
Lesson plan and all accompanying files for the 2 course deliveries.
Administer an in-class or online midterm evaluation or have CETL conduct a Class Dialogue during class time. Meet with a member of CETL (and mentor) to discuss results
Be observed by CETL and get feedback
Analysis paper on two full class deliveries
Teaching philosophy statement (revised)
Final report on immersion experience
Mentoring Interactions
Course syllabus and schedule feedback
Mentee's personal immersion goals
Roles and responsibilities of each party (contract)
Teaching philosophies of both parties (at beginning and end of practicum)
Discuss mid-term evaluation or class dialogue results
Mentor observes two class deliveries and gives feedback
Final grade assignment process
Final evaluation of mentee by mentor

Bibliography

1. Georgia Institute of Technology, Office of Institutional Research and Planning. [cited 2010, January]; Available from: http://www.irp.gatech.edu/apps/factbook/?page=75
2. Hoffer, Thomas B., et al. Doctorate Recipients from United States Universities: Summary Report, 2006. Chicago: Natl. Opinion Research Center, 2007. [Cited 2010 Jan. 2008]; Available from: www.norc.org/projects/survey+of+earned+doctorates.htm
3. Schuster, G., Llewellyn, D., May, G., & Usselman, M. (2003). *Tech to Teaching* Grant Proposal , Georgia Institute of Technology, NSF Grant No. 0833434. Abstract available from http://nsf.gov/awardsearch/showAward.do?AwardNumber=0833434
4. Adams, K.A., *What Colleges and Universities Want in New Faculty.* Preparing Future Faculty Occasional Paper Number 7. 2002, Washington, DC: Association of American Colleges and Universities and Council of Graduate Schools. [cited 2010 January]; Available from: http://www.aacu.org/pff/pdfs/PFF_Adams.PDF
5. Committee on Science Engineering and Public Policy (COSEPUP), *Reshaping the Graduate Education of Scientists and Engineers.* 1995, Washington, DC: National Academy Press. [cited 2010 January]; Available from: http://www.nap.edu/openbook.php?record_id=4935&page=R1
6. ASEE database, available from http://edms.asee.org/session/new
7. The Carnegie Foundation for the Advancement of Teaching. The Carnegie classification of institutions of higher education / with a foreword by Lee S. Shulman (A technical report). 2001. [cited 2010 January 8]; Available from: http://classifications.carnegiefoundation.org/downloads/2000_edition_data_printable.pdf
8. DeNeef, A.L., *The Preparing Future Faculty Program: What Difference Does it Make?* Preparing Future Faculty Occasional Paper Number 8. 2002, Washington, DC: Association of American Colleges and Universities and Council of Graduate Schools. [cited 2010 January]; Available from: http://www.aacu.org/pff/pdfs/PFF_DeNeef.PDF
9. Woodrow Wilson National Fellowship Foundation (WWNFF), *The Responsive Ph.D: Innovatios in U.S. Doctoral Education.* 2005, [cited 2010 January]; Available from: http://www.woodrow.org/images/pdf/resphd/ResponsivePhD_overview.pdf
10. Woodrow Wilson National Fellowship Foundation (WWNFF), *The Responsive Ph.D: Retrospective, Prospective Conference.* 2005, [cited 2010 January]; Available from: http://www.woodrow.org/images/pdf/resphd/PDF_Responsive_PhD_conf_summary.pdf
11. POD Network Conference, Houston, TX, Oct. 29, 2009. Structured Professional Development for Graduate Students: A Taxonomy. A. Kalish, S. Rohdieck, L.L.B. Border, L.N. Schram, L. von Hoene, E. Chandler, V. Maurer, C. Volpe Horii.
12. University of Wisconsin, Delta Program. [cited 2010 January]; Available from: http://www.delta.wisc.edu/
13. Fink., L. D. (2003). *Creating significant learning experiences: An integrated approach to designing college courses*. San Francisco: Jossey-Bass...
14. Weimer, M. (1991). *Improving College Teaching*. San Francisco: Jossey-Bass Publishers.
15. Soleil, L. & Young, K. SLAB Proposal: Graduate Student Career Day. 2008. (internal university grant)
16. Golde, C.M. & Dore, T.M., *The Survey of Doctoral Education and Career Preparation: The Importance of Disciplinary Contexts.* In *Path to the Professoriate: Strategies for Enriching the Preparation of Future Faculty.* 2004. San Francisco: Jossey-Bass.
17. Nyquist, J.D. & Wulff, D.H., *Working Effectively with Graduate Assistants.* Thousand Oaks, CA: Sage.
18. Nyquist, J.D., Manning, L., Wulff, D.H., Austin, A.E., Sprague, J., Fraser, P.K., Calcagno, C., & Woodford, B. *On the Road to Becoming a Professor: The Graduate Student Experience.* Change, 1999. **31**(3): p. 18-27.
19. Nyquist, J. D. (2002, November/December) The PhD: A tapestry of change for the 21st century. *Change, 34*(6), 12-20.
20. University of Michigan Regents. "How to Get the Mentoring You Want: A Guide for Graduate Students at a Diverse University" 2002. [cited 2010 January 8]; Available at: http://www.rackham.umich.edu/StudentInfo/Publications/StudentMentoring/contents.html
21. Walker, G.E., Golde, C.M., Jones, L., Bueschel, A.C., & Hutchings, P. *The Formation of Scholars: Rethinking Doctoral Education for the 21st Century*. 2008. San Francisco, Jossey-Bass.
22. Woodford, B., *How to Obtain the Mentoring You Need*. 2005. Seattle, WA: The Graduate School, University of Washington. [cited 2008, April]; Available from: http://www.grad.washington.edu/mentoring

23. DeHaan, R., Utschig, T.T., Noyes, C., Newton, S, & Llewellyn, D., "*Tech to Teaching* Annual Report" 2009. Georgia Institute of Technology, NSF Grant No. 0833434.
24. U.S. Department of Education, Graduate Assistance In Areas of National Need. [cited 2010 January]; Available from: http://www.ed.gov/programs/gaann/index.html