



CIRTL is preparing future faculty who not only value both teaching and research but can also integrate the two in ways that enable them to excel at both



Fewer than 1 of every 10 Ph.D. recipients become faculty at research universities



Most doctoral students who become faculty will be employed at institutions where superb undergraduate teaching is paramount



Improvement of future faculty preparation at tens of research universities will impact undergraduate education at thousands of colleges and universities

IMPROVING STEM GRADUATE EDUCATION THROUGH THE INTEGRATION OF RESEARCH, TEACHING, AND LEARNING

The U.S. system of graduate education confers more than 45,000 doctorates each year. Approximately half of these Ph.D. recipients will become college and university faculty, dispersing among more than 4000 research universities, comprehensive universities, liberal arts colleges, and community colleges. Remarkably, only 90 research universities produce 70% of U.S. Ph.D.s [1] [2]. **Thus, research universities play a crucial role in forming the next generation of science, technology, engineering and mathematics (STEM) faculty in the United States.**

The nation has repeatedly called for enhanced STEM learning for all [3]. Directly and indirectly, the next generation of STEM faculty will help shape STEM learning throughout the U.S. educational system. Preparing current doctoral students to meet such responsibilities as faculty is a primary responsibility and challenge for U.S. graduate schools.

For decades, STEM doctoral education has strongly emphasized training students for research careers. This research preparation, among the best in the world, is central to the intellectual vitality of the nation. Even so, few current students will have primarily research careers as faculty; fewer than 1 of every 10 Ph.D. recipients become faculty at research universities [4].

A great strength of U.S. higher education is that today's STEM graduate students will be faculty at a diverse array of colleges and universities. Their success will come from integration of their STEM research skills with their abilities to:

Effectively Teach and Mentor Undergraduates. Most doctoral students who become faculty will be employed at institutions where superb undergraduate teaching is paramount. Research university faculty also have rising expectations for undergraduate teaching excellence [5].

Encourage Diversity. Studies show that systematic biases deflect women and ethnic minorities from entering STEM doctoral training, successfully completing their degrees, and entering faculty careers. The repeated call for diversity in U.S. graduate schools can only be addressed by future faculty able to effectively teach and mentor diverse undergraduate students [6].

Balance the Demands of Academic Work. Graduate schools are facing attrition rates that near 35% in STEM fields. Some highly talented doctoral students express



Doctoral education in the U.S. must prepare faculty who can successfully integrate the research and teaching roles of contemporary academic work.

~

The mission of CIRTL is to prepare future faculty who are both superb researchers and excellent teachers.

~

“Put simply, the Delta program and the internship in particular were instrumental in placing me on my current career path. Through the Delta program, I was inspired to believe that I could become an effective teacher. The Delta program was also very useful in getting a job. In my job interviews, people seemed to be very impressed that I could talk about approaches to teaching and learning and that I was participating in a study to assess student learning.”

— Former Delta Program participant, a 2nd-year assistant professor of biology

reservations about pursuing careers as research faculty that they see as poor fits to their professional and personal priorities. Students exposed to the full range of academic roles are more likely to find their place in higher education and succeed as junior faculty [7].

Educate Teachers. Future faculty will provide the STEM undergraduate education for the 100,000 students hired each year as K-12 teachers. The education of STEM teachers can no longer be taken as an incidental outcome of undergraduate STEM courses. Intentional engagement must become part of undergraduate teaching [8].

Educate the Public. There are rising expectations for better connections between academic work and the needs of the public. Future faculty will have increasing involvement with outreach and broader impact [9].

Doctoral education in the U.S. must prepare faculty who can successfully integrate the research and teaching roles of contemporary academic work.

CIRTL: A SYSTEMIC APPROACH TO PREPARING FUTURE FACULTY

The **Center for the Integration of Research, Teaching, and Learning (CIRTL)** is demonstrating at multiple research universities that this integration enhances both research and learning outcomes.

The mission of CIRTL is to prepare future faculty — in STEM and in the social and behavioral sciences (SBE) — to be both superb researchers and excellent teachers. Funded by the National Science Foundation as one of two national centers for learning and teaching focused on postsecondary education, CIRTL is a collaboration of six leading research universities.

CIRTL is distinguished by its recognition that doctoral education is a powerful leverage point for enhancing undergraduate STEM and SBE education nationwide. Doctoral education at tens of research universities impacts undergraduate education at thousands of colleges and universities.

But how is it feasible to motivate change at research universities? First we recognize that improving teaching is essentially a research problem for each faculty member. Then we must demonstrate that the integration of research and teaching is an efficient approach to improving both research and learning at the research university itself as well as across the nation.

CIRTL approach integrates three fundamental ideas (the “CIRTL pillars”) which guide the design of every CIRTL class, program and activity for graduate students, post-docs and faculty:

Teaching-as-Research is the deliberate and systematic use of research methods to develop and implement teaching practices that advance the learning of students.

Excellent teaching requires knowing what students have learned; this is a research question. In Teaching-as-Research, STEM faculty use the experimental approach to answer questions about their teaching — defining objectives, developing hypotheses, designing experiments, gathering and analyzing data, and drawing and acting on conclusions. Teaching-as-Research resonates with STEM graduate students and faculty as a natural integration of research, teaching and learning.

CIRTL uses interdisciplinary and intergenerational **Learning Communities** to foster and support learning about teaching. Like research groups, learning communities are designed so that participants have functional interactions to achieve their common goals. Experiences in a learning community are typically collaborative, and indeed rely on the diversity of the participants to enhance learning. In a CIRTL learning community, graduate students, post-docs, and faculty work together to learn and, through teaching-as-research, generate new data-based ideas to enhance teaching and learning.

Learning-through-Diversity recognizes that excellence and diversity are necessarily intertwined, and that learning is enhanced by building on the diverse backgrounds, skills, and experiences of all learners in a group. Learning-through-Diversity begins with creating equitable learning environments that recognize and respect the diversity of students and teachers. Then it reaches further, leading faculty to incorporate their students' diversity in ways that enrich the learning of all participants.

To explore the effectiveness of these three ideas at a major research university, CIRTL developed a prototype learning community at the University of Wisconsin–Madison: the **Delta Program in Research, Teaching and Learning**. A Delta Program fact sheet is provided in the sidebar.

The sidebar demonstrates the demand for such a learning community. Delta participants comprise over 1800 graduate student, post-doc, faculty, and academic staff members in seven years.

THE CIRTL NETWORK: A LEARNING COMMUNITY OF RESEARCH UNIVERSITIES

One research university alone cannot create the entire national STEM faculty; a network of universities can. CIRTL began as three universities using the University of Wisconsin – Madison campus as a laboratory to develop and study the prototype Delta Program. In 2006, CIRTL expanded into the current CIRTL Network of six research universities:

***University of Colorado at Boulder
Howard University
Michigan State University
Texas A&M University
Vanderbilt University
University of Wisconsin – Madison***

Delta Program in Research, Teaching and Learning

www.delta.wisc.edu

2003 Launch

2003 – 2010 Participants

*1091 grad students
303 faculty
238 staff
233 post-docs*

*88 STEM and SBE
departments/
programs
represented*

2009 – 2010 Academic Year Opportunities

*- 8 semester-long
graduate courses
- 4 small group
programs
- 9 internships
- 7 mentor training
seminars
- 6 roundtable
dinners
- 2 Teaching portfolio
series workshops
- NSF Graduate
Fellowship workshops
- NSF CAREER
Award workshops*

2005-2009 Outcomes

*90% satisfaction
40% of successful
CAREER awards at
UW*

2010 Operating Budget

*\$ 185,000
Mostly from UW-
Madison*

CIRTL Resources

Guidebooks for Courses & Programs

*www.cirtl.net/
course_guidebooks*

The CIRTL Diversity Resources

*(to develop skills in
teaching to diverse
student audiences)*

*www.cirtl.net/
diversityresources*

The Delta Program Web Site

www.delta.wisc.edu

Research & Evaluation Publications

*www.cirtl.net/
bibliography*

Published November 2010

*This publication is funded
by a grant, DUE-0717768,
from the National Science
Foundation, for the
University of Wisconsin-
Madison, to support the
Center for the Integration
of Research, Teaching, and
Learning (CIRTL). The
opinions expressed here
do not necessarily reflect
the opinions or policies of
the NSF, and no official
endorsement should be
inferred.*

These diverse research universities have formed a cross-institutional learning community to function as a group of peers that are doing teaching-as-research around strategies to prepare future faculty. Each institution is developing a model for STEM and SBE doctoral student development which is appropriate for its own context, culture, and history.

The CIRTL Network universities share the common goal of preparing future faculty who are both excellent researchers and superb teachers. They also share the common strategy of using the CIRTL ideas as the foundation upon which to design and expand their doctoral preparation in teaching and learning.

The CIRTL Network is also exploring the hypothesis that a graduate student at one Network university will be better prepared for future faculty positions because of having interacted with graduate students and faculty at the other Network institutions. Thus, the CIRTL Network is committed to an array of ways to link the diverse academic cultures through distance learning, exchanges, collaborative teaching-as-research, and the like. We will describe our cross-network activities in more detail in a future CIRTL Brief, but they also can be found now at www.cirtl.net.

REFERENCES

1. Walker, G.E., et al., The formation of scholars: Rethinking doctoral education for the twenty-first century. 2008, San Francisco: Jossey-Bass.
2. Hoffer, T.B., et al., Doctorate recipients from United States universities: Summary report 2006. 2007, National Opinion Research Center: Chicago.
3. Committee on Science Engineering and Public Policy, Rising above the gathering storm: Energizing and employing America for a brighter economic future. 2006, Washington, DC: National Academies Press.
4. Gaff, J.G. and L.M. Lambert, Socializing future faculty to the values of undergraduate education, in Change. 1996. p. 38-45.
5. Evans, D., J. Grace, and D. Roen, Signs of change at a research-extensive university: Promoting the scholarship of teaching and learning at Arizona State University, in Faculty priorities reconsidered: Rewarding multiple forms of scholarship, K. O'Meara and R.E. Rice, Editors. 2005, Jossey-Bass: San Francisco. p. 209-229.
6. Nelson, D.J., A national analysis of minorities in science and engineering faculties at research universities. 2007, University of Oklahoma: Norman, OK.
7. Lovitts, B.E., Leaving the ivory tower: The causes and consequences of departure from doctoral study. 2001, Lanham, MD: Rowman & Littlefield.
8. National Center for Education Information. 2008 [cited 2008 June 10]; Available from: <http://www.ncei.com/>.
9. Council of Graduate Schools Advisory Committee on Graduate Education and American Competitiveness, Graduate education: The backbone of American competitiveness and innovation. 2007, Author: Washington, DC.