Teaching-as-Research:
A Concept for Change at Research Universities

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Preliminary Thoughts

A critical leverage point for change in STEM[1] higher education is the training of doctoral students at research universities. In the United States, roughly 100 research universities produce 80% of all doctoral degrees, and the vast majority of the faculty members in the nearly 4000 colleges and universities of the U.S. pass through these research universities. **Thus research universities have an unprecedented opportunity, and challenge, to lead the way in advancing change and innovation in graduate training, with the goal of systematically and rigorously preparing the future STEM faculty in ways that enhance student learning.** Furthermore, the time to address this challenge is now. With large numbers of faculty retirements in the near future, universities and colleges will soon be hiring young STEM scientists to replace their ranks.

Ironically, a research university is the one institution of higher education most divided with respect to its investments in teaching and research. Put in a positive light, faculty at research universities perceive themselves as uniquely contributing an important good to society through their generation of new knowledge. From the perspective of this goal, diversion of effort from research is not effective. Of course, more practical institutional and disciplinary reward systems also reinforce the importance of that research.

At the same time, research universities contribute to society through their mission to teach undergraduates and to train the next generation of scholars and citizens. Faculties of research universities are committed to the learning of their undergraduate students. Nonetheless, they are conflicted with respect to the amount of time to invest in their teaching relative to their research. Furthermore, they often see the two activities as fundamentally orthogonal.

In fact, the improvement of teaching is itself a research problem addressing the question "What have my students learned?" Indeed, the enhancement of student learning is a question subject to the experimental method of hypothesis, experiment, observation, analysis, and improvement. Thus my colleagues and I have suggested that the concept of **Teaching-as-Research** can play a powerful role in engaging STEM graduates-through-faculty[2] in reform of teaching practice. Our hypothesis is that the Teaching-as-Research idea places teaching in a context within which STEM researchers are comfortable and skilled (albeit in different methods), and thereby fosters their engagement in advancing

[1] Science, Technology, Engineering, and Mathematics
[2] Graduate students, post-doctoral researchers, faculty and academic staff.

their own teaching. Importantly, if our hypothesis proves true, this perspective naturally leads to self-sustained, ongoing improvement of STEM education. Like STEM disciplinary research, teaching becomes a dynamic and progressive activity rather than a static task. **Our ultimate goal is to develop STEM faculties who themselves continuously inquire into their students' learning.**

In more detail, our conceptualization of Teaching-as-Research involves the deliberate, systematic, and reflective use of research methods by STEM graduates-through-faculty to develop and implement practices that advance the learning experiences and learning outcomes of students and teachers. The conceptual steps in the teaching-as-research process follow the model of most STEM disciplinary research:

1. Learning foundational knowledge.
2. Developing goals and ideas (hypotheses) for improved student learning.
3. Defining measures of success and the required evidence.
4. Developing and implementing practices within an experimental construct.
5. Collecting and analyzing data.
6. Reflecting, evaluating, and iterating.

The application of Teaching-as-Research is meant to lead participants to an ongoing process of discovery and change, which is the core motivation of all researchers.

A powerful concept requires a community in which to flourish and develop. Thus we have integrated the Teaching-as-Research concept with the idea of a learning community. Learning communities are rich, enduring, integrative environments for change in teaching and learning. Within learning communities members connect and support each other around specific learning objectives and principles. Learning communities also foster strong relationships among members across an institution and thus build a foundation for institutional change. Of course, learning communities are familiar to STEM graduates-through-faculty in the forms of research groups, academic departments, or professional societies. Our goal – and challenge - is to develop an interdisciplinary and intergenerational learning community around Teaching-as-Research.

Finally, our conception of Teaching-as-Research is deeply and naturally linked to the issue of success for all students. Research into the question of "What have my students learned?" necessarily will reveal whether the findings are the same for all students. Likely they will not be the same, which will immediately raise the next research question of why not. Investigation into this question, and the associated foundational knowledge, will raise the wide variety of challenges associated with diverse learning styles, student demographics and previous education, and so on. Thus our Teaching-as-Research hypothesis includes bringing research faculty to face issues of diversity in student learning.

The development, implementation, and evaluation of these ideas is the mission of the *Center for the Integration of Research, Teaching and Learning*[3], a 5-yr project of the University of Wisconsin – Madison, Michigan State University and the Pennsylvania State University funded by the U.S. National Science Foundation (NSF). The initial

[3] www.cirtl.net

laboratory for our investigations is the interdisciplinary *Delta Program in Research, Teaching and Learning*[4] being developed by all of the CIRTL partners at the University of Wisconsin, a large, forefront research university. After the first semester (Fall 2003), the Delta learning community comprises:

1. A graduate curriculum including courses in *The College Classroom*, *Instructional Materials Development*, *Teaching with Technology*, and *Informal Education*. Each of these courses is modeled after disciplinary seminars where the centerpiece is a small piece of research. In these courses the research is the development, implementation, and analysis of an educational product. Importantly, each of these courses is team taught by two leading disciplinary researchers in both STEM and educational sciences.
2. An array of graduate-through-faculty small-group programs designed to foster communication across disciplines and career phases. For example, one successful program has been *Expeditionary Learning* in which every two weeks a group of 8-12 graduates-through-faculty go on expeditions to teaching and learning opportunities on campus, and then gather for reflection and discussion in the off-weeks. (The experience of attending a class outside your department and your field can be life-changing.)
3. Internships for graduate students and post-doctoral fellows. Modeled on mentoring partnerships in disciplinary research, these internships are opportunities for graduates-through-faculty to complete teaching-as-research projects that realize professional development for all involved and enhance learning outcomes for future students.
4. Monthly RoundTable dinners designed to bring together all members of the community in order to foster both connections and awareness that each of these small communities are part of a much larger campus community.
5. Self-initiated graduate student and post-doctoral learning communities around teaching and learning.
6. A physical place for gathering and comfortable communication.

In our first semester (Fall 2003), more than 200 STEM graduates-through-faculty participated in one or many facets of the Delta community.

Of course, the issue of permanent institutional change is central to the CIRTL project. One specific new influence promoting institutionalization of the Delta Program is worth highlighting here. Recently the NSF has re-emphasized the importance of the broader impact of all STEM research programs funded by the NSF. For example, major early-career and mid-career awards associated with substantial funding now require substantive and competitive broader impact components of the proposals and nominations. More broadly, the NSF has stated that *any* research proposal must discuss its broader impact plan in the proposal abstract or be returned to the proposer unreviewed. Thus the issue of broader impact is now of central importance to all research faculty funded by the NSF, which has particularly strong impact on the physical sciences, engineering, and mathematics and extends into the biological and social sciences.

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[4] www.delta.wisc.edu

This clarion call from the NSF is being sent to research faculty members, junior and senior, who typically have had little preparation to respond. While broader impact is meant very broadly by the NSF, most often investigators conceptualize it as formal or informal education initiatives. However, U.S. STEM graduate education to date includes little professional development in teaching and learning; typical graduate experiences are one or perhaps two teaching assistantships, with widely varying degrees of mentoring.

In the long term, the programs being designed by CIRTL will create the capacity in the future national STEM faculty to respond to the NSF, and to other US Federal agencies moving in similar directions. In the shorter term at the University of Wisconsin, the Delta Program presents an appealing route for research faculty to respond to the NSF. By promoting the participation in the Delta program of the graduates-through-faculty on their research teams, research faculty can develop quickly the capacity to create, as examples, outreach products or instructional materials (e.g., for undergraduate laboratories) based on their research. In addition, their graduates-through-faculty are a conduit for dissemination of successes as they move to future positions. Finally, this new capacity enhances the future workforce of the U.S., academic and beyond. All of these results are valued within the NSF concept of broader impact. Thus the NSF, through aligned actions both in their call to broader impact and in supporting CIRTL, have created a compelling incentive for the integration of research and teaching at research universities.

As our initial development laboratory, the Delta Program is being guided and studied by a team of leading evaluators and education researchers from the CIRTL partners (including Dr. Carol Colbeck at this conference). Ultimately our goal is to integrate the demonstrated successes of the Delta laboratory among 10 research universities in a *CIRTL Network*, including Michigan State and Penn State. We are in the process of identifying the other members of the CIRTL Network, with the goal of spanning the critical dimensions that distinguish research universities in order to lay the foundation for a research study into the process.

We imagine the CIRTL Network to be highly multi-directional, since not all aspects of the CIRTL programs will suit each university and each university will have much to contribute to the CIRTL programs. In this spirit, the integration of CIRTL programs into Michigan State and Penn State are underway in parallel with the development of the Delta Program, and existing and new successes at Michigan State and Penn State are being incorporated into the Delta Program.

At the end of the five-years of CIRTL we anticipate expanding the CIRTL Network to other research universities throughout the U.S. We also look forward to expanding our connections beyond the U.S. in order to learn from the rich array of successes in STEM faculty development around the world.

It is my great pleasure to acknowledge my many colleagues in CIRTL, all of who have contributed importantly to creating and guiding CIRTL. I also wish to thank the National Science Foundation for giving us the opportunity to try this experiment as an NSF Center for Learning and Teaching. Finally, I would like to particularly thank Dr. Judith Ramaley for her support and her insights as we begin this voyage.