Establishing a Faculty Development Focus
At a Public Technological Research University

Harvest Collier and Diane Hagni
Missouri University of Science and Technology, Division of Undergraduate Studies

Abstract

At STEM-dominated research institutions, where faculty incentives are heavily weighted toward research for promotion and tenure, faculty development centers must be creative and persistent in finding ways to promote improved teaching and learning environments in order to affect campus culture. While research continues to be vital to the mission of higher education institutions, new factors are compounding the need for more emphasis on effective undergraduate STEM teaching and learning, such as the increased call for new instructional strategies for science and engineering undergraduate education to prepare tomorrow's workforce for a highly technological world; evidence of students entering college less prepared in math and sciences; and demands by stakeholders to increase access, assessment, retention and persistence of students in state-funded institutions. This paper explores the history of a faculty development center at Missouri University of Science and Technology, which faces all of the challenges mentioned above, and the strategies it is using to help shift a campus culture toward improved teaching and learning.

Introduction

At Missouri University of Science and Technology, a Midwestern land grant institution in the University of Missouri system, close to 90 percent of the 7,000-plus students enrolled are seeking degrees in engineering or hard sciences. There are approximately 440 full- and part-time faculty members, the majority of which are tenured or tenure-track. Eighty-three percent are in STEM disciplines.

Many of these professors were teaching several years ago when it was common for freshmen in packed lecture halls to hear, "Look to your right; look to your left. One of you won't be here this time next year." Although that is no longer the accepted slogan at Missouri S&T, and students generally hear more empathetic messages from faculty on campus dedicated to their success, teaching strategies have not evolved all that much over the years, with the traditional lecture still dominating the landscape in many of the STEM disciplines.

Several cultural barriers to STEM faculty development exist that are not unique to this institution, including the inherent nature of STEM content and how it affects an instructor's approach to teaching as well as an institutional structure that values research above teaching. Added to these challenges are perennial budgetary constraints that have limited the number of faculty appointments even as student enrollments have increased substantially, significantly increasing faculty workload.

Notwithstanding the presence of several teaching professors on campus, many of whom have received training in educational theory, most faculty at this institution are content experts in their particular fields and lack pedagogical training. The majority teach as they had been taught themselves. To compound the issue, instructors in the "hard" disciplines deal with instructional

material that lends itself to a more "teacher-centered" approach to learning where transmission of information and worked examples are the highest goal.[1] However, some research studies have found that this approach is linked more to surface learning. Deeper learning has been linked to a more "student-focused/conceptual change" approach, more regularly seen with instructors in the humanities and soft sciences. [2]

At a land-grant, research-intensive institution such as Missouri S&T, the culture and reward structure highly favors research productivity. Although the Collected Rules and Regulations of the University of Missouri system couple "outstanding intellectual qualities" in both teaching and scholarship in considerations for promotion and tenure, the document also notes that unless research is at the "highest level," promotion and tenure will not be approved except for "very rare cases" where teaching and service contributions are "exceptionally compelling." [3] In other words, the condition for success is still publish or perish. Unless a professor has very poor student course evaluations, the department chairperson and those who review his or her dossier will have little to say about the quality of the instructor's classroom teaching.

Added to these challenges, budgetary concerns in state institutions have brought on a hiring freeze for the last several years at Missouri S&T, leaving in its wake student-to-faculty ratios averaging 16:1, a rise from 12:1 in 2000. Total student enrollments have risen 63% since 2000. Many courses are being taught without the help of graduate teaching assistants, even in high-enrollment courses. [4]

Taking these factors into consideration, it is evident that faculty must be motivated past the barriers of a lack of reward structure and pressing time constraints to be willing to invest in faculty development efforts to improve their teaching skills and enhance their students' learning experiences.

Change not optional

Even as tenure-track faculty feel pressure to juggle more plates with less resources in order to be successful, so administrators feel increased pressure from both internal and external stakeholders for change in the STEM classroom – change that appears to be no longer optional. Along with a need to prepare tomorrow's workforce in a rapidly changing technological world, there are challenges in retaining students throughout the entire educational process. As many of these students are not adequately prepared for college-level work, the institution needs to answer the attendant demands for increased access, retention, persistence and assessment of these students.

A new report on Discipline-Based Education Research from the National Academy of Sciences calls for significant changes to undergraduate STEM education in order to prepare a "diverse technical workforce and science-literate citizenry."[5] The ubiquitous nature of information and knowledge makes the "sage on the stage" paradigm less relevant in today's classroom. Moreover, students continue to enter college with significant misconceptions associated with key concepts in various STEM disciplines. To overcome these misconceptions, as well as accommodate the ways novices learn, research-based strategies, such as interactive lectures, small group work, and authentic problem-solving, have been found to be more effective than traditional lectures.[6]

At the same time, the snapshot of high school graduates' level of preparedness for college-level academics has more negative than positive images. Although the mean grade point average of graduating high school students has increased over the years as well as the number of college preparatory classes taken in secondary school, college success measures have not improved and in many cases have worsened. [7] In a report entitled "High-School Teachers' and College Faculty Members' Perceptions of Students' Preparedness for College," from the Chronicle of Higher Education in 2006, the nearly 1,100 faculty surveyed had a negative view of how prepared current students were in comparison to five and 10 years ago. Faculty were asked to rate current students on a three-point scale with 1 = Not as well prepared, 2 = Prepared about the same, and 3 = Better prepared. The mean was 1.94 for comparisons with students from five years ago and 1.76 for comparisons with students 10 years ago, indicating that students are less prepared for college than their counterparts of a decade ago.[8]

In order to prepare students for the rigors of higher education at Missouri S&T, incoming freshmen are offered the option of enrolling in a three-week summer program called Hit the Ground Running (HGR), where they are immersed in chemistry, math and English on a collegiate level. Approximately 10% of the freshman class takes advantage of this opportunity. The program also gives some indication of the trend of student preparedness. Since the initial year of the program in 2006, the percentage of students receiving at least one failing grade in an HGR component has risen from 21.3% in 2006 to 49.6% in 2011, although there have been no appreciable changes in the curriculum or type of instruction presented.

In another measure of student preparedness, an average of 45% of the incoming freshman class at Missouri S&T for the last several years has been placed in Algebra or Trigonometry courses, instead of Calculus for Engineers, the first math class to count toward a student's degree program. This is due to the fact that, according to their placement exams, they are not ready for Calculus. Of the students placed in the most basic Algebra class (Math 2), about 50% of them receive D's, F's or Withheld grades.

Demand for access, assessment, retention and persistence

There are several factors that point toward the need of a change in culture at the organizational level. First, the University of Missouri system is part of the national Access to Success Initiative, which is working toward a goal of reducing college-going and graduation gaps by 50% for low-income and underrepresented minority students by the year 2015. Currently, underrepresented minority students make up 8% of the undergraduate population at Missouri S&T; approximately 23% of the student population is Pell Grant eligible. If the goal to increase these numbers is going to be met (12% underrepresented minorities and 30% Pell Grant eligible students by fall 2015), new resources and strategies to address success for this segment of students will be necessary and will involve the efforts of administrators, faculty and staff. A committee on Missouri S&T campus retention identified continued promotion of student-faculty engagement activities as key to improving student retention and success.[9]

Second, changes in criteria from the Higher Learning Commission that make continuous assessment of learning a priority will require a culture change at Missouri S&T. New requirements demand regular assessment of how students learn and what they learn beyond simply reporting test scores.

Finally, regarding state funding, the University of Missouri system, as well as all state-funded higher education institutions in Missouri, will be subject to performance-based funding within a couple of years, in which retention and persistence are some of the main criteria used to determine benchmarks and decide future public funding for individual institutions.

Clearly, these factors influencing faculty both from within the classroom and at an institutional level make a strong case for the need for professional development focusing on the learning process, even as other pressures limit the discretionary time instructors have to spend on these efforts.

A faculty development center

In the early years of the new millennium, Missouri S&T's vice provost for Undergraduate Studies and co-author of this paper began to recognize the need to promote the critical improvement in student learning. Also serving as longtime chemistry professor to large lecture classes of incoming freshman, he knew the challenges the students were facing in being successful. In order to foster student-teacher engagement and other strategies that were needed to transform S&T's learning environment, he formed the Center for Educational Research and Teaching Innovation (CERTI) in 2003, the first such faculty development center established on the S&T campus.

Although it is more typical for faculty development efforts to be housed in academic affairs offices, this particular Center is housed under the Division of Undergraduate Studies, which oversees a variety of offices as diverse as The Writing Center, a Regional Professional Development Center, the Freshman Engineering Program, and the Teacher Education Program. No separate budget is allocated for the faculty development center, but it is part of the overall budget of the undergraduate studies office. Funding is limited to one staff person – a full-time coordinator – and a small budget for events. Directing the Center is simply one more hat that the vice provost for undergraduate studies wears. A volunteer steering committee comprised of faculty and teaching assistants across various disciplines on campus helps direct the effort.

Faculty development strategies that emerged in changing culture

An initial task for this committee was to discover and implement strategies that could begin to shift the organizational culture toward more of an emphasis on teaching and learning.

Clickers for active learning

Early on, CERTI introduced a tool to campus to help student engagement and learning outcomes, and, surprisingly, it became a catapult to launch faculty engagement as well. This tool was a personal response system, colloquially known as "clickers," introduced in 2004 in an effort to help freshman students be more successful in introductory chemistry classes. After the early pilot showed dramatic results in student outcomes in chemistry, faculty interest from other departments grew as more instructors heard about results and wanted to implement the technology.

There was not a formal educational technology group on campus at the time, so CERTI, along with representatives from the IT department, put in place a controlled-growth plan to make sure that clickers had every chance to succeed and would be available to any instructor anywhere on

campus. This was a formidable goal at that time when only a handful of classrooms were equipped for multi-media presentations. The way in which clickers were rolled out to the campus was so successful it turned out to be a prototype for how future technologies would be introduced. A side benefit to this successful project was the emergence of an office of educational technology in 2008 to assist faculty with technology that enhances teaching and learning in the classroom.[10]

After almost a decade of use, the most recent data shows that clicker technology has been utilized by up to 14 of the campus' 21 departments. Seventy-six unique instructors have used clickers in their classrooms at any given time, and more than 49% of the student body now carries a clicker that can be used for multiple classes.[11] The steady growth in the number of clicker courses and instructors since 2005 is shown in Figure 1.
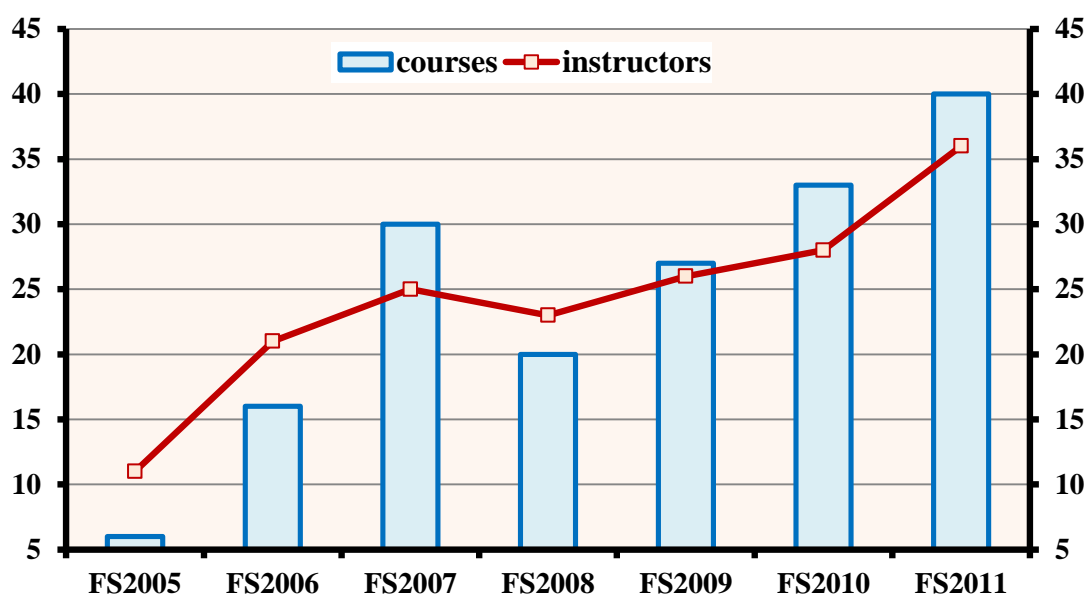

Figure 1 Growth of Clicker Courses and Instructors, 2005-2011

Another outgrowth of the clicker project was the development of a faculty learning community (FLC) around this instructional tool. This group of early adopters of the technology began meeting regularly over lunch to share ideas and troubleshoot problems. Since that time, CERTI has organized other meetings along the same lines, also calling them faculty learning communities, (although, in reality, they differ from pure FLCs as they are open to all faculty and meet around a variety of topics related to teaching and learning.) They do serve the purpose of gathering instructors with similar interests who are willing to learn and share ideas. In these events, faculty bring a lunch, CERTI provides dessert, and various topics are presented and discussed, such as end-of-semester course evaluations, academic dishonesty, classroom disruption management, best practices in laboratories, and technology tools for teaching (the latter presented in conjunction with the educational technology office).

Instructors from engineering disciplines have made up about one-third of the attendance for the past two years at faculty development events, followed closely by those in the hard sciences and

mathematics fields. Approximately two-thirds of instructor representation comes from the STEM disciplines (Figure 2). About 24% of the faculty representing 19 of the university's 21 departments attended one or more CERTI faculty development events in the 2011-2012 school year.
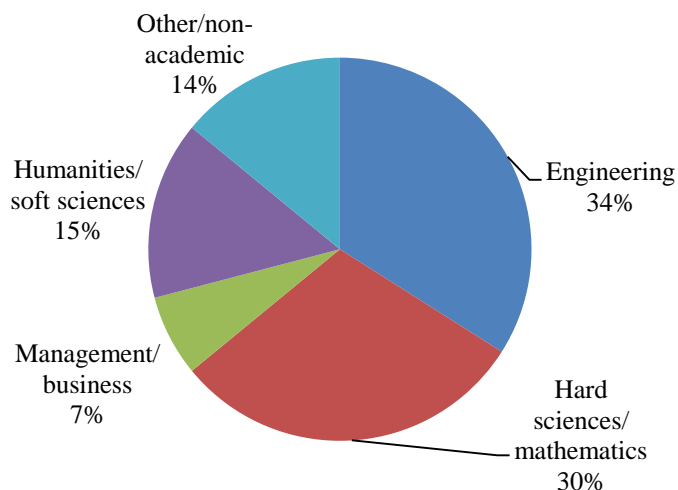

Figure 2 Distribution of Participants at CERTI Faculty Development Events, 2010-2012

Curators' Teaching Professors Summits

In 2009, CERTI began tapping the Curators' Teaching Professors on campus to share from their expertise in a fall series called the Curators' Teaching Summit. Missouri S&T has 11 Curators' Teaching Professors (two retired) who were chosen for these prestigious positions because of their established reputation as outstanding teachers; 7 of the 11 teach in STEM disciplines. They enjoy high regard on the campus for their reputation of teaching excellence.

Although at first reluctant to share with their peers, being unsure of their reception, the Curators' Teaching Professors have proven to be a significant draw to the rest of the campus. At the three events of the fall 2011 Summits, there were 163 total attendees, with 67 unique participants. There was an average attendance of just under 50 people for each individual event. Instructors ranged from lecturers to senior researchers to full professors and professor emeriti.

The summits are comprised of three hour-long luncheon events spread out over the fall semester, organized around a single topic, such as, "What Not to Do in Your Class or Lab," "Creative Teaching Techniques," "Balancing Teaching and Research," and, most recently in fall 2011, "Tac(k)tical Teaching: Strategies for Success in the Millennial Classroom."

The format of the summits has evolved over the years, beginning with traditional presentations made by individual or groups of Curators' Professors, moving to more interactive panel discussions and then to Curators' Professors serving as discussion moderators at round-table venues. At one event in 2011, clickers were used to poll the discussion groups on their thoughts, and then the tables were asked to share their answers and rationale with their group. This proved to be the most popular event of the series, according to satisfaction surveys, even though many of those who participated had never used clickers before, including the majority of the Curators' Teaching Professors.

Another strategy used was case studies, again with the Curators' Professors moderating the discussions, and then the groups presenting their findings to the audience at large. This was another popular event, although the time constraints using these active learning techniques have proven to be somewhat problematic.

The combination of venue, presenters/moderators, relevant topics and active learning strategies combined to bring about high levels of satisfaction with the events, according to exit surveys. The 2011 sessions' exit survey results recorded a 4.28 mean on a 5-point Likert scale. Additionally, 35 attendees filled out an online survey several weeks after the fall 2011 "Tac(k)tickal Teaching" Summit, asking to what degree the participant agreed or disagreed with 13 statements presented. Choices were "strongly disagreed," "disagreed," "neither agreed nor disagreed," "agreed" or "strongly agreed." Selected results are shown below:

Survey Question (n = 35)	"Agreed" or "Strongly Agreed"
The Summit helped me understand today's incoming college students better	89%
I have a more accurate idea of how to handle my classroom from the information I gained from the Summit	89%
I feel better equipped to teach Millennial students due to my participation in the Summit	80%
I was encouraged to modify some of my teaching practices through the information I received during the Summit	82%
Something I learned from the Summit has caused me to reconsider how I deliver content to my students	74%
I believe I will be more effective in classroom management due to what I learned during the Summit	79%
Something I learned from the Summit has caused me to reconsider strategies for managing my classroom	67%

Faculty offered these comments regarding what they could "take away" from the "Tac(k)tical Teaching" Summit:

- Things I can change in my class
- How my colleagues deal with many of these issues
- Useful statistics, very interesting and help understanding the class better
- The vast variety of issues in classrooms that disturb
- Knowing that others face the same frustrations and difficulties that I do as a teacher – feeling less alone
- Tips to help do better with presenting
- Feedback from colleagues

- Sharing opinions and experience with others gives me many good ideas to solve class-related issues
- Working in groups works!

In an unsolicited comment to CERTI, an assistant math professor who won his first Outstanding Teacher Award at S&T in 2011, noted, "You can see that the teaching summit (which I also attended last year) has helped me in the classroom. Thanks for such great events and hope more will come in the future."

Comments from the exit surveys and open-ended questions on the post-Summit online survey provided these insights:

- Faculty are interested in concrete examples from presenters who have proven success regarding classroom issues
- Faculty are looking for a one-size-fits-all answer to many teaching issues
- Faculty appreciate limited presentation of research that validates the strategies being proposed, but more practical than theoretical is preferred, especially when there is limited time to deliver content
- Some faculty feel isolated, and there is a psychological benefit to collegial sharing around these topics
- Faculty are interested in how similar or dissimilar they are to their peers in their strategies regarding classroom issues
- Faculty respond to events designed with their felt needs in mind
- The round table discussion, case studies and clicker participation were all popular strategies, however, the time constraints often left faculty without the definitive answers they were looking for

Focus group focusing on professional development

In a recently convened focus group of eight faculty members from diverse disciplines on campus who regularly attend CERTI events (i.e., at least three events during a school year), group members shared why they attended these events and the benefits they perceived. Many of their comments reiterated findings from the previous surveys. They appreciated opportunities to:

- interact with professors respected in teaching
- share experiences with faculty from various disciplines
- lessen feelings of isolation
- be mentored by the Curators' Teaching Professors
- gain ideas in order to try new things in the classroom
- receive help with classroom management issues
- see modeled the type of active learning that is being promoted by CERTI
- be affirmed in their desire to see improved teaching and learning on campus

The challenge is to discover whether high satisfaction with CERTI events is leading to change in teaching strategies in the classroom. Even more difficult to measure is whether these changes are leading to improved learning outcomes among students. According to Felder, Brent & Prince, improvements in teaching cannot be assumed to follow from the instructor's satisfaction with an

event. They add that it is "next to impossible" to correlate what occurs during an instructional event with improvements in learning.[12] However, what can be measured are instructors' self-assessments of pre- and post-workshop gains in their attitudes about teaching and learning, skill development, etc.[13] This will be a project for future CERTI activities.

Changing teaching through research: mini-grant program for educational research

Another measure of change in campus culture at Missouri S&T is the growth of an educational research mini-grant program begun in 2011 through the collaboration of CERTI and the office of the Vice Provost for Academic Affairs. Five mini-grants totaling $21,000 were distributed during the first round of funding to individuals as well as interdisciplinary teams to conduct projects that examined teaching and learning practices in the faculty member's discipline in a systematic way using pedagogical research methods. Results were to be measurable improvements in the quality of instruction in the undergraduate and graduate programs of the department or campus. The academic affairs office provided funding.

In March 2012, results were presented at the campus' first ever Educational Research Symposium as part of the Teaching and Learning Technology Conference. In the second round of funding, 13 projects were submitted as opposed to eight during the first round, with another $21,000 this year being awarded to nine projects, again due to collaboration with the vice provost for academic affairs' office.

Although earlier attempts to affect campus culture came about more serendipitously, in the last few years the CERTI steering committee has followed a strategic planning process that is aligned with the campus' strategic and tactical plans. Other activities that CERTI is involved with include highlighting perennial award-winning teachers and their teaching tips in the online CERTI newsletter; being involved in a national course redesign initiative of the largest gateway course at Missouri S&T, chemistry 1; offering one-on-one consultation for faculty through instructional design staff; and offering online resources of archived workshops, webinars, academic integrity materials and other resources: http://certi.mst.edu.

Conclusion and future developments

Despite formidable barriers in this institution's culture to professional development in teaching and learning, we have discovered that STEM faculty at Missouri S&T will respond to faculty development efforts with some important caveats: if there are topics that address their felt-needs, if there are well-respected presenters (even those in-house), if there are active learning elements that present practical information participants can implement in their classes, and if faculty feel that their time is used efficiently.

The professional development process appears to be more effective when faculty members can try out the active learning strategies themselves that are being promoted during the event, such as clickers, round-table discussions, case studies, group work and other active learning strategies. Building collegiality around the topics of teaching and learning, such as through discussion groups, helps to break down silos. Evidently, faculty members have very few other opportunities to interact with their peers -- even from their own departments -- and they have expressed that this type of environment has been beneficial in terms of morale.

For smaller faculty development centers, being able to collaborate with other offices on campus that are involved with teaching and learning issues, such as educational technology, academic affairs or student affairs, is key in terms of funding and in making a united case for campus change.

The challenge in any type of professional development activity is to help participants take the information they have been exposed to and transfer it to their working environment, in this case, the classroom. Further, once instructors make the transfer, the more formidable challenge is to observe and document improvements in student learning. Towards that end, CERTI is planning a pilot faculty learning community around the topic of educational research in fall 2012. Instructors will have the opportunity to discover at a deeper level how educational research can benefit their individual classes, and then be supported as they do the actual research and make the appropriate changes to improve the learning environment and outcomes of students. This cohort will then form the seed of future groups of faculty engaged in educational research in the hopes of bringing further change to the campus culture.

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Biographical Information

AUTHOR HARVEST COLLIER, hcollier@mst.edu, is the Vice Provost for Undergraduate Studies and professor of chemistry at Missouri University of Science and Technology. He also serves as the director of Missouri S&T's Center for Educational Research and Teaching Innovation. In these roles, he has initiated and led significant programs for STEM-enhanced learning environments and improved student learning outcomes.

AUTHOR DIANE HAGNI, hagnid@mst.edu, is the coordinator for the Center for Educational Research and Teaching Innovation (CERTI) at Missouri University of Science and Technology. She is currently pursuing a master's degree in adult education and holds a bachelor of journalism degree from University of Missouri-Columbia.