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# Engaging STEM Faculty While Attending To Professional Realities: An Exploration Of Successful Postsecondary STEM Education Reform At Five Science & Mathematics Teacher Imperative Institutions

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With Foreword and Highlights by Jennifer B. Presley and Kacy Redd
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This project is a component of APLU's Science and Mathematics Teacher Imperative, a consortium of 132 of APLU's public research universities, and 13 university systems that is working to transform middle and high school science, technology, engineering, and mathematics (STEM) education by preparing a new generation of world-class science and mathematics teachers. Collectively, SMTI members prepare more than 8,000 science and mathematics teachers annually – making it the largest STEM new teacher initiative in the country. For more information about SMTI, visit **http://www.APLU.org/SMTI**, or contact Kacy Redd, associate director, science and mathematics education policy, kredd@aplu.org.

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# Foreword and Highlights

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In 2008, the National Science Foundation awarded a Mathematics and Science Partnership RETA (Research, Evaluation and Technical Assistance) grant to the Association of Public and Land-grant Universities (APLU) to "Promote Institutional Change to Strengthen Science and Mathematics Teacher Preparation". APLU selected 27 (now 25) institutions from the 86 APLU institutions whose senior leadership had committed to the goal of the Science and Mathematics Teacher Imperative (SMTI: to increase the quality, quantity and diversity of their science and mathematics teacher candidates.[1] The selected group of institutions was called The Leadership Collaborative (TLC). Major activities over the period of the grant (2008-2012) included institutional implementation and assessment plans, conferences, including one for provosts, and by the third year, the development of several learning communities to study group-generated topics.

As the work of the project emerged, participants also considered undergraduate education as an integral intervening variable to the process of promoting institutional change to strengthen science (and mathematics) teacher preparation at large research-oriented universities. One of the learning communities chose to study how some of the participating institutions were successfully creating space for undergraduate education reform while attending to the traditional constraints that face university faculty at research institutions (it's about research, research, research). The learning community participants, each of the eight members representing a different TLC institution, chose to undertake a qualitative study of five of the institutions: Boise State University, Florida International University, Portland State University, the University of California, Santa Barbara and the University of Colorado, Boulder. The intention of the study was to document how change to support improved postsecondary STEM education occurred within the context of the research-university environment, with an emphasis on the role of faculty. This report provides the findings from that study. We believe the approaches detailed in this report provide new insights and confirm others about how to promote institutional change to foster undergraduate education (and by proxy teacher preparation) reform through faculty participation. Many are low cost solutions, and all represent pragmatic practices that provide 'existence proof' that reform is well underway among faculty in research-focused universities, and is becoming integrated into their professional cultures.

Here we draw from Jana Bouwma-Gearhart's report and provide highlights that should be of interest, and of use, to senior university management as well as deans, department chairs and faculty who are embarking on, or already on the path to undergraduate education reform.

## I. STRUCTURAL SUPPORTS

Interviewees spoke consistently of the importance of various types of external support to the successful implementation of reform. These include:

- Financial supports from the institution. Small efforts help, such as buying reform participants' time, providing stipends for conference participation and other professional activities. Larger efforts extend to creating novel faculty and postdoctoral positions and instituting the University of Colorado Boulder's undergraduate Learning Assistant program http://laprogram.colorado.edu/.
- Financial supports from respected organizations, specially funding agencies such as the National Science Foundation and the Howard Hughes Medical Institute.

1 Information about SMTI can be found at www.aplu.org/SMTI.

- Providing convening space. This can be very modest in nature – although another TLC study has documented the growing practice of creating STEM education centers. Funds for light refreshments turned out to be amazingly important to many of the collaborative efforts.
- Utilizing teaching tools, such as clickers. This also included developing curricula and course revisions that were useable by multiple faculty and instructors without significantly increasing their workload. Since time was, as always, reported to be in critically short supply, this strategy can help to break through this faculty barrier to participation in undergraduate education reform.

External supports appeared to be most useful for drawing in new participants. But interviewees also noted that veteran STEM education reformers often worked without any notable financial incentives. Instead, they were intrinsically motivated to volunteer their time since they had learned from earlier activities that their efforts contributed to the greater good of student learning.

## II. POLICIES AND PRACTICES THAT ATTEND TO ISSUES OF HIRING, PROMOTION AND TENURE

Typical concerns about faculty policies and practices with regard to hiring, promotion and tenure were raised, but it was very interesting to discover that a majority of respondents felt that space had been created in policies and/or practices at their institutions to reward education reform efforts. Importantly, there was strong sentiment that external entities such as esteemed foundations, professional societies and accrediting bodies were positively influencing institutional adaptation.

Unique hiring practices and positions held great promise for interviewees. These hires held positions that allowed for tenure and promotion to be granted on the strength of their pedagogical practices and research on issues of teaching and learning. These individuals had strong backgrounds in education theory and research related to the discipline. Multiple institutions had instituted a promotion policy for instructors similar to tenure-line faculty but allowing them to show scholarship success in the STEM discipline or in Education. These positions had various titles such as "Lecturers/instructors with potential for tenure/security of employment." Appointees could have dual appointments in a STEM department and Education, or full-time in a STEM department – usually with a STEM doctorate. They had higher teaching loads than their colleagues. Also growing in prevalence was the hiring of new STEM faculty with the explicit commitment that they would do education research in the discipline, and this could lead to tenure. These appointees were, however, expected to hold STEM doctorates. A third category was regular faculty who had transitioned into discipline-based education research – although most were already tenured. Some were, however, able to gain promotion based in part on their reform education work.

Many interviewees spoke with enthusiasm about the prospect of a new generation of faculty who is gaining a much deeper understanding of STEM pedagogy in undergraduate and graduate school as a result of their involvement in education reform and the opportunity to learn from teaching experts.

## III. FOSTERING STEM FACULTY PARTICIPATION AND INTERDISCIPLINARY COLLABORATION

While faculty committed to STEM undergraduate education reform are clearly intrinsically motivated to provide a quality education to students, the importance of extrinsic factors cannot be undervalued in terms of motivating other STEM faculty and instructor participation. Given that many reform-participating STEM faculty are not initially part of the stereotypical "choir" with respect to the need for postsecondary STEM reform in their departments and classrooms, and the fact that many of their colleagues still are not yet participating in reform, those attempting to encourage greater STEM faculty and instructors in reform may consider enticing participation through potentially powerful extrinsic factors. These factors include the influence of strong department chairs and deans and other respected STEM colleagues, financial motivations, affiliations with prestigious grants and disciplinary organizations, and

the prestige and safety often secured via an already-established and distinguished reform group.

The need for disciplinary faculty and education faculty to work together to strengthen the preparation of teachers is well established. What became clear from these interviews was the relevance of these collaborations to the broader realm of undergraduate education improvement as well. Interviewees identified four stages of evolution through which STEM faculty progress as they gain understanding and appreciation for education research and theory, and their Education unit colleagues. These were initial suspicion, followed by awareness and respect for other types of knowledge, then acknowledgement of the value of others' research. The fourth and final stage emerged with the acceptance of education research as an area of expertise, and its researchers as experts. The more STEM faculty had experience with discipline-based education research, education theory, and individuals trained in the education disciplines, the less likely they were to see their standard professional realities as barriers to reform. Education faculty involved in interdisciplinary collaborations, on the other hand, were well served to "meet STEM faculty and instructors where they are on their trajectory with respect to knowing and understanding pedagogical research and how this may translate to practice." It was also important for them to understand and respect the frames through which STEM disciplinary faculty viewed their work. Having strong STEM backgrounds (even STEM doctorates) themselves was advantageous to Education faculty. Opportunities for informal gatherings without the presence of skeptics were enormously important to building the trust and respect needed for the interdisciplinary collaboration that is essential for successful undergraduate education reform.

## IV. THE NEED FOR COMMON FOCUS

The need to build STEM reform collaborations around specific foci was almost universally mentioned. Strategies to support the selected focus included the use of data (often with regard to undergraduate student performance), building synergy with related reform initiatives, and using education theory and research to inform the selected effort. The inclusion of Education faculty in improvement endeavors was seen to help firm up shared foci and garner funding for the collaborations.

## V. RE-ENVISIONING POWER TOWARDS CHANGE

This report documents the importance of both explicit, or positional power, and also "hidden" power. Traditional power holders included deans and especially department chairs, although both they and faculty were aware of the importance of giving prominent initial support but with a diminishing presence as reform initiatives mature. Those who made the reform efforts really take hold usually held less traditional positions, especially those in novel faculty positions (see above) and Education faculty with strong STEM training. Postdoctoral fellows collectively had power to promote reform efforts, as did, even, undergraduate Learning Assistants. Also influential were established – and esteemed – faculty who embrace education reform and discipline-based education research specialists in STEM departments and Education units.

Perhaps most influential were those whose disciplinary education, research and theory expertise and communication skills rose to the level of "literacy broker". These individuals could translate education research and theory into a form that was understandable and usable by STEM faculty and instructors and speak the language of STEM with respect to disciplinary ways of knowing and processes. The academic home of these brokers varied. But they all were people who could convey infectious excitement and enthusiasm, treat collaborators in other disciplines as peers, and help STEM faculty and instructors embrace their role in the success of undergraduate STEM students, including future secondary STEM educators.

We offer special thanks to Jana Bouwma-Gearhart who has tirelessly and creatively worked to draw from the extensive interview data a set of operating precepts that we believe will assist other institutions and their leaders as they also strive to reform undergraduate education.

# Engaging STEM Faculty While Attending To Professional Realities: An Exploration of Successful Postsecondary STEM Education Reform at Five Science & Mathematics Teacher Imperative Institutions

Jana Bouwma-Gearhart, Oregon State University

## Introduction

In 2008, APLU was awarded an NSF grant to "Promote Institutional Change to Strengthen Science and Mathematics Teacher Preparation" among a group of 25 institutions drawn from the larger APLU/SMTI effort. Under the auspices of the grant, a learning community of eight institutions was convened to specifically investigate the issue of engagement of science, technology, engineering, and mathematics (STEM) faculty and instructors in reform efforts to improve undergraduate STEM education and, although assumed by proxy only, the preparation of secondary school mathematics and science teachers. The author represented one of those institutions. Other participants are listed in Footnote 4.

It was apparent from our meeting in October 2010 that the respective institutions were already implementing a variety of reform efforts that had undergraduate student success improvement within the STEM disciplines as their foci. Additionally evident was that these reform efforts appeared to be successful at improving undergraduate education while attending to the professional realities of STEM faculty and instructors whose main teaching appointments are in a STEM department, and whose main current or past research focus is within a STEM discipline. Some efforts seemed already to be achieving the committed and meaningful participation of multiple STEM faculty and instructors despite the assumed barriers to their participation in undergraduate education reform at our research-focused institutions. To document these reform efforts, this research project examines what works in terms of involving STEM faculty and instructors in reform initiatives while attending to their specific professional realities.

## Research Context

Much of the research on postsecondary faculty work focuses on the challenges of working in high pressure postsecondary environments at the expense of documenting the triumphs.[1] Research concerning faculty at universities with greatest research output is especially negative, focusing on factors that determine the personal beliefs and practices that act as barriers to better teaching and learning at the postsecondary level. With an overwhelming focus on these barriers, most associated research lacks practical recommendations for encouraging and supporting faculty to improve undergraduate education within the current realities of modern universities.

O'Meara et al. (2009) asked whether "[b]y focusing only on constraints faced by faculty, might we fail to see and study achievements? Might we fail to see faculty overcoming barriers toward growth and learning?" (pp.156-157). This research report adds to O'Meara et al.'s call by documenting some of the factors that foster postsecondary STEM reform endeavors that increase undergraduate student success. Based on data collected from site visits to five SMTI-affiliated universities, this paper attends explicitly to the realities of postsecondary faculty members' professional milieu. This report provides insight to a wide array of stakeholders attempting to improve undergraduate STEM education in light of the realities of postsecondary structures and practices and, specifically, the realities of STEM faculty and instructors.

1 Authors of a recent Association for the Study of Higher Education (ASHE) Report (O'Meara, Terosky, & Neumann, 2009) speak of the *narrative of constraint* that has historically emerged from research into postsecondary faculty realities. Citing the research of Rhoades, Kiyama, McCormick, and Quiroz (2008), the Report's authors state that the literature on faculty work overwhelmingly focuses on the challenges of those working within high-pressure postsecondary environments at the expense of documenting their triumphs.

Specifically, this research was guided by the following questions:

1. What are the characteristics of potentially effective postsecondary STEM education reform initiatives that involve faculty in the STEM disciplines?
2. How can undergraduate STEM education be improved for all students while attending to the professional realities faced by STEM faculty?

## Methodology

Given the nature of our research problem, and the range of backgrounds of the group of eight individuals comprising the learning community, we envisioned a research endeavor that would capitalize on our diverse experiences in postsecondary education. Towards this end, during our earliest interactions, our learning community co-created the research focus, plan, and tools. In order to continue the cross-disciplinary work in more depth Jana Bouwma-Gearhart, a representative of the STEM education perspective, and Cherilynn Morrow, co-chair of the learning community and an astronomer with experience in STEM discipline-based education reform, were responsible for conducting the interviews at the five institutions that were visited. Learning community members acted as liaisons for these visits. Bouwma-Gearhart was responsible for the analysis of findings presented in this report.

The eight learning community members created an interview tool to uncover participants' overall perceptions of the STEM education reform initiatives with which they were familiar. We used a semi-structured interview tool that would allow interviewees to recall, reflect upon and synthesize their experiences (Lattuca & Creamer, 2005; Boud, Cohen, & Walker, 1993; Livingston, 1997). We also aimed to create an interview tool that would encourage interviewees to think beyond the personal and offer insight into the success and challenges of STEM reform initiatives from a systems-perspective. (See Appendix A for the interview protocol.)

We chose to focus on five of the institutions represented by our learning community members; therefore, our research relied on a *convenience sample* (Stake, 1995). These institutions were chosen based on the following:

- Assurances of affiliated learning community members that postsecondary STEM reform initiatives were well underway at their institutions;
- Assurances that that these initiatives had improved, or were making progress towards improving, undergraduate STEM education;
- The potential of these initiatives to inform our interests regarding undergraduate STEM education reform and the professional realities of STEM faculty and instructors.

It is important to note that we did not insist on evidence of reform effectiveness when choosing our research sites. Our five institutions for investigation were:

- Boise State University
- Florida International University
- Portland State University
- University of Colorado at Boulder
- University of California, Santa Barbara

The home institutions of the two interviewers associated with this research, the University of Kentucky and Georgia State University, served as research pilots for the study. (See Appendix B for the Carnegie Classifications of the five institutions that served as our cases.)

The learning community members representing the five institutions studied for this report were instrumental to collecting data at their respective institutions. These institutional liaisons identified

research initiatives and affiliated individuals to be interviewed, and they coordinated the site visits for the two main interviewers. The institutional liaisons were asked to identify initiatives[1] that could best inform the research questions and that involved important roles for STEM faculty. They were also asked to consider potential access to the individuals associated with the initiatives during the respective campus visit. (See Appendix C for guidance provided to institutional liaisons regarding choosing initiatives and interviewees.) Institutional liaisons, given their own role in STEM reform initiatives on their own campuses, also served as research subjects. Additional research subjects from each of the institutions were recruited by institutional liaisons via personal email, phone, or in-person with a description of the study and invitation to participate. Interviews, ranging from 11-17 per campus, were completed during a 2-3 day site-visit to each institution and lasted 1-2.5 hours each, all within a three-week timeframe in February 2011. Interviews were conducted as group interviews or with individual interviewees, as per arrangements made by the institutional liaisons and with consideration of any scheduling requests made by the research subjects.

In all, 66 interviewees informed the analysis presented in this report. Of these,

- 17 individuals were from Boise State University, 13 were from Florida International University, 11 were from Portland State University, 13 were from University of Colorado at Boulder, and 12 were from University of California, Santa Barbara;
- 31 were female and 35 were male;
- 24 were STEM faculty in tenure-track lines, with 21 of these tenured;
- 8 were Education[2] faculty in tenure-track lines, with 5 of these tenured;
- Of those tenured in the two categories above, 7 were department chairs or associate chairs (5 of STEM departments, 2 of Education departments);
- 2 were STEM instructors and tenure ineligible;
- 6 were lecturers with security (3) or potential for security (3) of employment (4 affiliated with STEM departments, 1 affiliated with an Education unit, and 1 with both affiliations);
- 9 were deans or associate deans (5 of STEM colleges, 3 of Education colleges, 1 of "Other");
- 4 were provosts or presidents;
- 7 were other project leaders, coordinators/managers, or administrators of STEM reform initiatives not covered in other categories;
- 2 were postdoctoral researchers or graduate students focused on disciplinary-based research,
- 4 were classified as "Other."

Jana Bouwma-Gearhart was responsible for the analysis of data that constitutes this report, while Morrow provided outlines for several of the vignettes. Kacy Redd further enhanced and refined vignettes and developed others. Bouwma-Gearhart used NVIVO qualitative analysis software to first inductively examine and code general patterns across interviewees' talk and then to uncover more nuanced patterns in the data by running coding overlap analysis resulting in Pearson's correlation coefficients. Appendix D contains further information about how data were analyzed and the criteria used to judge the qualitative descriptions of the strength of Pearson's correlation coefficients. Appendix E contains cluster analysis results.

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1 The purpose of this research report is not to explore the actual initiatives, but the processes that surround them at the five institutions. The types of initiatives being undertaken are listed on page 12 (check which page it is finally on).

2 The term "education" is capitalized when referring to departments, colleges, or schools of education , referred to collectively in this report as Education units, and the individuals that work in them, in order to differentiate individuals and units affiliated with the discipline of "Education" versus the term "education" used more broadly a noun.

Given the small interviewee sample size of five institutions, caution must be exercised in generalizing findings to similar universities. This research is largely exploratory. However, since these five institutions — of different sizes and research volume, in five different states across the country — demonstrated similar strategies aimed at promoting undergraduate education reform, these elements further suggest the promise the findings hold for others to emulate as they strive to encourage or sustain STEM education reform initiatives at research-focused universities.

## Findings and Discussion

Five major categories for factors that contributed positively to the success of STEM education reform efforts at these institutions were identified. They include:

I. Structural supports;
II. Novel and re-envisioned policies and practices that attend to issues of hiring, promotion, and tenure;
III. Fostering strong interdisciplinary collaborations;
IV. Need for common focus;
V. Leveraging the influence of participants: re-envisioning power for change.

### I. Structural Supports

Many (about 70%) interviewees spoke of extrinsic structural supports — financial, physical and pedagogical - that fostered successful postsecondary STEM reform collaborations. They also noted, however, that as participants moved from novice to veteran participants of STEM education reform efforts, their continuing efforts became voluntary, motivated by the intrinsic reward of knowing that they were contributing the greater good of students' learning.

**Financial supports from the institution.** *"The fact is that we do support reform here. I would expect that all provosts support it with words. The reform is more compelling if you support it with money."*

Interviewees discussed how important it was, as they tried to implement reform, for senior leadership to "put their money where their mouth was," explaining that financial support was key to garnering both participants' initial interest and long-term participation in reform initiatives.

Supports from higher administration came in various forms, including:

- Buying reform participants' time through course releases, provision of teaching assistants, or full-credit for co-teaching a course, to securing STEM faculty and instructors' participation in both the reforming of classes and implementation of reformed classes.
- Teaching fellowships and awards and other modest teaching improvement or mentoring stipends for STEM faculty and instructors that were paid during the academic year or summer months. This support allowed them to attend conferences on teaching, to write grant proposals to support additional reform, or participate in learning communities focused on teaching and learning.

Often, faculty, instructors, and staff members' previous commitment, and the external validation of their previous good work (often via their securing of grants from external funding bodies or via publications), were factors in the decisions of provosts, deans, and department chairs to grant money to an initiative.

**Financial supports from respected organizations.** Being funding by (or the potential of being funded by) certain prestigious organizations to engage in postsecondary STEM reform activity served as a major motivator of STEM faculty and instructors' participation. This funding was associated with organizations with some focus on improving undergraduate education, such as the National Science Foundation and the Howard Hughes Medical Institute. Beyond the potential to buy participants' time to allow them to engage in reform activity, this type of financial support also was seen to bolster reform participants' bids for tenure and promotion.

**Providing space.** Interviewees discussed the importance of physical spaces in effective and maintainable reform initiatives, all of which were collaborations among multiple individuals. While interviewees from multiple institutions spoke of the promise of a teaching and learning center specifically earmarked for STEM reform activities, more often spaces for effective collaboration were those costing relatively nothing for their use, including:

- Conference rooms "*with a view*" or other university spaces conducive to inspirational work on reform.
- Faculty members' homes, often the site of dinners or socials that brought together reform-minded individuals.
- Taverns and other businesses, the ultimate in cheap space from an institutional perspective.

**Other Structural Supports.** Respondents also spoke of efforts that could be undertaken to promote good teaching and learning practices with little or no fiscal impact. Among approaches mentioned were:

- Using the relatively cheap labor of students, most notably advanced undergraduates serving as learning assistants (Otero et al, 2006; Otero, Pollock and Finkelstein, 2010) who benefit from earning credits or experience while training as budding pedagogical experts but earn only modest stipends. Using Learning Assistants also allows class size to be increased while improving instruction.
- Utilizing promising teaching tools for pedagogical improvement.
- Developing curricula and course revisions that were useable by multiple faculty and instructors without significantly increasing their workload. These courses were often departments' introductory courses.
- Increasing enrollments (and thus sometimes departmental revenue) through novel delivery of STEM curriculum and instruction via virtual or distance-learning course models.
- Working together across STEM disciplines, for example in discipline-based education research groups that involve individuals across STEM, thus alleviating the need for separately funded initiatives.
- Supporting modest budgets for food and drink that naturally motivate the social interaction of individuals concerned with postsecondary STEM education. This is discussed in more detail in a later section.

## II. Policies and Practices That Attend to Issues of Hiring, Promotion and Tenure

Considering our focus on postsecondary STEM education reform endeavors with special consideration of STEM faculty and instructors' professional realities, issues concerning promotion and tenure were, not surprisingly, discussed by almost all (about 90%) of our interviewees. What was surprising was that less than half of those who raised promotion and tenure practices spoke of them as barriers or constraints to more widespread, effective, or meaningful STEM faculty and instructor participation in postsecondary education reform. A majority spoke of approaches that lessened the constraints of tenure and promotion practices that may typically act to impede postsecondary education reform. And 20% of interviewees discussed issues of tenure and promotion only in these ways.

Interviewees issued a call to those at all levels overseeing tenure and promotion to move beyond evaluating individuals' worth solely on their past disciplinary research and give more credit for good teaching. "*Ultimately the day of reckoning when you come up for tenure is based on research. There is a pressure to have different assignments and our college has instituted different assignments, but when push comes to shove it is a research record that is the overwhelming weight. Committees are supposed to ask or judge in terms of what these assignments were, but so far I haven't really seen any notice or change there.*" Of most importance to many interviewees was that they receive recognition for their reform activities at the departmental and review committee levels. Some noted the need for departments to become more aligned with review committees that were occasionally seen as more aligned with institutional priorities, and thus more considerate of teaching reform when weighing an individual's professional accomplishments.

Factors that were identified by interviewees as lessening the barriers that promotion and tenure policies and practices typically create can be grouped into three categories: *unique hiring practices and positions, the role of esteemed foundational or society support and accrediting bodies, and making typical tenure* and *promotion milestones more attainable.*

**Unique hiring practices and positions.** Sixty-two percent (62%) of interviewees spoke of the promise of unique hiring practices that foster and secure more postsecondary education reform activity at institutions. These hires held positions that allowed for tenure and promotion to be granted on the strength of their pedagogical practices and research. Candidates that were sought for these positions had experience in education theory and research well beyond that of typical STEM faculty and instructors. These individuals were thought to have "space to care about teaching in their job description. If given space to care, you can hold them more responsible."

- **Lecturers/instructors with potential for tenure.** Policies were in place at multiple institutions for the promotion of lecturers/instructors "demonstrating contribution to something broader than their own teaching, like in the pedagogical literature." Multiple institutions had "instituted a promotion policy for instructors similar to tenure-line faculty allowing these people to show scholarship success in the STEM discipline or in education." These instructors were sometimes hired with dual appointments in a STEM department and Education unit. At other times, they were full-time in a STEM department with the explicit research focus of education in that discipline, often with a STEM doctorate in hand. As a group, their teaching load appeared higher than other faculty in their departments.
- **Novel STEM faculty appointments and promotions.** "We're trying to come up with a model of hiring people with departmental buy-in from the beginning that the person will be doing education research in the discipline and they will get tenure based on that. Otherwise, it is challenging as we have faculty interested in doing this but, like with doing interdisciplinary research, will say 'I get no respect.' The holy grail is to get a number of faculty tenured in a discipline on the basis of education research." Multiple institutions had hired faculty members in STEM departments with the explicit aim to research and publish in STEM education. These faculty members sometimes held joint appointments or joint responsibilities between a STEM department and an Education unit, and were seen as an embodiment of departmental commitment (upon sacrificing a more traditional faculty line) to education reform. Candidates for these faculty lines were expected to come with doctorates in STEM areas. More STEM faculty members were envisioned by many interviewees to be hired with this explicit focus in the future, as a result of departmental or institutional practices and sometimes the result of candidates' more rigorous training in pedagogy while still training as future faculty.

- **Regular STEM Faculty Doing STEM Education Research.** Beyond individuals specifically hired as education researchers in STEM departments, research in STEM education was, in fact, the agenda of numerous faculty members in STEM departments involved in postsecondary reform, albeit most often those already tenured. Usually, these faculty members were involved in discipline-based education research - education scholarship recognized by some STEM interviewees as the most legitimate sort of education research. On rare occasions, those in more typical STEM faculty lines were promoted via revised tenure and promotion considerations and practices. "Last year we promoted someone to full professor primarily based on her initiatives to improve undergraduate education. She had a reasonable research portfolio, but would not have been promoted just on her discipline-based academic research without these other considerations and her supplementation with educational research. It tipped the balance."

**The role of esteemed foundational or society support and accrediting bodies.** More than half (55%) of interviewees discussed the role of esteemed foundational, society, or accrediting body support of reform endeavor activity. The ability of STEM faculty and instructors to overcome barriers concerning education reform participation, notably tenure and promotion concerns, was correlated moderately positively with esteemed foundational, society, or accrediting body support of reform endeavors. Multiple interviewees cited the espoused stances and direct support of reform endeavors by the National Science Foundation, Howard Hughes Medical Institute, and SMTI/APLU as strengthening tenure and promotion arguments concerning education reformers. These bodies were seen as "outside levers" with potential for pushing departments, especially, as well as review committees and institutions towards the greater weighting of teaching practices in reviews.

**Making tenure and promotion milestones more attainable.** Sixty percent (60%) of interviewees said reform endeavors make some work of faculty and instructors easier. Interviewees discussed winning the support of other STEM faculty and instructors for postsecondary education reform because it improved their own work that would be considered for tenure and promotion. Reform activity often resulted in faculty receiving help with their teaching. In fact, overcoming resistance and barriers to education reform was positively correlated with other educators' presence and work. Postdoctoral research scholars and other STEM instructors at multiple universities were purposefully given the task to help alleviate time constraints felt by STEM faculty with respect to their teaching. These individuals were valued for the curricula they created for classes and their assessment of these curricula. Curriculum created by these educators could be archived and thus accessed by other faculty in the future. The opportunity to receive immediately useable ideas and activities based on best teaching practices that had already been vetted in the classrooms of others was highly valued by STEM faculty and instructors just beginning to attempt to reform their own teaching practices. Also discussed by STEM faculty and instructors was the greater ease of teaching better prepared undergraduate students, a noticed result of undergraduate reform.

Reform activity also resulted in faculty receiving help with their research. Some faculty had publications that were coauthored with postdoctoral research scholars and based on student outcome data. The data were primarily collected by the postdoctoral research scholars who were also credited with bringing *"the education research-based literature into departments that don't have a really strong discipline-based education research community."* In addition, faculty research was strengthened via reform activity through funding of undergraduate laboratory aides in exchange for the more effective educating/mentoring of these undergraduates by the faculty. STEM faculty also talked about the prospect of attracting and screening potential high-quality graduate students to their labs through undergraduate STEM reform initiatives in which they participated.

## Vignettes: Engagement in Action at Five SMTI Institutions

### Boise State University | STEM Education Research Scholars

Boise State University formed the STEM Education Research Scholars group, a faculty learning community designed to support STEM discipline faculty and further their knowledge, confidence and productivity in education research and design. The Scholars group formed in response to STEM faculty expressing a lack of formal training in the education sciences, an area they draw from when addressing "broader impacts" in even the most technical STEM grants. Specifically, the group explores education literature, designs and implements research projects, and writes grants and scholarly articles. Its guiding theoretical construct is the Scholarship of Teaching and Learning, a concept that requires a paradigm shift: recognizing that teaching and learning can be the subject of research as well.

The group consists of eight to ten faculty and research staff and is facilitated by an education faculty member, Louis Nadelson, associate professor, College of Education. He and Barbara Morgan, distinguished educator in residence, proposed the scholars group in 2009 to meet the faculty's needs for formal education in the theory, practice, and research design of teaching and learning. The Provost and Vice President for Research provided seed funding, and the VP for Research currently sponsors the group. The group also has guidance and program structure from the Center for Teaching and Learning, under the Provost's unit. These investments led to 13 interdisciplinary proposals and three submitted papers in the first year, and a deepening relationship between faculty members in the second year. In 2010, Boise State won an I3 award from NSF, which will fund the research scholars group.

During the year-long professional development experience, participants in the STEM Education Scholars group receive a stipend of $500 for summer participation, $500 toward project expenses, and books suggested by the facilitator, including Creswell's Research Design and NRC's How People Learn. The participants include a mixture of tenured/tenure track faculty, special lecturers, and usually one non-Ph.D. research staff. They are expected to attend two day-long retreats in the summer and weekly one-hour meetings during the academic year. During the weekly meetings, members discuss assigned reading materials and work on scholarly projects. The group focuses on various topics and levels of expertise in STEM education research and reform to meet participant needs. Key benefits noted by participants are general professional development for STEM faculty, highly productive interdisciplinary connections, time and support for its main focus, and nurturing of ambassadors concerned with improving STEM education.

### Florida International University | Investing in a Physics Education Research Group

Florida International University's Physics Education Research Group (PERG) was instrumental in driving an institution-wide science and mathematics education innovation initiative. Led by Laird Kramer, a physicist in the College of Arts and Sciences, and Eric Brewe, a physics education researcher in the College of Education, the PERG uses a research-based, cross-college approach to develop, implement, and investigate education innovation at FIU. The group advocates broad STEM education reform and targets strategic, comprehensive efforts that engage multiple stakeholders. The work has resulted in a transformation of the introductory physics courses, implementation of a Learning Assistants (LA) program[1] in five departments, the formation of a Discipline-Based Education Research group, and an education research and funding model that serves the STEM disciplines.

### Portland State University | Community Engagement

Portland State University's commitment to engaging the community can be seen in their SUCCESS (Schools, Universities, and Communities Committed to Educational Success for all Students) initiative, which has

1 PERG won a PhysTEC grant in 2007, which led to the adoption of the Learning Assistants model. The LA program recruits top undergraduate students in STEM introductory courses and provides them with a low-stakes opportunity to try teaching before committing to a teacher preparation track or program. LAs take a pedagogy seminar and teach in introductory STEM courses or reformed laboratories under the supervision of a faculty member. For more information on the Learning Assistants program, visit http://laprogram.colorado.edu/

the goal of creating a more seamless, efficient, and effective education system. PSU is partnering with local K-12 schools, community colleges, community-based organizations, businesses, and the local and state government to realize a new vision where the partnership has shared responsibility and common outcomes and metrics that help drive the system to ensure a high-quality education for all students in the region. PSU has identified its role in this partnership as developing collective impact processes for the community, implementing these processes by leveraging resources and partnerships, and serving as a national leader in collective impact development.

Portland is one of seven demonstration sites for Strive Every Child Cradle-to-Career Network. The Strive network is working to ensure that all children are prepared for college and the workforce. Portland State University, as the anchor university in this network, leads the data team to collect and analyze the common metrics across the partnership.

### University of California, Santa Barbara | Lecturers with Security of Employment (LSOEs)

The University of California System has university faculty positions, Lecturers with Security of Employment (LSOE), with the primary duty of teaching. LSOEs are faculty appointments designed primarily for specialized curricular duties that would be difficult for any other type of appointment to perform. LSOEs are expected to be excellent teachers, develop superior curricular materials and programs for improving teaching, and be engaged in service. In contrast to regular ladder faculty, they are not required to do research, but they do have the flexibility to do research and apply for research funding. LSOEs are equivalent to regular ladder faculty in criteria for hiring, salary, promotion, job security[2], and faculty governance. See the table in this insert for information about salary, review period, and promotion schedule for these positions.

In addition to a focus on teaching, LSOEs are an integral part of several more formalized initiatives or projects at UCSB. They support CalTeach[3], and along with regular faculty members, serve as program directors of the Science and Mathematics Initiative (SMI). They also helped bring together regular science faculty, LSOEs, and university leadership to create a science/mathematics education minor in which STEM majors can explore teaching.

| Title | Salary Equivalent to | Review Period | Promotion in |
|---|---|---|---|
| Lecturer with Potential Security of Employment (PSOE) | Asst. Professor | Every 2 yrs. | 6th yr. |
| Lecturer with Security of Employment (SOE) | Assoc. Professor | Every 2 yrs. | 6th yr. |
| Senior Lecturer with Security of Employment (Senior SOE) | Professor | Every 3 yrs. | |

### University of Colorado Boulder | Faculty Peer Evaluations

The University of Colorado Boulder has led several successful cross-disciplinary and cross-institutional efforts including the Learning Assistant Program and the Science Education Initiative. One less visible transformational practice at CU Boulder has been faculty peer evaluation of instruction. Each year the Chair of the Physics Department appoints a faculty committee to evaluate the teaching of all non-full professor faculty members. Each committee member observes four to six faculty members as they teach and then assesses the educator on presentation skills, class engagement, preparation, and alignment of learning goals. The peer evaluation report is submitted to a faculty evaluation committee. In addition to that report, student evaluations, a teaching portfolio, and, in some cases, student learning data are used to make decisions about salary raises and tenure/promotion.

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2 The official policy in the University of California Academic Personnel Manual states, "All appointments and promotions to the ranks of Lecturer SOE and Senior Lecturer SOE are continuous until terminated by resignation, retirement, or dismissal. A Senior Lecturer SOE may be demoted to Lecturer SOE. 'An appointment with security of employment shall not be terminated except for good cause after the opportunity for a hearing before the properly constituted advisory committee of the Academic Senate.' (Regents' Standing Order 103.10)." Available at http://www.ucop.edu/acadpersonnel/apm/section2.pdf

3 CalTeach is a University of California system-wide program to recruit, support, and prepare exceptional secondary science and mathematics teachers (http://education.ucsb.edu/Undergrad-Studies/Science-Math-Initiative/science-math-initiative-main.htm)

## III. Fostering Interdisciplinary Collaboration

Respondents at each of the five institutions spent considerable time explaining the importance of establishing and maintaining strong and respectful collaborations focused on STEM education reform. *"It's creating time and space to have disciplinary faculty, education faculty around the table presenting, discussing, deliberating, problem solving about issues of teaching and learning."* Interviewees usually spoke of collaborations that were interdisciplinary spanning multiple STEM disciplines and including Education units.

**The importance of congenial physical meeting space.** Multiple interviewees across institutions discussed the promise of access to good food and libations during something akin to an informal "pedagogy happy hour" for fostering strong interpersonal connections and commitments regarding undergraduate STEM education improvement. Most notable was the strong positive correlation between interviewees' talk regarding these spaces and mentioning those individuals who were described as *"community straddlers"* — those with part of their professional selves in a STEM discipline community and the other part (although often with unequal distribution) in a community concerned with STEM pedagogy. *"There are a bunch of individuals that span the two communities." "You can bring people in that are rooted in other disciplines or on fringes."* Individuals' presence and comfort in these special reform spaces, especially untenured participants, was noted. These spaces were known for fostering comfortable interactions between participants and free of colleagues perceived to be judgmental of reform action (most notably in the STEM disciplines). Such venues provided safe meeting spaces for some participants who would prefer that their departmental colleagues not be aware of their reform endeavors, lest they be dubbed less serious about the *"real"* work of faculty, that being research.

Talk of these spaces included discussion of the preferred absence of superiors (provosts, deans, at times department chairs) that may drive some reform action and that could, as a result, get in the way of the more "organic" faculty and instructor-driven action that was noted as a main root of successful reform endeavors. At the same time, interviewees noted that financial support from an institutional unit for food and drink consumed in these spaces was a very strong motivator for participation. Interviewees described these events as enhancing trust and respect between participants and strongly positively correlated with participants' motivations to engage in the social connections made in these spaces. Removed from the daily grind of their jobs, often with a beer and spring roll in hand, new and stronger relationships were forged between those deemed to be of similar persuasions and mindsets. Often, reports of the fun times motivated others to get involved too. *"It's a way to evangelize outward by showing people a place to reduce internal fears that you don't know what you're doing and you don't have to do it alone."*

**Evolution in viewing the academic "other."** *"Trust and respect forged personally, professionally, and intellectually, I think, is a piece of what keeps people coming back to the table."* Interviewees alluded to an evolution that they witnessed in effective STEM reform initiatives with respect to viewing other disciplines' research and researchers. This evolution seemed to involve some typical stages passed through most clearly by STEM faculty and instructors with respect to education research and theory and, specifically, with respect to those working in Education units. The first stage seemed to be one of suspicion of education research and academics, replaced by a second stage of *"simple awareness and respect for the other types of knowledge."* A third stage concerned acknowledgement that others' research was of value or importance. *"This pedagogy course has STEM faculty valuing what School of Education people do and that it has impact." "Once I was meeting people from the School of Education, I realized they had something important to say."* A fourth and final stage seemed to accept education research as expertise and its researchers as experts. *"In academia there is a lot of ego. You'd like to get a collaboration with someone who knows something about something more than you. You are taking them seriously professionally. What I like around here is that people take others' expertise seriously. "*

**Varying familiarity with education research, theory, and researchers.** Across interviews, discussion of barriers to reform for STEM faculty and instructors was strongly positively correlated with discussion of their lack of experience, as a group, with education research, theory, and education researchers. Interviewees discussed the need to meet STEM faculty and instructors where they are on their trajectory with respect to knowing and understanding pedagogical research and how this may translate to practice. *"We don't really learn to teach except by standing in front of a class, but there is a lot of literature about that. I learned about the taxonomy of learning objectives and it was an eye-opener for me. And this is a simple thing that changed my practice but I was never exposed to this." "I am embarrassed to say I didn't know how rich that literature was."* According to interviewees, helping these novices required the construction of a *"tool kit"* that allowed teaching *"some other way"* via *"professional development as informal as possible."* Even STEM faculty and instructors with some experience with education research and theory required opportunities to learn gradually through well-planned activities allowing them movement to *"the next step."*

Moving beyond interest and initial exploration of education research into action akin to *"a research project, actually quantifying what a teaching effect is"* required significant time and assistance for some. Interviewees noted that helping STEM faculty and instructors down a meaningful and effective pedagogical path required the work of both other STEM colleagues and those seen as pedagogy experts, often, but not always, affiliated with Education units. *"There are many different routes to developing expertise in something like biology education research or for teaching and learning in biology. One way is bringing people with different expertise to partner, and then there is bringing in those of dual or hybrid identity spanning STEM and Education."* While lack of experience with education research or theory had a strong correlation with resistance and barriers towards reform, social connections with knowledgeable others helped to alleviate this very salient barrier to STEM faculty and instructors' participation in reform activities.

**Professional autonomy.** *"Whatever a faculty member's particular choices are for how they teach belongs to the faculty member."* Interviewees were also very cognizant of the reality of faculty and instructor autonomy. At times interviewees lamented this norm that left unchecked, and thus unmodified, the faulty practices of postsecondary STEM educators. At the same time, interviewees recognized that faculty and instructor autonomy was ultimately at the root of much reform activity meant to improve the teaching of STEM at the postsecondary level. *"Our department has an awful lot of autonomy, so you are going to feel free to make curricular experiments and changes." "If you try to get something done from the top down, it's going to take a lot longer than if it bubbles up from the faculty."* Given the departmental-level influences on faculty autonomy, interviewees claimed that departmental-based change, from normalizing conversation concerning teaching at regular department meetings to more concerted and widespread education improvement action, was a key lever towards STEM education improvement and STEM faculty and instructors' participation in this reform.

**Faculty professional development.** Overall, interviewees stressed that activities that made participants' reform work easier, especially their work as educators, made for meaningful professional development activity. A variety of professional development activities for STEM faculty and instructors were needed, including some for those expressing a "passionate interest in teaching well," perhaps focused on a specific teaching method or the development of course learning objectives. STEM faculty and instructors further along in their evolution with respect to education research and theory and interest in reform needed access to various activities that would better meet them where they were on their trajectories; the importance of immediate feedback with respect to reformed teaching practices was noted by interviewees as especially important to these STEM faculty and instructors.

Professional development for STEM faculty and instructors concerned many things: the creation of course learning goals, engagement in education research and assessment of student learning, coordination of departmental curriculum, and general training regarding best teaching practices. Participation in professional development activities were always voluntary and were often delivered via models built on common language and norms of interaction for STEM faculty and instructors, similar to groups that focused on discipline-based education research.

Providing professional development concerning teaching and learning for atypical STEM instructors, such as postdoctoral teaching fellows or undergraduate Learning Assistants was also raised as important. These offerings were, at times, the same as those for STEM faculty and instructors but, other times, were separate events. They conferred credits to participants at times and other times were an unpaid obligation associated with these individuals' positions.

## IV. The Need for Common Focus

Nearly all interviewees (94%) alluded to successful postsecondary STEM reform collaborations being built on a specific focus and the need of reform participants to be cognizant of a shared purpose. Interviewees most often discussed reform initiatives with the following, often interrelated foci:

- Increasing students' STEM content knowledge and, to a lesser extent, their awareness and engagement in the processes of science;
- Better retention of undergraduates in the STEM disciplines, mostly through their undergraduate years, sometimes out of fear of dwindling numbers of students in certain departments;
- Increasing the number and improving preparation of secondary STEM teachers;
- Creating more STEM literate citizens.

**Data as the basis for focus.** Interviewees discussed the importance of data — at times anecdotal but often more firm — as the basis for initial common collaboration goals. Data underlying collaboration goals most often demonstrated lackluster undergraduate student performance in STEM courses or majors. These data were often described as "the game-changer" for those not initially convinced that reformed practices could be effective. Data detailing student gains (or lack thereof as was most frequently the case) were most effective in motivating an individual STEM faculty member's or instructor's participation in related reform endeavors. The motivation was even more pronounced when the data pertained to the majors and course(s) associated with that individual. These data were collected, analyzed, and presented by STEM faculty or instructors themselves or by others seen as more pedagogy-savvy, such as postdoctoral teaching fellows or Education faculty. Interviewees stated that data most meaningful to those with STEM backgrounds were presented via graphs or statistics and "not a bunch of quotes." Student gains as end products of a specific reform initiative were meaningful to both committed reformers and to their colleagues not yet committed with respect to motivating future reform initiative action.

**Synergy with related reform initiatives.** Many respondents spoke of the importance of creating synergy across STEM reform initiatives to capitalize on resources already secured. About two-thirds (68%) of interviewees spoke of successful undergraduate STEM education reform initiatives having synergy with others. Synergy between reform initiatives was seen in a very practical sense, in terms of ability to capitalize on the resources and work of related initiatives and activities. Physics education research and discipline-based education research groups, for instance, were cited as being complements of and providing resources for one another at the same institution. Synergy was created between initiatives by propinquity of those working on similar reform projects but with different explicit foci in activity, like Learning Assistants and postdoctoral fellows who interacted and shared materials. Synergy was discussed by some interviewees in terms of unifying initiatives with respect to their guiding objectives

and philosophies; for these interviewees, initiatives previously functioning "like their own little island," notably at times in the same STEM department, were problematic. *"We had solo artists all over town that needed to be brought together."*

At some institutions, synergy was seen as an "approach towards educational transformation." Multiple institutions had NSF grants for fostering synergy between institutions' STEM education initiatives, and interviewees spoke of the power of this purposeful melding of initiatives and related people in achieving collective goals, even missions, faster. Synergy with greater national movements was also of salience to interviewees. These included those more STEM-discipline specific, such as the Physics Education Research (PER) and Discipline-based education research (DBER) movements and those espoused by disciplinary societies and institutions, such as the American Physical Society. Synergy was also discussed with respect to more general postsecondary STEM higher education improvement initiatives funded by the National Science Foundation and Howard Hughes Medical Institute, and even those with wider postsecondary education focus, such as the Boyer Commission. The calls of these societies and institutions were used to frame and guide reform initiatives and were thought to motivate and justify the reform work of STEM faculty and instructors.

**Education theory and research underlying a focus.** Education theory and research, by and large, did inform most reform initiatives. The degree to which it did varied both with respect to reform initiatives' underlying design and the degree to which education theory and research were considered throughout initiatives' subsequent activities. Involvement of those from an Education unit seemed to foster more consultation and reaction to education theory and research throughout an initiative. Across interviewees, discussion of education research and theory had a strong positive correlation with breaking down barriers in the way of reform as well as with social connections. According to interviewees, especially STEM faculty and instructors, a main way to alleviate the barrier of engaging with education research and theory was to connect with someone more versed in it.. Collaborations deemed most successful had key individuals, some housed in STEM departments and others in Education units, to help other participants decipher and consider education research and theory and resulting best practices with respect to their projects. DBER groups were noted for their strong focus on education research firmly nested in STEM disciplines. *"A handful of people whose research agenda is DBER are engaged in rigorous study that is also strong theoretically; others I call DBER-lite with simple pre/post test."* Both types of groups supported and inspired research projects to be undertaken by individuals and groups and united and catered to STEM faculty and instructors via language with which they could resonate, while *"helping to shift the disciplinary language and show there can be scholarship behind teaching."*

**Evolution of focused collaboration.** Interviewees explained that over time, the shared goals of participants involved in effective reform initiatives evolved in a typical way, with basic goals of a few reform drivers eventually morphing into larger philosophies or visions adopted by a greater number of committed participants. Across interviewees, focused collaboration was positively correlated to a moderate degree with shared departmental or institutional mission. But it worked in different ways at different institutions. For some interviewees, collaborations were driven by reform goals that were embraced by their departments' or institutions' missions. For others, the strength of collaboration to accomplish reform goals had the power, if realized, to impact departmental or institutional mission.

**Focus and the involvement of those from Education fields.** Interviewees' references to a common focus for reform activity showed a strong positive correlation with the involvement of Education faculty and instructors in collaborations. Financial motivations were also strongly correlated with a shared, common focus of collaboration, and there was a moderate correlation between financial motivations and the involvement of Education faculty in collaborations. This suggests that the involvement of individuals more nested in the field of Education may help firm up shared foci and help garner program funding for the collaborations.

## V. Leveraging the Influence of Participants: Re-envisioning Power Towards Change

Ultimately, our research was meant to document change: reform at postsecondary institutions with the focus of improving undergraduate STEM education. We had good reason to suspect this change was occurring at multiple institutions but lacked knowledge of how the change had happened or was occurring. Many of the factors allowing for the change we sought to document have already been discussed in the sections above concerning structural supports and tenure and promotion issues. This next section continues the discussion of some of the factors mentioned above within a different conceptual framework, attending to issues of personal and collective power and how power translates into action.

Nearly all (more than 95%) of our interviewees discussed factors impacting postsecondary STEM reform endeavors that conveyed the importance and impact of individuals' and groups' power towards improving undergraduate education. Particularly salient were interviewees' discussion of power distribution and dynamics that seemed somewhat novel in postsecondary environments. Most (90%) interviewees discussed their experiences with postsecondary education reform in a way that indicated that reform success may be partially dependent on power dynamics that differ from the norms typically assumed at universities. Interviewees spoke of reform work in ways that highlighted the power of some individuals who historically have had relatively little power in postsecondary environments when compared to STEM faculty and higher administration. All were recognized for their abilities to work with STEM faculty and instructors on reform initiatives. At times, those typically less empowered were seen as critical change agents individually; at other times they were seen to be powerful collectively.

**Novel powerful individuals.** Those pegged as powerful individuals were described by others as having both "hidden" and more explicit and obvious power. These individuals also recognized their own power regarding reform initiatives, albeit to differing degrees. *"I am the glue." "I knew as an Education faculty member it was critically important to form relationships between the STEM departments and the School of Education and that would be something that I worked very hard to do."*

According to interviewees, those assuming a somewhat surprising, but welcomed, heightened level of individual power in reform initiatives included:

- Lecturers/instructors with potential for tenure/security of employment;
- Other special title series such as STEM directors and coordinators;
- Education faculty with strong STEM training;
- STEM faculty with enhanced pedagogical training;
- K-12 educators teaching STEM faculty, with resultant professional development for the STEM faculty viewed as a positive byproduct of initiatives meant to provide professional development for K-12 educators.

Notably, some of these individuals were the novel hires discussed in the previous section. Coding with respect to these novel positions was positively correlated, to a moderate degree, with both overcoming resistance and barriers to reform as well as with fostering social connections and motivations regarding reform. These individuals were often seen, as evidenced by another moderately strong positive correlation, as those with the ability to strengthen STEM faculty and instructors' familiarity and reliance on education research and theory.

**Novel collective power.** The presence and interaction with postdoctoral teaching fellows and undergraduate Learning Assistants by faculty and instructors was noted as impacting faculty members' professional development and communication regarding teaching. Postdoctoral teaching fellows and undergraduate Learning Assistants were billed as *"consultants in the departments,"* as *"often they were the most pedagogically sophisticated people in the room when compared to faculty members."*

Keys to postdoctoral fellows' power were:

- With doctorates in hand, the acceptance of fellows by STEM faculty and others as scholars in the STEM disciplines;
- Lacking background comparable to that of faculty in Education, fellows' appearance of not posing a threat to STEM faculty with respect to research background in pedagogy;
- Care in challenging STEM faculty and instructors incrementally, for instance by *"starting simple, so that they don't feel bombarded, changing just one thing in their course as we want them to actually do it well and continue doing it;"*
- The materials and activities they created for STEM faculty and instructors, thus alleviating these educators' professional burdens.

Undergraduates working as Learning Assistants often interacted with and influenced STEM faculty and instructors beyond those with which their position directed they most closely work and were, thus, dubbed *"the glue and thread running around campus connecting initiatives and their people even when we aren't talking to one another."* These students were seen as getting to know STEM professors and instructors well, even at the largest universities.

Interviewees noted that many undergraduate Learning Assistants eventually pursued graduate work. Taken together, Learning Assistants and teaching postdoctoral scholars represented a growing body of budding pedagogical specialists with the power to ultimately change the postsecondary STEM faculty workforce for the better. However, Learning Assistants and postdoctoral research scholars can be costly to the university, and interviewees acknowledged that their collective power as reform agents may be significantly limited as a result.

**The power of deans and department chairs.** The power that department chairs and deans held with respect to postsecondary education reform activity was noted by interviewees, with approximately 44% of them discussing their influence. Interviewees discussed the need for initial direct support from chairs and deans to inspire reform and to a degree that could challenge faculty members' typical autonomy with respect to teaching activities. *"It's nice to have a chair next to you saying 'we really want you to try these changes in your courses.'"* Chair and dean interviewees, for their part, realized the need to be relatively "hands-off" with respect to most reform initiatives once they were underway. *"My role as chair is primarily a facilitator, sometimes identifier of potential innovations; more often innovations percolate up from people and my primary role tends to be responding to that with 'that seems like a good idea' so I can make that happen." "Reform is something I've always wanted to do and figured I would take advantage of being Dean and try to implement it, knowing that it is better and easier coming from bottom up."* Interviewees viewed deans and chairs as potentially powerful change catalysts in initiating reform efforts, but commented that their presence should be felt less and less as reform initiatives continued. Chairs seemed especially effective at getting postsecondary STEM education reform moving when they shared data with the aim of convincing STEM faculty and instructors of poor student outcomes in their departments.

**STEM faculty and instructors who are open about their reform involvement.** According to interviewees, recognizing the engagement of other STEM faculty and instructors in postsecondary STEM education reform activities motivated other STEM faculty and instructors' participation in and support of reform activities.

STEM faculty and instructors recognized for being able to engage and influence others:

- Were open about their participation in reform work, often speaking of it candidly and forcefully, during typical work-day interactions;
- Invoked experiences with faculty mentors from graduate student and postdoctoral researcher days;

- Seemed equally influential whether they were within one's home department or affiliated with other STEM departments. According to interviewees, STEM faculty and instructors recognized for engaging with and influencing others were often affiliated with the most esteemed STEM departments;
- Were often affiliated with STEM discipline-based education research and, thus, framed research into teaching and learning in a way that resonates with STEM faculty and instructors;
- Were accomplished researchers in their STEM discipline, at least through the postdoctoral level, and held their appointments in a STEM department;
- Grew in influence with STEM discipline achievements (not pedagogy-based) beyond securing tenure, ranging from being recipients of prestigious research grants to achieving National Academy of Sciences/ Nobel Laureate distinction;
- Grew in influence with respect to achievements that were pedagogy-based if they had achieved STEM discipline achievements beyond tenure.

These respected individuals were seen often as *"having proved themselves in the STEM world and now in the world of education."* These individuals were considered very powerful change agents, exerting what some deemed to be peer pressure that resulted initially in pushing their STEM colleagues and affiliated departments towards consideration of postsecondary STEM education problems (often via presentation of student achievement data). These individuals were also credited for inspiring a leap of faith in considering data in light of education research and theory. Most often, the specific reform actions encouraged by these individuals concerned curriculum and instruction revision at the level of individual courses and departmental course sequences.

With these benefits in mind, interviewees affiliated with STEM departments expressed the wish for more involvement from those from Education units in their reform initiatives, while acknowledging the burden this presented to Education faculty and instructors. Education faculty and instructors holding advanced degrees in a STEM discipline were especially commended for their ability to inspire and support the participation of STEM faculty members and instructors in reform.

For their part, STEM education specialists, both Education unit and STEM department faculty and instructors, generally enjoyed being involved in reform initiatives and were pleased to find their work and contributions well received by most STEM faculty and instructors; they also acknowledged their professional limitations. In addition, these education specialists conveyed that the most meaningful collaborations moved beyond service to others and allowed for their own professional movement and growth as well. *"I can exercise my mind around issues in STEM education and it is one of those few places where you have an opportunity for professional growth besides education research meetings."*

**Tenured versus non-tenured faculty involvement (tenure level).** Notably it was heard across interviews that *"most faculty working on reform are senior professors that are looking for the next thing to do and realize that stuff is not working." "Full professors can do what they want unless their chair stands in their way."* Yet our research uncovered multiple, seemingly effective reform initiatives involving and even being led by untenured faculty members from both STEM departments and Education units. *"We've seen in our tenure-earning faculty enthusiasm and energy to try new things. They tend to be more outspoken than faculty in the past—those kids—and it gets the tenured faculty thinking 'maybe that's something I could get involved with.'"* Interviewees welcomed an impending change with respect to new STEM faculty hires on standard tenure lines. *"Fairly soon, we will start seeing young faculty being hired who as graduate students were involved in reform."* Still, the takeaway across interviewees was that while practices to recognize and reward reform efforts are improving, tenure concerns still often posed a disincentive to engagement in undergraduate STEM reform initiatives for untenured faculty both in the STEM and Education disciplines as evidenced, perhaps, by a lack of not-yet tenured interviewees in our sample. Interviewees insisted that this reality needed to be thoroughly weighed by potential re-

formers, their mentors, and other reformers considering recruiting untenured faculty to the cause. The most effective reform endeavors engaged junior faculty only with these realities in mind and, potentially, with practices and policies in place to alleviate tenure as a barrier.

**Literacy Brokers.** According to STEM faculty and instructors, the most meaningful engagement in reform involved respected and pedagogically well-informed and practiced STEM and Education faculty. These were, at times, faculty and instructors affiliated with Education units, and, at other times, faculty and instructors with appointments in STEM departments.

Interviewees discussed those most knowledgeable and practiced with respect to education research and theory in ways akin to other social scientists' notion of community *brokers*, most notably with respect to brokers of literacy practices as informed by Perry (2009). With education research and theory as the literacy, education research and theory experts acted as brokers by translating this somewhat foreign literacy for STEM faculty and instructors seeking support. Education unit-affiliated faculty and instructors, especially with terminal degrees in a STEM discipline, were discussed most often in this way. STEM-department affiliated faculty and instructors, who also had appreciable training in education research and theory were a close second as literacy brokers, while budding pedagogy experts, Learning Assistants and postdoctoral teaching fellows, were a more distant third. Far from just supplying missing knowledge and practices, the most successful brokers were familiar enough with the context of the STEM faculty and instructors to frame education research and theory in relation to typical STEM research and teaching practices. And the most successful brokering also involved the interchange of knowledge concerning undergraduate reform education between parties who were each knowledgeable in key ways. STEM faculty and instructors seeking help towards education reform were viewed by the most successful brokers as having very meaningful exclusive expertise to offer the collaboration. They allowed STEM faculty and instructors to incorporate as much or as little new knowledge of education research and theory into their reform activities as they wanted.

Those credited with being these education research and theory specialists were commended by interviewees for:

- Conveying their infectious excitement and enthusiasm for improving STEM education and the rigor and validity of education research;
- Treating STEM faculty and instructors as peers and not inferior with respect to their pedagogical knowledge and practices;
- Translating education research and theory into a form that was understandable and useable by STEM faculty and instructors;
- An ability to speak the "talk" of STEM, with respect to disciplinary ways of knowing and processes;
- Helping STEM faculty and instructors accept their roles in the success of undergraduate students in the STEM disciplines, including the success of future secondary STEM educators.

These individuals served as successful brokers of STEM education research and theory for STEM faculty and instructors who encountered an unfamiliar new paradigm. The concept of literacy brokers is expanded in Bouwma-Gearhart, Perry and Presley (2012).

Individual versus group power interactions: Lone rangers, pied pipers, and social action of a choir. Ninety-one percent (91%) of interviewees spoke of work on reform initiatives in a way that alluded to the interplay of individual versus group power interactions and the effects of each. Given the framing of our research questions and planning, the reform initiatives discussed by interviewees incorporated the work of multiple individuals at universities and none concerned just one "lone ranger." Still, certain individuals were identified by interviewees as having enhanced power in comparison to others involved in a reform initiative. This often occurred in the earliest days of the initiative but sometimes lasted

well into an initiative's life. This enhanced power was sometimes lamented by interviewees, discussed as somewhat of a burden on the individual as a result of others not yet "stepping up" to take some of the leadership and activity associated with a reform endeavor. Those in these positions were faculty and instructors from STEM or Education units alike, with or without tenure.

Yet these individuals, initially shouldering much of the burden of initiative work, were recognized by interviewees for encouraging others to join and truly engage in the effort's work. *"He is the pied piper in the department."* Coding for individuals described by interviewees as main recruiters to a project positively correlated strongly with social connections and motivations concerning reform. As the person in charge of recruiting for the effort, these individuals were recognized as shouldering a significant amount of work with respect to the continuation of some reform initiatives. *"We need to clone him."* Often pied pipers were also the community straddlers and assumed the extra work of uniting previously divided communities. *"Before this person, there was quite a separation between A&S and Education. There was not much interest then to really bridge the gap with some unapproachable on both sides of the fence."* Still, these individuals were described as having endless energy and seemingly capable of handling the various aspects of the reform initiatives that they juggled. And some, notably staff, had job descriptions explicit to the management of an initiative or multiple initiatives and were recognized as doing their somewhat prescribed job amazingly well, especially in terms of recruiting others to the initiative.

Interviewees noted that those acting as the initial pied pipers of movements were very powerful in their ability to inspire more widespread reform. Pied pipers eventually comprised a "choir" of sorts, formed within departments, colleges, and at universities. Yet beyond "preaching to the choir," made up of other pied pipers, they wielded the power to expand the choir too through their recruiting efforts. From there, these individuals, known among interviewees for fostering trust and respect among reformers, were key in "making sure the choir is still singing the same tune. Then it resonates with structure around you that starts vibrating. We are shifting from being a voluntary effort of lone heroes to one that is institutionally rewarded for it with the university saying this is what you are here for."

## Conclusion

The findings in this report are based on site visits to five SMTI-affiliated universities to ascertain factors that help to foster successful postsecondary STEM reform endeavors that increase undergraduate student success. We found that STEM faculty and instructors, who were the explicit focus for the SMTI learning community that inspired this research, can have an integral and pro-active role in the change effort. Our research begins to document the very real and seemingly powerful actions of those in the faculty ranks to improve postsecondary education. The findings in this report add to the small body of existing research about faculty participation in reform efforts. It moves beyond prior work that has examined competing faculty professional rewards and constraints, and instead documents the greater array of positive motivations and actions of postsecondary educators for participation in STEM reform initiatives. Furthermore, those who are actually involved in undergraduate education reform see space in their institutions' policies and practices for hiring, promotion, and tenure to reward non-traditional scholarship and dedication to reform efforts. Time remains a constraining variable, but even here, institutions are beginning to develop strategies to ease faculty and instructors' transitions to reformed approaches to teaching.

Change at the level of an institution was not the focus of the reform work of those included in this study. Most often, reform was aimed at the level of an instructor's practice, one or two specific courses, or a STEM department. Even interviewees participating in across-STEM initiatives spoke of the limitations of their work with respect to institutional change. While many interviewees explicitly stated or alluded to a belief that collective reform work does or can lead to wider-spread educational transformation, the importance of this synergy was most strongly asserted by those who described their

institutions' reform efforts to be well underway. What this paper does not do is document how those reforms got underway. Other research provides evidence that institutional leaders play an important role in culture change through what they say and how they say it (Chaffee, 1985, 2010), as well as their budget priorities. Gauging the relative importance of the various influences of reform initiatives towards greater transformation have yet to be determined, but what we can say now is that all play integral roles in change.

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## Appendix A: Interview Protocol

INTRODUCTION: As you know [either 1. through your direct involvement in our SMTI learning community or 2. via contact with our learning community representative] our SMTI working group is studying the question: How can undergraduate STEM education be improved for all students while attending to the realities faced by STEM faculty and instructors? In hopes of answering this, we are asking you to share your experiences of initiatives/projects related to postsecondary STEM education reform so that we may begin to uncover what works with respect to best involving STEM faculty and instructors in a positive and realistic way towards postsecondary STEM education improvement. For purposes of this interview, we define STEM faculty and instructors as individuals with advanced training in the STEM disciplines, usually with a terminal degree in the STEM disciplines, usually a doctorate.

[This set of questions can be asked multiple times to elicit interviewee's responses with respect to multiple initiatives.]

1. Please tell me about the nature of your position at your university.
2. Please tell me about an initiative related to STEM education reform with which you are personally familiar (institutional, departmental, individual….any level) [IF NOT ADDRESSED, CHECK FOR INFORMATION REGARDING ANY SECONDARY TEACHER TRAINING INITIATIVES]
3. What led those involved in the initiative to undertake this initiative? [to check rationale]. [If needed] What problem(s)/challenges are the initiative intended to address?
4. What factors have been key to the success of this initiative?
5. What have been the major challenge(s) to carrying through with this initiative?
6. What evidence do you have for effectiveness of the initiative...or what plans do you have for assessing effectiveness?
7. [IF NECESSARY] What do you think are the major challenge(s) to improving STEM education at your institution?
8. [IF NOT ALREADY EMERGED THROUGH ANSWERS ABOVE] Please tell me about the role of STEM Faculty in the initiative(s) you've described.
9. [IF NOT ALREADY EMERGED THROUGH ANSWERS ABOVE] Please tell me about the role of STEM Faculty in supporting quality secondary-level teacher education…from recruitment to professional development and everything in between.
10. How can undergraduate STEM education be improved for all students while attending to the realities faced by STEM faculty?
    1. [IF NOT ALREADY DISCUSSED] What characteristics of your institution affect the involvement of STEM faculty in undergraduate STEM education?
    2. [IF NOT ALREADY DISCUSSED] What characteristics regarding the nature of STEM faculty members' positions affect the involvement of STEM faculty in undergraduate STEM education?
11. How would you summarize the environment/culture at your institution relative to undergraduate STEM education reform?

## Appendix B: 2010 Carnegie Classifications* for Institutions Used in Research

| **Institution**<br><br>*Carnegie Classification Characteristic* | **Boise State University** | **Florida International University** | **Portland State University** | **University of Colorado Boulder** | **University of California Santa Barbara** |
|---|---|---|---|---|---|
| *Level* | 4-year or above | 4-year or above | 4-year or above | 4-year or above | 4-year or above |
| *Control* | Public | Public | Public | Public | Public |
| *Student Population* | 18,933 | 39,610 | 27,901 | 33,010 | 22,850 |
| *Undergraduate Instructional Programs* | Bal/SGC: Balanced arts & sciences/ professions, some graduate coexistence | Prof + A&S/HGC: Professions plus arts & sciences, high graduate coexistence | Bal/HGC: Balanced arts & sciences/ professions, high graduate coexistence | A&S + Prof/HGC: Arts & Sciences plus professions, high graduate coexistence | A&S-F/HGC: Arts & Sciences focus, high graduate coexistence |
| *Graduate Instructional Program* | Doc/Prof: Doctoral, professional dominant | CompDoc/NMed-Vet: Comprehensive doctoral (no medical/ veterinary) | Doc/STEM: Doctoral, STEM dominant | CompDoc/NMed-Vet: Comprehensive doctoral (no medical/ veterinary) | CompDoc/NMed-Vet: Comprehensive doctoral (no medical/ veterinary) |
| *Enrollment Profile* | VHU: Very high undergraduate | HU: High Undergraduate | HU: High Undergraduate | HU: High Undergraduate | HU: High Undergraduate |
| *Undergraduate Profile* | MFT4/S/HTI: Medium full-time four-year, selective, higher transfer-in | MFT4/S/HTI: Medium full-time four-year, selective, higher transfer-in | MFT4/S/HTI: Medium full-time four-year, selective, higher transfer-in | FT4/MS/LTI: Full-time four-year, more selective, lower transfer-in | FT4/MS/HTI: Full-time four-year, more selective, higher transfer-in |
| *Size and Setting* | L4/NR: Large four-year, primarily nonresidential | L4/NR: Large four-year, primarily nonresidential | L4/NR: Large four-year, primarily nonresidential | L4/NR: Large four-year, primarily nonresidential | L4/R: Large four-year, primarily residential |
| *Basic* | Master's L: Master's Colleges and Universities (larger programs) | RU/H: Research Universities (high research activity) | RU/H: Research Universities (high research activity) | RU/VH: Research Universities (very high research activity) | RU/VH: Research Universities (very high research activity) |
| *Elective Classification* | Curricular Engagement and Outreach and Partnerships | Curricular Engagement and Outreach and Partnerships | Curricular Engagement and Outreach and Partnerships | None listed | None listed |

*Source: http://classifications.Carnegiefoundation.org/ Accessed May 31, 2011

## Appendix C: Guidance Provided to Institutional Liaisons to Select Interviewees

1. How do I decide who to involve in the interview process?

   Please consider the following in selecting your interviewees:

   a. Which Innovations on Campus are most relevant to our Research questions (see above)? Who is involved in them? What would get the best story/vignette out?

   b. Consider those you know and with whom you have a positive relationship and good professional access….

   c. Who can be available on the days of the visit?

2. How do we decide which of our STEM innovations to focus on?

   The PLC committee member should study the research question and the interview protocol (NOTE: please do not forward the protocol to other interviewees. If you already have, please just let us know). Then ask themselves:

   a. Who is involved in STEM teaching innovations on campus that could provide substantive answers to the interview protocol questions?

   b. Which of our STEM teaching innovations involve important roles for STEM faculty that are constructed in light of the realities they face?

## Appendix D: Analysis Methodology

Dr. Bouwma-Gearhart used NVIVO qualitative analysis software to first examine the data using an exploratory approach with the goal of identifying general patterns across interviewees' talk. Factors mentioned by interviewees that seemed to inform our research question were labeled by NVIVO codes. Dr. Bouwma-Gearhart then engaged in more deductive coding to uncover more nuanced patterns in the data. This was partially accomplished by recoding data under the factors appearing most salient (in terms of number of interviewees making a claim or percentage of all text coded under these factors) and creating sub-codes. Deductive analysis was also accomplished via NVIVO cluster analysis that yielded analysis of factor (code) overlap to uncover the most pertinent relationships between all identified factors for further qualitative analysis. Cluster analysis was run using Pearson's correlations (to assess amount of coding overlap with respect to two factors). Only strong or moderately strong correlations are reported. (See Appendix E for cluster analysis results.)

The strength of Pearson's correlation coefficients (r) was judged using the following criteria:

| Value of r | Qualitative Description of the Strength |
|---|---|
| 0.90 to 1.00 | Very Strong Positive Correlation |
| 0.70 to 0.89 | Strong Positive Correlation |
| 0.50 to 0.69 | Moderate Positive Correlation |
| -0.49 to 0.49 | Weak or No Correlation, positive or negative |
| -0.50 to -0.69 | Moderate Negative Correlation |
| -0.70 to -0.89 | Strong Negative Correlation |
| -0.90 to -1.00 | Very Strong Negative Correlation |

## Appendix E: Results of NVivo Cluster Analysis: Pearson's Correlation Coefficient Values (r) for Nodes with Moderate to Strong Correlation

| Node A | Node B | r |
|---|---|---|
| Hiring or attracting those of same persuasion or with relevant job description | Novel teaching or research responsibilities or professional path | 1 |
| Discipline or department or course based group and focus and support and framing | Esteemed institution or foundational or accreditation or society support or push | 1 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Resistance and barriers | 1 |
| Lone rangers and choir | Social connections and motivations | 0.829156 |
| Education research or theory-based or people or experience with | Social connections and motivations | 0.784465 |
| Education research or theory-based or people or experience with | Resistance and barriers | 0.784465 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Education research or theory-based or people or experience with | 0.784465 |
| Agreed upon need for improvement or focus | Financial motivations | 0.784465 |
| Social connections and motivations | Trust and respect between participants | 0.707107 |
| Community straddlers | Space pros and cons | 0.707107 |
| Agreed upon need for improvement or focus | Education faculty involvement or not | 0.707107 |
| Mission and culture alignment and change | Synergy and collaboration with or birth from related initiatives or models even elsewhere | 0.681385 |
| K12 teacher issues | Personal characteristics of involved faculty | 0.681385 |
| Financially feasible or not | Review docs and policies and issues | 0.681385 |
| Financial motivations | Review docs and policies and issues | 0.681385 |
| Financial motivations | Mission and culture alignment and change | 0.681385 |
| Education research or theory-based or people or experience with | Novel teaching or research responsibilities or professional path | 0.681385 |
| Education research or theory-based or people or experience with | Hiring or attracting those of same persuasion or with relevant job description | 0.681385 |
| Education research or theory-based or people or experience with | Esteemed institution or foundational or accreditation or society support or push | 0.681385 |
| Discipline or department or course based group and focus and support and framing | Education research or theory-based or people or experience with | 0.681385 |
| Dean support or push | Those not caring not involved | 0.666667 |
| Space pros and cons | Tenure level of the STEM faculty involved and convinced | 0.661438 |
| Education school prominence | STEM department prominence | 0.659091 |
| Data confirms or drives actions | Dept Chair leading charge or not in way | 0.659091 |
| Education research or theory-based or people or experience with | Lone rangers and choir | 0.650444 |
| Data confirms or drives actions | Financial motivations | 0.650444 |
| Leap of faith originally re pedagogy | Peer pressure or models from colleagues or organizations | 0.612372 |
| Community straddlers | Those not caring not involved | 0.612372 |
| National or wider attention securance and radar | Provost support | 0.600099 |
| Resistance and barriers | Social connections and motivations | 0.583333 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Social connections and motivations | 0.583333 |
| Dean support or push | Space pros and cons | 0.57735 |
| Education specialist involvement NOT education faculty | Tenure level of the STEM faculty involved and convinced | 0.564076 |
| Personal characteristics of involved faculty | Space pros and cons | 0.5547 |

| Node A | Node B | r |
|---|---|---|
| Education research or theory-based or people or experience with | Trust and respect between participants | 0.5547 |
| Education faculty involvement or not | Financial motivations | 0.5547 |
| Review docs and policies and issues | Student or participant gains noticed | 0.534522 |
| Resistance and barriers | Tenure level of the STEM faculty involved and convinced | 0.534522 |
| Resistance and barriers | Review docs and policies and issues | 0.534522 |
| Novel teaching or research responsibilities or professional path | Social connections and motivations | 0.534522 |
| Novel teaching or research responsibilities or professional path | Resistance and barriers | 0.534522 |
| Hiring or attracting those of same persuasion or with relevant job description | Social connections and motivations | 0.534522 |
| Hiring or attracting those of same persuasion or with relevant job description | Resistance and barriers | 0.534522 |
| Esteemed institution or foundational or accreditation or society support or push | Social connections and motivations | 0.534522 |
| Esteemed institution or foundational or accreditation or society support or push | Resistance and barriers | 0.534522 |
| Discipline or department or course based group and focus and support and framing | Social connections and motivations | 0.534522 |
| Discipline or department or course based group and focus and support and framing | Resistance and barriers | 0.534522 |
| Community straddlers | K12 teacher issues | 0.534522 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Tenure level of the STEM faculty involved and convinced | 0.534522 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Review docs and policies and issues | 0.534522 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Novel teaching or research responsibilities or professional path | 0.534522 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Hiring or attracting those of same persuasion or with relevant job description | 0.534522 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Esteemed institution or foundational or accreditation or society support or push | 0.534522 |
| Cognizant of (faculty) time constraints and pressing needs and autonomy | Discipline or department or course based group and focus and support and framing | 0.534522 |
| Agreed upon need for improvement or focus | Review docs and policies and issues | 0.534522 |
| Agreed upon need for improvement or focus | Mission and culture alignment and change | 0.534522 |
| Lone rangers and choir | Trust and respect between participants | 0.533002 |
| K12 teacher issues | Student or participant gains noticed | -0.534522 |
| Esteemed institution or foundational or accreditation or society support or push | Leap of faith originally re pedagogy | -0.534522 |
| Esteemed award or accolade | Mission and culture alignment and change | -0.534522 |
| Discipline or department or course based group and focus and support and framing | Leap of faith originally re pedagogy | -0.534522 |
| Agreed upon need for improvement or focus | Proximity to movement and personal involvement | -0.534522 |
| Education faculty involvement or not | Support of greater public | -0.5547 |
| Other Power of One individuals not in typical title or role | Provost support | -0.564076 |
| Community straddlers | Student or participant gains noticed | -0.583333 |
| National or wider attention securance and radar | Student or participant gains noticed | -0.612372 |
| Esteemed institution or foundational or accreditation or society support or push | Support of greater public | -0.681385 |
| Discipline or department or course based group and focus and support and framing | Support of greater public | -0.681385 |

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