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Creating a STEM Identity: Investment with Return

Abstract

Establishing a strong STEM (science, technology, engineering and mathematics) identity at Boise State University, a metropolitan campus with approximately 3,655 undergraduate STEM students and a total undergraduate enrollment of approximately 19,042 (16,136 FTE) has been an important step toward creating a climate conducive to facilitating fundamental change. Examples of such change include building collaborations among faculty within and across departments, establishing the identity of students as part of a community beyond their chosen major, improving the efficiency and effectiveness of university systems, and perhaps most importantly, developing a framework to think deliberately about ways to effect change. This paper is focused on describing and categorizing the development of a STEM "identity" over the past decade within a metropolitan campus that does not have an overall STEM central mission.

The College of Engineering (CoE), established in 1997 as a result of a regional demand for engineering and computer science graduates, began focusing heavily on student success initiatives in 2004 with support from the Engineering Schools of the West Initiative, through the William and Flora Hewlett Foundation. This first wave of initiatives was critically assessed, and engineering student success became a focal point for the CoE. Internal research conducted under this grant exposed numerous roadblocks that impeded students' academic success. In 2010, another large grant, funded through the National Science Foundation Science Talent Expansion Program (STEP), was awarded to increase the numbers of students graduating with STEM degrees. This grant engaged an interdisciplinary, cross-college team of STEM educators passionate about continuous improvement and pedagogical reform. Six months after the STEP grant launch, a second grant was awarded, a NSF Innovation through Institutional Integration (I^3) grant. All activities associated with these grants were deliberately categorized as "STEM" activities, in order to benefit all STEM students and faculty. This had the added benefit of unifying the STEM community and helping launch a sense of common purpose among STEM faculty and staff. We discuss a framework and present supporting cases to show how developing a STEM identity has been a critical step towards cross-curricular integration and improvements in pedagogical development, structures, policies and a sense of STEM community.

Introduction: Why a STEM identity?

We describe, retrospectively, the deliberate efforts of faculty involved in externally funded undergraduate education and retention-focused grants to establish a cohesive organization-level STEM identity at this university. The general notion of an organizational identity – characterized in our present work as a STEM identity – is not new (for the seminal work on organizational identity, see Albert & Whetten, 1985)[1]. There are a variety of different theories that are utilized within the organizational identity literature (Ravasi & van Rekom, 2003)[2] that can help researchers categorize an organization's identity, ranging from social identity theory to narrative analysis to communication theory. He and Brown (2013)[3] summarized four major approaches to organizational identity as functionalist (identities are composed of essential and tangible features), social constructivist (the product of individuals' thoughts which are collectively believed), psychodynamic (unconscious processes shape collective identities), and post-modern (a linguistic and image-based approach to identity identification).

The story of the development of a STEM identity on our campus may serve as an example of the operationalization of an organizational identity theory in action; in other words, our STEM identity development may serve as data that supports various elements of organizational identity theory. Positioned in the current context of STEM education as a national priority[4] and the proliferation of university STEM centers and departments, this work may prompt other institutions to explore deliberate identity development in STEM as part of their evolving mission or to examine their current level of STEM identity development in order to strategize ways to develop further.

The need for a STEM identity at this university, with a focus on STEM student success, was initially motivated by lessons learned during an externally funded $1M grant from the William and Flora Hewlett Foundation's Engineering Schools of the West Initiative (ESWI). This five-year grant, awarded to the College of Engineering (CoE) in 2003, focused on the quality of undergraduate education in engineering and recruitment and retention of engineering students. The initiative brought representatives from the nine universities in the West that received awards together on a regular basis, in order to create a "multiplier effect", leading to a change in the institution that would also be instructive to other colleges and universities.[5] The annual meetings promoted exchanges of ideas and effective practices.

The grant focused on overcoming barriers engineering students experienced in the first two years. Strategies undertaken during the funding period included learning communities to integrate introductory engineering and mathematics, peer learning facilitators for mathematics and physics, a redesigned introduction to engineering course including a special section for mathematically underprepared students, research experiences for lower division and underrepresented students, and a variety of other recruitment and mentoring strategies.

Research on student success conducted during the grant illuminated various barriers encountered by students. For example, in the 2005-2006 academic year, 52% and 49% of students who took Calculus 1 and Calculus 2 at our university passed with a C or better, respectively – an extraordinarily low pass rate for these courses, given that the entry level ACT/SAT math scores/prerequisites were not dissimilar to those set by other universities. The outcomes of this research made us question our own assumptions, revealing that the level of mathematics preparation was not significantly correlated to whether or not students persisted in engineering, while the grade earned in their first college level mathematics class did correlate positively with persistence.[6] The analysis on student success and other grant foci in turn motivated a broader approach to improving the student experience at this university. It became apparent that the success of engineering students on this campus could not be separated from their experiences in entry and lower division level math, physics, chemistry and university general education curriculum coursework, and grant-focused efforts focused heavily on reforms to these entry courses (Hampikian, et al.[7],[8]; Callahan et al.,[9]). Significant pedagogical change across disciplines was warranted in order to create a unified and coherent undergraduate foundation in math and science to prepare engineering students for success not only in engineering, but for their next mathematics or science course.

This need for a more integrated curriculum for STEM students was embraced by the ESWI researchers and some colleagues in other STEM departments, but stalled as these individuals attempted to diffuse the idea within their departments and more broadly across other STEM disciplines. As the ESWI grant was concluding in 2008, some strong partnerships had formed that crossed college boundaries and a nucleus of interdisciplinary, student-focused STEM faculty had begun collaborating with one another about student success, reading the student success literature, thinking about learning outcomes and beginning to understand course design. They enthusiastically reached out to diffuse their ideas to their colleagues by hosting roundtable discussions, sharing pedagogical ideas, making recommendations to departments and university administrators, and presenting research data they saw as compelling. The reaction by those outside the ESWI team to this enthusiastic call for change and integrated STEM efforts ranged from intrigued to lukewarm to disinterested.

The difficulty and low success rate of organically diffusing pedagogy reform, even when based on solid data, has itself been the study of recent research. Borrego, Froyd and Hall (2010)[10] found that even high levels of awareness of innovative engineering education practices did not translate into high levels of adoption. Henderson, Beach and Finkelstein (2011)[11], in an analytical review of literature based on 191 conceptual and empirical journal articles published between 1995 and 2008, concluded that simply disseminating "best practice curricular materials…to other faculty does not work." (Henderson et al., 2011, p. 971) Like Seymour (2001)[12] they found weakness in the (unproven) theory that Seymour suggested as ascribed to by many STEM reform projects and funding agencies, that "good ideas supported by convincing evidence of efficacy, will spread 'naturally' – that, on learning about the success of particular initiatives, others will become convinced enough to try them." (Seymour, 2001, p. 92). Henderson et al. suggested that effective change strategies require long-term interventions, development of shared beliefs among individuals involved, and understanding of complexities of university systems.

Ultimately, the ESWI grant did not catalyze wide adoption of pedagogical change beyond the CoE as it did not create a shared sense of mission or interventions and alliances throughout all levels of university systems. A major lesson learned during the ESWI grant was therefore that there could not be a "we" versus "them" approach to student success, but rather that there needed to be a shared mission. We outline the path of faculty engagement as a community as it gradually moved from an individual level of engagement, to a department-focused level of engagement and then to an integrated level of engagement. How the development of a STEM identity led to this will be described.

Developing a Framework

Following the Hewlett Foundation ESWI grant, there have been at least 25 initiatives or grants with some integrative elements that have moved the university toward a STEM identity. This vigorous STEM education-focused environment provided research teams with many successes and failures to observe and opportunities to build on factors that emerged for cultivating a STEM identity. Circumstances surrounding projects that involved three general areas: *faculty engagement/community*, *STEM curricular/co-curricular activities*, and *university leadership/systems* manifested themselves in a series of five sequential stages or levels, see Table 1. Level 0 refers to an autonomous stage, with descriptors across the three areas as shown in Table 1; Level 1 refers to an exploring stage, Level 2 to a building/connecting stage, Level 3 to a collaborating/unifying stage and Level 4 to an integrated stage. Table 1 summarizes the path of this university as it moved from no central STEM integration to a nearly integrated system that enables STEM goals across departments, colleges and campus. Table 1 was developed through analysis of five cases that are presented in the next section.

Table 1: Categories of Development of a STEM Identity

Level	Stage Descriptor	A: Faculty Engagement/ Community	B: STEM Curricular/Co-Curricular Activities	C: University Leadership/ Systems
0	Autonomous	• Faculty work independently on coursework, projects, etc. Little to no discussion on pedagogy, course outcomes, etc.	•Individual efforts in departments	• No central STEM Integration
1	Exploring	• Faculty recognize need for and begin communication within the department to improve courses, pedagogy within a course • Limited, if any, interaction with constituent departments.	• Departments try diffusing their successes to other departments	• Task forces and initiatives that recognize STEM needs
2	Building/ Connecting	• Individuals reach across departments for specific projects • Constituents consulted	• Specific curricular and co-curricular projects (such as math success) are undertaken	•University leaders join ownership of STEM grants or initiatives
3	Collaborating /Unifying	•STEM education research a university focus • Interdisciplinary STEM faculty learning communities are commonplace • We, the faculty, a collaborative effort	• Extensive integration and development of STEM student success programs •Learning outcomes span courses and departments	•Policies and strategic plans deliberately include STEM •Specify data to measure STEM outcomes
4	Integrated	•STEM faculty engage on curricular, co-curricular, scholarly work, policies •STEM center seen as resource for faculty success •Integrated STEM first-year curriculum	•Curriculum and learning outcomes integrated across STEM departments •Students identify with STEM as a community •University systems deployed, if needed, for integration	• University systems enable STEM goals • Resources allocated in a way that recognizes STEM goals and strategic plan

Case Results

In this section, five cases are presented that illustrate progression of this university toward an organizational STEM identity. The selection of cases presented is subjective and occurred in reflection following more than a half decade or more of work and self-analysis. The first two cases are directed toward Faculty Engagement/Community (column A from Table 1); the next two cases are directed toward STEM Curricular/Co-Curricular Activities (column B) and the last case concerns University Leadership/Systems (column C).

This narration has been made possible through the perspective gained as a result of the Hewlett Foundation's Engineering Schools of the West Initiative as well as the three integrative grants listed below that were awarded by the National Science Foundation and that are focused on institutional transformation:

- a $1M Science Talent Expansion Program (STEP) award (2010-2015)
- a $1.25M Innovation through Institutional Integration award (2010-2015), referred to as "I^3",
- and a recently awarded $2M WIDER award (2013-2016), referred to as "WIDER"

CASE 1: STEM INSTRUCTIONAL DEVELOPMENT FROM LEVEL 0 TO LEVEL 3

Faculty Engagement/Community: Faculty engagement both within and also across individual STEM departments has been essential in creating a STEM identity. For example, this case study focuses on STEM instructional development.

The growth of a culture of STEM faculty instructional development has coincided, in part, with increased faculty development campus-wide. During the middle of the five-year ESWI grant a campus Center for Teaching and Learning (CTL) was established in 2006. Prior to this, opportunities for instructional development were limited and focused primarily on teaching with technology. Not surprisingly, dialogue around teaching practice, opportunities to learn about evidence-based instructional practices in STEM, and the culture of teaching improvement were also limited. Generally, teaching practice was focused completely on individual faculty and adoption of best practices was ad hoc. This was Level 0. The founding director of the CTL moved into this new role after ten years as a faculty member in the Chemistry department and several years of providing campus leadership around general education. As such, the CTL was launched with existing campus-wide faculty connections, especially in STEM. Further, because the director came from a STEM discipline, there was programming pitched toward best practices in STEM from the beginning. For example, the CTL hosted sessions on cooperative learning and inquiry based learning. Over time, with support of faculty and campus administrators, we moved the general campus culture to Level 2, building a culture of faculty development. In 2012-2013, 24% of the science and math faculty from the College of Arts and Sciences; and 59% of all faculty in the College of Engineering participated in at least one faculty development event or program. Other colleges at this university range in participation rates from 19-27%. This kind of participation serves to build awareness of evidence-based teaching and of the value of continuous improvement in teaching.

Faculty communities were some of the first mechanisms through which the campus began exploring and articulating a cohesive STEM vision. For example, 41 faculty and staff in nearly 20 departments came together in fall 2008 in an ad hoc STEM Caucus focused on STEM education research and K-12 initiatives. This grassroots interest led to more formal faculty learning communities and symposia, and eventually to the integrative I^3 grant in 2010.

A particular effort to specifically support STEM faculty development was begun in January 2011. A "Best Practices in STEM Teaching Symposium" was held in which STEM faculty who had already established themselves as either adopters of evidence-based instructional practices (or those interested) were invited to an event co-hosted by the CTL and the campus STEM Station, which was supported by the I^3 grant. In preparation for the event, the organizers assembled several sets of instructional- and assessment-practice case studies based on work going on at Boise State. The 32 participants in the half-day event focused on the discussion of these case studies that served to both celebrate the accomplishments of those adopting best practices and to make their implementation of best practice real. (One participant noted the case studies were useful because it made them feel "I can do this if she can do it"). Participants came away with new ideas and a renewed sense of commitment to teaching innovation within a supportive and collegial community. The impact was so swift that four months later, at least a third of participants reported they had made changes to their teaching immediately that semester. Participants were also invited to consider how they might contribute to further dialogue around teaching and learning within their own departments. Several in attendance took this invitation seriously, adopted a "Leadership in Place" approach and began to intentionally lead from within their departments, fostering significant pedagogical change at the department level. Follow-up events have been held for broader STEM faculty audiences and further solidified the Level 2 culture across campus at that time.

In the 2007-2008 academic year, the CTL started a faculty learning community (FLC) program (Cox, 2001).[13] The program has involved interdisciplinary communities of 8-10 faculty in a year-long process of inquiry to promote faculty development and enhance student learning. The program is designed to stimulate dialogue, reflection, and innovation in teaching, to foster a sense of community, and to promote scholarly teaching practice. In the early years of this program, a number of STEM faculty were involved in interdisciplinary dialogue around undergraduate research, first year student-success, and active learning in large enrollment courses. More recently, with support from the Idaho STEP project, we have supported two STEM-specific FLCs. In 2010-2011, an interdisciplinary group of eight faculty from engineering, sciences and math focused on the topic of STEM Student Success[14] and in 2012-2013 a group of 10 faculty who teach calculus considered Best Practices in Calculus. In addition to these groups, a parallel experience focused on STEM Education Research has been supported by the I^3 grant. Since 2009 there have been seven year-long cohorts (generally eight faculty per group) from departments across campus. In January 2014, we held our first STEM Education Research Poster Session that further facilitated the sharing of ideas of 35 teams and 112 attendees across departmental and college boundaries.

The FLC experiences have been intensive, involving faculty in dialogue and exploration over a year or more. They have contributed to a significant number of STEM faculty with professional relationships beyond their own department and college, ready to identify and engage in improving student learning and success as STEM faculty. This has taken us to Level 3. We have a significant amount of cross campus collaboration. Not only do faculty from across departments and colleges know each other as a result of potential research connections, we have also leveraged the relationships to foster discussions across department boundaries around teaching and learning. Faculty generally recognize the importance of supporting students, even if the students are not their own majors.

CASE 2: MATH INTEGRATION WITH OTHER STEM DEPARTMENTS FROM LEVEL 0 TO LEVEL 3

Faculty Engagement/Community: Our mathematics department has undergone significant development in terms of faculty engagement, moving from level 0, to level 3. In Fall 2005, about two years following the launch of the Hewlett Grant, enrollment in STEM majors was 1,983, representing 12.6% of the university's enrollment and with 256 entering first-time, full time students. In fall of 2012, STEM enrollment was 3,348, comprising 17% of the university's enrollment, and with 563 entering first-time, full-time (FTFT) freshmen, corresponding to 25% of incoming FTFT students. During this rapid period of growth, the mathematics department faced issues of capacity, student success, pressure to conduct research and pressure from constituent groups while also handling budget cuts.

A snapshot of the student experience in mathematics in the 2005-2006 time-frame reveals a level of faculty engagement at level 0 – faculty worked independently on coursework with little to no discussion of student outcomes. From the students' perspective, it seemed to matter more *who you took* than *what you learned*. An extreme example of this is drawn from the 2005-2006 academic year, and one instructor's Calculus I pass rate of 33%, passing 9/27 students who took the course (with pass rate defined as # students receiving grades of A, B or C divided by # students receiving grades of A, B, C, D, F or W.) As a reference point, the average pass rate for calculus across that academic year was approximately 51% (Bullock, et al., 2009.)[15] In addition, within the mathematics department, there was limited discussion of what students should be able to do, following Calculus II (for example), the prerequisite for Calculus III and Differential Equations. This affected student success in those post-requisite courses.

The ESWI team, as it began to understand the student experience, attempted to discuss some of these issues with the department of mathematics. One research result in particular, was very compelling, and concerned assumptions– that the grade in a student's first mathematics course and not the level of mathematics course in which students enrolled their first semester was a predictor of graduation.[7] These communications, from engineering **to** mathematics, were largely unsuccessful, and instilled an unproductive sense of "we" versus "them" rather than a team approach. As efforts were made to bridge this divide, it faded slowly, over time; and faculty gradually transcended disciplinary boundaries. An example of the proactive work undertaken was the invitation of mathematics faculty members to participate in teaching the introduction to engineering course in 2005 (with a small monetary incentive and a math course buyout). One faculty member signed up; shortly after this, that faculty member became the mathematics department chair. Over the next six years, he collaboratively guided his department toward an outcomes-driven, student-centric, constituency-aware culture, while also growing the department's research portfolio. A lesson learned from this experience concerns the need for leadership to be willing to cross boundaries to get things moving beyond level 1. It was serendipitous that this mathematics faculty member (who became chair), a former aerospace engineering major who turned to mathematics in his undergraduate career, self-engaged himself in the needs and issues being experienced by applications-oriented engineering majors and faculty members.

The first major STEM integration project that the mathematics department tackled was Calculus III and Differential Equations. By Fall 2009, as a result of both the need to increase capacity and the need to improve section-to-section consistency, the way these courses were offered was significantly altered. Planning funds from the Provost's office, directed toward increasing capacity while incorporating pedagogical improvements, helped implement this project. Two lead mathematics faculty, both tenured faculty professors, became course leads and each of them began the project in a planning phase the preceding year, by asking their largest constituent group, engineering "what did they need students to be able to do after completing these courses?" Over the next several years, a mechanical engineering professor worked with both mathematics professors and assisted with these courses so that they included a weekly application of how the mathematics applies in real-world, engineering applications. The engineering professor took on an increased teaching load in order to accomplish this; he attended all the mathematics classes, and a strong camaraderie developed between the professors. The course was first offered at an increased capacity of 80 (from 40) but very quickly moved to 120 in response to the need for more seats – at times without additional assistance provided despite the increased capacity. One of the significant lessons the mathematics faculty learned from this experience was that that there was a need to develop Calculus II student outcomes. This project lasted three years, and the faculty engagement level both within the department of mathematics and across to its constituent departments propelled mathematics faculty engagement over this timeframe into Level 3. Starting in the 2011-2012 academic year, the ongoing instruction moved to a sustainable model that retained an applications focus without the engineering professor needing to teach engineering applications in the course. The courses remain application and constituency-focused using real-world examples routinely in their instruction.

Another Level 3 example occurred in spring 2011, when an engineering professor who was living as Faculty in Residence in the Engineering Residential College, a Living Learning Community, decided to retake Calculus I. While completing the course, she gained in-depth experiences as a student to augment her perspective of an experienced educator with a strong background on STEM retention. The engineering and math professor's observations and experiences are presented elsewhere (Callahan, et al., 2012).[16] One of the reflections of the math professor succinctly expresses the changing environment he perceived: "The entire experiment – having an engineering professor in my Calculus class – gave me a stronger sense of education as a collaborative effort instead of a solo act." (Callahan, et al., 2012, p. 10).[16]

The networking between departments and across colleges continues to grow. As of Fall 2013 and as a result of a Provost's office initiative, a Program Transformation Grant for $75,000 was awarded to a STEM team. Eight instructors and faculty from engineering, physics and mathematics have been meeting twice monthly as part of a faculty learning community on this campus. As one component of this activity, Calculus I is being integrated with Physics with Calculus. To help accomplish this, one instructor of Calculus attended Physics; an additional two are doing so in the spring with the physics instructor also attending Calculus, while the initial project lead will be integrating Calculus II with second semester Physics. The gains from this are profound – the calculus instructor has begun to use notation that helps students see the links between what is being taught in Calculus and what is needed to apply in Physics; units are associated with problems, and more. Even more compelling is how there is the developing sense of "we, the faculty, a collaborative effort," as mentioned earlier, in this interdisciplinary group that has developed over the semester.

Finally, mathematics also become very highly engaged in terms of participation in faculty learning communities; this was described in the preceding section.

CASE 3: LEARNING COMMUNITIES TO BLOCK SCHEDULING FROM LEVEL 0 TO LEVEL 4

STEM Curricular/Co-Curricular Activities: A strategy for creating commonalities and connections between students and faculty and to thereby positively influence student engagement (Zhao, C. and Kuh, G., 2004)[17] and persistence is to establish learning communities, curricular structures that link different disciplines around a common theme (e.g. Gablenick, F., MacGregor, J., Matthews, R., and Smith, B.L., 1990).[18] Between approximately 2003 and 2007-2008, curricular learning communities were routinely established by engineering, for engineering students. These were established each semester through personal communication between faculty and staff in the (CoE) and a student success coordinator who interacted with the Registrar to reserve seats in two or more courses. For example, 24 seats would be set aside in one particular section of Introduction to Engineering and one particular chemistry laboratory and lecture combination. Between three and eight learning communities would be established each semester; more for the fall semester and fewer in the spring. Students would enroll in the learning community after learning about these via email, word of mouth, or during summer orientation sessions. Although these learning communities involved different departments, it was truly a level zero stage, as the intended use of the benefit was strictly for engineering students (refer to Table 1, Column B). Over time, some of the benefits of these learning communities had diffused to other departments in science and mathematics, which led in 2007-2008 to increasing the numbers and types of learning communities that were established each semester – and this STEM curricular activity moved to Level 1. The main benefit appreciated by non-engineering STEM departments was actually more related to capacity issues that the university was facing rather than any benefit realized by students in terms of increased student engagement. Internal communications concerning learning communities between departments and in messaging to students utilized “STEM” in their heading (e.g. STEM Learning Communities, Fall, 2009.)

There were many logistical issues associated with the learning communities. Setting them up was not automated; prerequisites were not checked by the system when students enrolled in learning communities, necessitating checks by hand; instructional faculty involved in the learning communities had to be contacted for their permission to enroll their class in a learning community; and more. A drawback of learning communities was that it masked true capacity as seen by the Registrar. For these reasons, one of the STEP grant activities was to institutionalize STEM learning communities and registration aspects associated with incoming STEM students. As of Fall, 2013, this was accomplished, which involved bringing this activity through Level 3 and into Level 4, as it was necessary to extensively integrate across departments and bring to bear university systems such as the Registrar, capacity planning by the Provost’s office and more.

CASE 4: CO-CURRICULAR PATHWAYS TO COLLABORATION FROM LEVEL 1 TO LEVEL 3

STEM Curricular/Co-Curricular Activities: Co-curricular programs, such as cohort-based activities, summer bridge and academic support, set the stage for cross-departmental STEM collaboration, often prior to formal curricular partnerships. However, challenges sustaining even successful co-curricular programs revealed the necessity of paying attention to all three factors of the identity development process – A, Faculty Engagement, B, STEM Curricular and Co-Curricular Activities, and C, University Leadership/Systems. For example, the ESWI team’s first efforts to create a peer learning program encountered obstacles to sustainability. Similar in some elements to Supplemental Instruction[19], the student peer facilitators named the ESWI program Active Learning Facilitators (ALFs); and it supported mainly pre-calculus and calculus courses, up to 20 sections per semester.[20] The ALF program emphasized strong connections with faculty sponsors and held weekly strategy sessions where ALFs contributed their suggestions for improvement. Run by Engineering faculty and staff as part of ESWI, the ALF program achieved cooperation with some Mathematics, Geosciences and Physics faculty; student participants enjoyed the group dynamics and succeeded at higher rates than non-participants.

Toward the end of ESWI (2007-2008) the ALF program, armed with significant evidence and data, tried vigorously to move from level 1 to 2 and hand off (institutionalize) the program to the Academic Enhancement (AE) office, which coordinates tutoring programs. ESWI provided incentives to institutionalize the program with funding for student ALFs and staff support. However, certain aspects of the ALF program were incompatible with AE culture, structure, and goals; and the ALF program largely faded away. In addition, AE may not have recognized the particular needs of STEM students. The "STEM Identity" that was later created helped identify the collective need for STEM student success.

In 2010, the newly funded STEM Station, part of the I^3 program, prioritized a new Learning Facilitators program (later changed to Learning Assistants to align with University of Colorado's program).[21] This time, specific strategies were incorporated from day one to ensure success across STEM disciplines and engage faculty and Academic Enhancement. Emphasizing both curricular and co-curricular goals, the STEM Station calls university partners to adopt *Learning Partnerships*[22], a heuristic associated with the framework of *self-authorship*[23], identified by Marcia Baxter-Magolda. Also, the PI and Co-PI of the STEM Station are the Provost and Vice-Provost, and they had leadership authority to assign implementation responsibility largely to AE, with the grant project team acting mainly as advisors and supporters. AE's strong relationships with the STEM departments further ensure program success and have enabled the Learning Assistant program to achieve a near-Level 4 level of integration.

The co-curricular Learning Assistants program has also opened doors to curricular reform. Several faculty from Mathematics, Physics, Chemistry, and Engineering who became familiar with peer learning facilitation through the Learning Assistants program are now involved in the new WIDER grant. Their comfort with peer-led learning is empowering them to lead their departments in exploring other evidence-based, peer-led, and active learning in their classrooms.

CASE 5: STEM AS AN OFFICIAL UNIVERSITY DEFINITION FROM LEVEL 0 TO LEVEL 3

University Leadership/Systems: Cultivating a STEM identity involved developing the terminology to describe and the methodology to measure facets of STEM identity. Describing and measuring STEM as a priority bestowed it credibility and visibility. In 2010, STEP and I^3 projects began working with Institutional Research to define a set of majors as "STEM." This was the first step toward moving away from silo-ed departments that did not perceive themselves as being part of anything larger than members of their own college, whether Arts & Sciences, or Engineering. The final definition of "STEM" departments was set in early 2011, based on Classification of Instructional Programs (CIP) codes defined by U.S. Department of Education identified as STEM in the NSF LSAMP (Louis Stokes Alliance for Minority Participation) Crosswalk[24] and the National Center for Education Statistics.[25]

Measurements of STEM student enrollment and degree attainment were conducted -- required as part of the reporting for both STEP and I^3, showed that our institution lagged behind its peers in the percentage of students majoring in STEM. With the national call for STEM professionals, regional demand for a strengthened STEM workforce, and university priorities for increasing research in STEM fields, the Provost made the case in September 2011 to the university deans for making STEM a university priority. The I^3 team crafted a university vision for STEM, which the Vice Provost provided to the university strategic planning team. Consequently, in the university's strategic plan for 2012-2017, the one-page summary of university strategies identifies STEM as the only group of academic majors (other than Foundational Studies, which are the general education courses) called out specifically for attention; and STEM is mentioned twice in this summary.[26]

That systems and priorities have been created for measuring STEM reflects an achievement of Level 3. Strategic plan recognition of STEM edges toward Level 4. Evidence of achieving Level 4 will depend on how university resources are allocated to achieve the university's strategic plan.

With widespread announcement of the university's strategic plan in 2012, this apparent promotion of STEM as a new university identity characteristic precipitated a multitude of responses from campus constituents and including both STEM and non-STEM faculty. Engagement by STEM faculty in collaborative initiatives soared, as some non-STEM faculty expressed questions and concern as to where they fit in. This alerted the STEM team leaders of the need to reach out and deliberately collaborate with arts and humanities faculty. A lesson learned from this was the need to engage with the appropriate constituencies during the prioritization process. A benefit is that non-STEM disciplines (arts, health, social sciences, education) now have a mechanism to integrate with "the sciences" and bring the aesthetic and human elements to STEM.

Discussion, Limitations and Future Work

The social constructionist perspective, as summarized by a review of the literature (He, 2013, p.7), regards organizational identity (OI) as being "the socially constructed product of relationships between collectively held, and socially structured individual cognitions regarding 'who the organization is.'" The social constructionist OI refers thus to "relatively shared understandings concerning what is central…about an organization, that give meaning to members' experience of work, and which derive from a complex of interactions by multiple actors from across professional groups and hierarchical levels." (He, 2013, p. 8). He and Brown go on to state that this approach to the study of OI shows OI to be "more malleable, less the product of senior executives' decisions and more open to political influence at different levels" (He, 2013, p. 8). In the cases presented in the preceding section, the emergence of a "STEM identity" was seen to derive from many different interactions by different professional groups and hierarchical levels (staff, faculty, faculty in role of student, administration) – and was not a product of an executive level decision, but an emergent result of shared beliefs (e.g. that student success is important), values (e.g. we are committed educators) and assumptions (e.g. student persistence is influenced by how well they do in their first math class, rather than the math level). Thus, the social constructionist perspective on organizational identity appears a good fit with observations associated with the development of a STEM identity on this campus.

In terms of organizational identification (OID) – that which occurs "when employees perceive oneness with an employing organization and feel that they belong to it" (Ashforth & Mael, 1989[27] – referred to by He, 2013, p.12), there is the capacity to generate a range of positive employee and organizational outcomes, including organizational citizenship behavior, and more.

Many of the examples presented in the Case Results section demonstrate organizational citizenship. For example, in Case 2, the mechanical engineering professor elected to teach a much higher course load, and help the mathematics department out of his commitment to improve the student experience. Likewise, the mathematics faculty, without additional assistance or compensation, increased section size to accommodate increased student capacity, in order to not delay students in their degree progress. Thus, organizational identification – employee perception – may have factored into growing an organization-level STEM identity.

The cases demonstrate progress toward an organization-level STEM identity, yet only Case 1 (learning communities) proposes a Level 4 status where systems, policies and curricular efforts are integrated across STEM departments. The formation of a fully formed organization-level STEM identity remains a work in progress on our campus. The recognition that organizational identity formation spans hierarchical levels is at the heart of a new endeavor by the WIDER team to apply a specific change model to propagate evidence-based instructional practices across the STEM curriculum. The team is adapting and deploying Dormant's CACAO change model,[28] a synthesis and application of highly regarded change theories: Everett Rogers' work on the diffusion of innovations[29] (passive, bottom- or middle-up) and John Kotter's work on the purposeful implementation of designed changes (active, top-down).[30,31,32] In doing so WIDER incorporates all three factors of the identity development process that this research has put forth as noting or marking the development of a STEM identity – A, Faculty Engagement, B, STEM Curricular and Co-Curricular Activities, and C, University Leadership/Systems. Successful achievement of the WIDER goals will move this university's "STEM identity" toward level 4.

Recognizing that other colleges of engineering may be utilizing STEM as a unifying theme, our intention of sharing this framework is to start a dialog about the development of an organization-level STEM identity, particularly for institutions in which engineering and science may not be the pre-eminent thrust. Future work could further refine the framework proposed in Table 1 or develop a rubric or tool for institutions to benchmark their organization level identity development in STEM.

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