Analyzing Cultural Processes in Higher Education: STEM and Education Faculty Collaboration in Teacher Education

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System-wide Change for All Learners and Educators
May 16, 2007

Paper presented at the 2007 Annual Meeting of the American Educational Research Association, Chicago

The preparation of this document was supported by a grant from the National Science Foundation to the University of Wisconsin–Madison (EHR 0227016) for a Mathematics & Science Partnership project called the System-wide Change for All Learners and Educators (SCALE) Partnership. At UW–Madison, the SCALE project is housed in the Wisconsin Center for Education Research. The other five partners are the University of Pittsburgh, where the SCALE project is housed within the Learning Resources Development Center's Institute for Learning; the Los Angeles Unified School District; the Denver Public School District; the Providence Public School District; and, the Madison Metropolitan School District. All opinions, findings, or conclusions are those of the authors and do not necessarily reflect the views of the supporting agency.

Abstract: The lack of coordination between STEM and education faculty in teacher preparation is viewed as a crucial breakdown in the system of teacher education. This paper describes findings from a qualitative case study of one Institution of Higher Education (IHE) participating in System-wide Change for All Learners and Educators (SCALE), an NSF-funded Math & Science Partnership project. This research is an embedded case study of a comprehensive university on the West Coast, which employed a grounded theory approach to analyzing interview (N=41) and document data, a framework for Educational Culture Process Analysis, and causal network analysis. At this IHE, bifurcated state regulations and IHE programs governing teacher preparation, differences between STEM and education faculty's ownership of teacher preparation, and strained relations characterized by stereotypes, interacted to create an institutional context that was generally unfavorable. In this context, SCALE created five new opportunities for STEM and education faculty to interact, including a series of professional development workshops led by an education faculty who deftly negotiated STEM faculty concerns that they would be "told how to teach" and given tools that were poorly suited to their courses. Through these interactions SCALE was successful in fostering a nascent "community of practice" of STEM and education faculty, influencing some STEM faculty's pedagogical practices and their perspectives regarding the value of pedagogy and educational research, and changing some structural elements of the teacher preparation program. However, SCALE was unable to influence several factors that invariably shape individual practice and group meaning systems, and continued opportunities for interaction into the future will be needed for this emerging network to become a factor that effectively fosters long-term institutional change.

Context of Study: This case study is part of the Institutions of Higher Education (IHE) Case Studies line of work for the System-wide Change for All Learners and Educators (SCALE) project. SCALE is a large national Math and Science Partnership project funded by the National Science Foundation (NSF). The IHE Case Studies focus on the structural and behavioral dynamics influencing the implementation of the SCALE strategies for effecting change in IHEs. One of the dynamics on which this line of work focuses is efforts to improve collaborations between STEM and education faculty regarding pre-service programs. This paper reports findings from one of the case studies on factors that impede or enable STEM and education faculty collaboration on teacher preparation programming at an IHE participating in the SCALE MSP.

The Problem

As numerous studies and reports attest, the challenges facing math and science education in the U.S. are systemic, including public policy, funding, curricular strategies, and institutional policies that span the educational continuum from higher education to K-12 (American Association for the Advancement of Science, 1989; Committee on Science, Engineering, and Public Policy (COSEPUP), 2006; National Research Council (CSMTP), 2000; U.S. Department of Education, 2006; U.S. Office of Science and Technology Policy, 2006). One of the many challenges in improving teacher preparation and professional development practices in the U.S. is the complex nature of the preparation process. Future K-12 teachers obtain their math and science content and pedagogical training from diverse institutions and stakeholders, whose programs are governed by various policies that often operate in isolation and with little coordination. As a consequence, the quality of training often is uneven, if not haphazard. The stakeholders include, among others, STEM and education faculty at the IHE level, as well as district administrators and math and science coordinators at the K-12 level (Mundry et al., 1999).

Since in most states, students seeking to earn secondary school teaching credentials are STEM majors, and in all states students seeking to earn primary and secondary school teaching credentials take STEM courses, national policy makers are increasingly recognizing and scrutinizing the roles that STEM faculty play in the teacher training continuum by instructing pre-service candidates in disciplinary content and modeling pedagogical methods. For example, the *Shaping the Future* report by the National Science Foundation (1996) recognized these roles when it urged STEM faculty to use active learning strategies in their undergraduate courses not only to help students understand discipline content more deeply but also to model effective pedagogy that future teachers can use in their own instruction. Researchers have also identified high rates of attrition among undergraduate science majors as one of the consequences of poor undergraduate instruction and academic assistance (Seymour and Hewitt, 1997).

In 1998, the National Research Council addressed this issue by establishing a Committee on Science and Mathematics Teacher Preparation (CSMTP). The CSMTP report (NRC, 2000) states that a significant restructuring of the relationships within higher education

regarding teacher preparation, including new collaborations between STEM faculty and education faculty, is required to adequately prepare and train effective teachers. One goal of these new collaborative relationships would be to shift faculty's perception of the responsibility for teacher preparation solely from colleges of education to an all-campus endeavor. Other researchers call for partnerships between STEM faculty and their colleagues in colleges of education to make STEM departments more hospitable to future teachers (National Research Council, 1997).

The National Science Foundation (NSF) Math & Science Partnership (MSP) program aims to encourage partnerships between STEM faculty, education faculty, and IHE administrators with the K-12 districts they serve in "efforts to effect deep, lasting improvement in K-12 mathematics and science education" (NSF, 2003). Thus the theory of change of the MSP initiative is predicated on increased involvement of faculty in the STEM disciplines in the teacher training continuum, in order to effect lasting improvements in K-12 student learning (CASHE, 2006; NSF, 2003). The System-wide Change for All Learners and Educators (SCALE) project is a comprehensive MSP project funded from 2003-2007. The SCALE IHE partners include one research university located in the Midwest, and two comprehensive universities located on the West Coast.

This research is informed by the dual need to evaluate the efficacy of the SCALE program, and to better understand how and why it operated the way it did at each IHE. This need to explore the effect of contextual variables and their dynamics on STEM and education faculty approaches to inter-departmental collaboration in general, and teacher preparation in particular – led to the following research questions:

1) How, if at all, does the institutional context(s) influence STEM and education faculty's collaboration on teacher preparation programs?
2) Is SCALE contributing to changes in this area?

Importance of the Study and Contributions

The MSP program is facing the extremely difficult undertaking of fostering change in higher education, a sector known to be very resistant to change. Researchers cite the persistence and resilience of institutional tradition (Kezar & Eckel, 2002), the decentralized and "loosely coupled" nature of IHEs (Birnbaum, 1988), and the unique elements of organizational structures as characteristics of IHEs that make them resistant to change efforts (Cuban, 2000; Schroeder, 2001). These challenges are pertinent to the MSP program, and may account for limited effects of this program on STEM faculty and institutional processes. For example, a 2006 review of institutional changes of 21 MSP higher education partners found that curricular changes are occurring at IHEs across the MSPs, but with a majority of the changes in pre-service programs and in-service professional development, and not in STEM departments. Furthermore, changes were at the individual level instead of the institutional level, with no department-wide initiatives or collaborative team efforts (CASHE, 2006).

For interventions that take place in complex institutional environments, such as the MSP program, there are calls for increasing attention to the effect of contextual variables on

program implementation and outcomes (Katzenmeyer & Lawrenz, 2006; Anderson and Helms, 2001). Researchers commonly use a technical-causal model to research and evaluate initiatives where individuals (and institutions) are put through a treatment to achieve hoped for change or results (Davis et al, 2003). Evaluators also use simplified logic models that conceptualize an intervention in terms of inputs, process, and outcomes, which is an insufficient approach when dealing with complex problems (Patton, 2006). Some educational researchers argue for the need to examine reform efforts systemically to understand the pathways and impediments to successful reform (Anderson and Helms, 2001). Anderson and Helms (2001:5) argue that "(W)hile a systemic view quickly establishes that there are no simple solutions in the process of reform, one would expect that there are some very strategic leverage points," and that "with the fuller understanding of reform that research provides, reformers may be in a better position to identify these strategic leverage points – that is, particularly productive entry points to the complex system – and take productive action."

However, it is one thing to desire to conduct 'holistic' research, and another to categorize and make sense of the immense amount of conceptually incongruent data such an approach entails. In the course of this research and concurrent reviews of the literature in higher education, business management, and evaluation, it became apparent that there were few conceptual or methodological frameworks that adequately fit the contextual issues and the individual experiences of multiple context(s) that were emerging in the data. In order to explain these emerging patterns, it therefore was necessary to develop a conceptual framework for organizing, analyzing, and reporting these complex data.

Relevant Literature

A literature review of a wide range of subjects was conducted for this research. Due to the limitations of this paper only an abridged version of this review is presented. Among the bodies of research reviewed were studies on STEM and education faculty collaboration, methods for conducting systems-based research, and organizational culture research in higher education and organizational studies. This review of systems-based research methods and organizational culture was required due to the paucity of readily available approaches for studying reform initiatives in complex institutional settings.

STEM and Education Faculty Collaboration

There is little research on the specific topic of STEM and education faculty collaboration, particularly regarding teacher preparation. Studies that describe the history of education schools and their low status in society and in higher education provide the greatest insights into the lack of collaboration between the two faculty groups (Labaree, 2004). Another body of literature that is instructive addresses factors that influence faculty collaborative activity in general, including obstacles to instructional innovation among STEM faculty (Walczyk, J.L. et al, 2007), inter-disciplinary interactions and differences (Becher,& Trowler, 2001), and different cultural factors influencing faculty behavior (Austin, 1990). Also of interest is the significant body of literature on higher education and K-12 faculty collaborations, but these studies focus almost exclusively on education faculty and K-12 (reflecting the absence of STEM faculty in these collaborations). Examples include collaboration within professional development schools (Rice 2002),

faculty involvement in practicum/field sites (Beck and Kosnik, 2002), university faculty in partner schools (Ginsberg and Rhodes, 2003), and modeling co-teaching in education coursework (Kluth and Straut, 2003).

Systems-based Research Methods

As previously noted, despite calls for systemic evaluations and context-based institutional research, there are relatively few examples of methods for conducting such an empirical investigation. Much more common are technical-causal models to research and evaluate interventions (Davis et al, 2003). The primary limitation with this approach is that it depicts programs in linear cause-effect linkages that fail to illuminate organizational dynamics (Owen and Lambert, 1998). There are also numerous examples of approaches in evaluation and social science that attempt to incorporate a more systemic approach (Preskill, 1991; Fetterman, 1990; Schein 1985). However, these do not describe in sufficient detail specific empirical research methods and analytic strategies. Other researchers argue that, while evaluators often work implicitly with systems models, an explicit understanding of systems thinking in organizational action is not common (Owen and Lambert, 1998).

In contrast, there are several examples of methodologies in operational research and qualitative data methods that are appropriate for, or were designed to, analyze behavior within complex institutional settings. For example, the soft systems methodology is widely used in action research, systems engineering, operational research, and business to analyze 'soft' systems that involve a significant social component –in contrast to 'hard' systems thinking (Checkland and Scholes, 1990). Examples of qualitative methods include causal network analysis (Miles & Huberman, 1994) and causal mapping (Montibeller and Belton, 2006). A characteristic of each of these methods is the graphic depiction of complex organizational processes as a way to understand causal relationships and dynamic processes.

Organizational Culture

In examining the nature of inter-disciplinary collaborations in higher education, a construct that is commonly employed is that of organizational culture. Despite a recent waning of interest in and criticism of the construct, culture remains a pervasive buzzword in higher education and management, and continues to be an attractive concept that provides organizational researchers multiple ways to explain social group behaviors (Alavi et al, 2005; Ashkanasy et al, 2000). It is tempting to trace the genesis of cultural analyses in higher education to the human relations studies of the 1930s, C.P. Snow's *Two cultures of academia* (1959), or even the popularization of the term that occurred with the widespread attention given to Japanese business models in the 1980s. However, it is important to note that anthropologists and sociologists have long been studying some of the central questions embedded within the notion of organizational culture, including the influence of social and institutional structures on individual action, and individual and group identity formation, and the role of context in shaping cultural expression.

Indeed, some researchers claim that for the study of organizational culture to win broader acceptance in the social sciences, it needs better grounding in the vast literatures in

anthropology and sociology (Lincoln and Guillot, 2004). To name but a few, relevant approaches include the structuration theory of Giddens (1979), the importance of history and macro-level forces as outlined by Wolf (1982) and Mintz (1985), the importance of grounding cultural analysis in local contexts (Geertz, 1973), and the contested nature of cultural representation (Clifford & Marcus, 1986).

Some criticisms of uses of the concept include the use of the term without definition or operationalization, or its use to explain any complex of behavioral and practical routines within an organizational unit (Bate, 1997). Furthermore, when the construct is employed, it frequently refers to convergence across differences and normative consensus, which results in the lack of attention to conflict and the presence of sub-cultures formed, for example, to express resistance (Lincoln and Guillot, 2004; Martin, 2002; Bate, 1997; Van Maanen & Barley, 1985). This reliance on the normative concept of culture is an example of the field not keeping up with recent theoretical approaches in anthropology and sociology, which is a common risk in cross-disciplinary work (Martin, 2002). Other critiques include the failure to account for local differences among organizational units, such as academic departments, the use of culture theory in ways that obfuscate rather than clarify (Knight & Trowler, 2000), and the lack of attention to contextual factors that influence faculty behaviors and group identity (Becher & Trowler, 2001).

Fortunately, examples of organizational culture analysis in higher education that avoid these missteps are numerous. Kuh and Whitt (1988) provide a detailed analysis and road-map for understanding different levels of organizational cultures, and Becher and Trowler (2001) analyze academic tribes and territories in a way that accounts for both structural influences and the individual autonomy that characterizes the academic profession. Of particular interest to this study are two approaches that explicitly account for the role of contextual factors on organizational behaviors. First, the nuanced and sociologically rooted analysis of French academia by Pierre Bourdieu (1984) incorporates a relational model that accounts for the effects of phenomena he calls the social field, individual disposition, and resource and capital distribution. Second, the interactional and relational aspects of culture reinterpretation and construction of Van Maanen and Barley (1985) include a detailed model that can by employed in empirical research.

Design and Logic of Inquiry

Research Design

This research is a longitudinal embedded case study that follows an inductive approach to the analysis of qualitative data. The specific analytic methods of grounded theory (Strauss & Corbin, 1990) and causal network analysis (Miles & Huberman, 1984) were integrated into the case study to ensure the methodological rigor of the research. Case studies are a methodology for conducting empirical inquiry into a "contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2003:23). Moreover, qualitative case study research is particularly appropriate for descriptive and exploratory studies that seek to grasp the "how" and "why" elements of project operations (Merriam, 1998). An embedded case study contains more than one sub-unit of analysis (Yin, 2003; Scholz and

Tietje, 2001). The units of analysis in this research include individual faculty, academic departments, and the institution of higher education as a whole.

This research is both exploratory and explanatory. It is exploratory due to the lack of knowledge of the local contexts prior to data collection. For the exploratory phase a grounded theory approach to analyzing interview and document data was utilized. Once an informed understanding of the local context was achieved, the analytic strategy shifted to an explanatory mode in order to explain why certain phenomena were being observed. For the explanatory phase a causal network analysis was conducted.

This research was conducted at a research university in the midwest, and two comprehensive universities in the west coast. *This paper only describes findings from one of the comprehensive universities in the west coast*. Each site was selected as a case by virtue of its involvement with the SCALE MSP.

Data Collection

The types of data collected include semi-structured interviews and university documents. I collected and analyzed data in two phases. The first phase was an exploratory examination of institutional contexts. The second phase utilized findings from the first phase, and in a more formalized fashion, aimed to explain why SCALE did or did not lead to changes in the institutional context.

Semi-structured Interviews

In order to obtain systematic and complex qualitative information about change at various organizational levels, I interviewed STEM and education faculty, academic staff, and administrators who were directly involved in teacher preparation activities. I collected data at two points in time: Time 1 (June-July 2005) and Time 2 (December 2006 – January 2007). At T1 a total of 23 interviews were conducted, 17 with SCALE participants and 6 with non-SCALE participants. At T2 a total of 18 interviews were conducted, 10 with SCALE participants and 8 with non-SCALE participants. Due to respondent unavailability and faculty turnover (at both CSUDH and with SCALE) only 8 SCALE participants were interviewed at both T1 and T2. Besides these 8 interviews, 5 SCALE participants interviewed at T1 offered observations about the initial effects of the intervention, and 2 SCALE participants were interviewed only at T2. The interviews were semi-structured, which allowed for respondents to elaborate on key topics and for new lines of inquiry to be pursued by the researcher. I selected respondents using a purposive sampling procedure.

Document review

I also collected and analyzed university documents relevant to the research question. Examples of documents included reports from the university's Office of Institutional Research, strategic plans, external evaluations of related programs, and recruitment, tenure, and promotion (RTP) policies. I asked respondents to identify relevant documents, and also sought out relevant materials related to the university. Review of

these documents enabled the triangulation of findings from the interviews and observations to produce more credible evidence.

Data Analysis

Phase 1: Exploratory

Inductive Analysis of Data

I utilized a grounded theory approach to analyze the interview and document-based data, in the tradition of Strauss and Corbin (1990), in which a structured coding system was used to analyze the data. The mechanics of this approach to grounded theory include identifying a coding paradigm, or potential themes in the data, constantly comparing the emerging categories, and constructing an explanatory model with exemplars from the data (Bernard, 2002). I identified themes based on their numerical occurrence, topical relevance, and respondent-identified importance (Ryan & Bernard, 2003). I then used the constant comparative method of analysis to assess the validity of the emerging findings. Using multiple sources of evidence in this manner enhances validity and reliability (Miles & Huberman, 1994).

Developing the Framework for Educational Culture Process Analysis

Using the findings from the inductive analysis of data from all three IHE case studies, and utilizing methods and theory used in organizational studies of higher education (Van Maanen, 1985), and social practice theory in sociology (Bourdieu, 1977) I developed a classification system. A classification system was necessary to organize the collected data, and analyze relationships among different factors within that context. In developing the classification system, I paid close attention to ensure that the model fit the data and that theoretical concepts were used to "interrogate the data instead of explaining it" (Reay, D. 2004:44).

The following components of the classification framework are broad categories that include indicators that can be used to track changes in the institutional ontext(s). It is important to note that these categories are derived from analyses of complex institutional environments that were exclusively focused on STEM education, teacher preparation, and IHE/K-12 partnerships. Since this framework has not yet been applied to other IHEs using other research questions, it is possible that it can only capture institutional culture(s) related to SCALE goals.

External Influences: Institution type, national and state education policy, academic training of faculty, economic forces affecting education, and local K-12 characteristics.
The Internal Ecology: Location, organizational structure (governance, teacher education programs, STEM degree programs), student body composition, instructional workforce composition, personnel policies, leadership, and reform initiatives.
Task-Based Interactions: Structure of interactions between STEM and education faculty, and between IHE and K-12 faculty.
Resources: Material resources (time, funding), and social resources (community of practice).

Shared Meanings: Societal values and interpretations about the fields of STEM and education, institutional values and interpretations about the institution's mission and identity, and disciplinary values and interpretations about academic disciplines.
Individual Disposition: An individual's workload considerations, personality, background and training, professional identity, and status.
Practices: An individual's classroom instruction (planning and delivery) and collaborative activities.

It is also important to note that this framework, as employed in this case study, captures individual-level experiences and perspectives about multi-level phenomenon. For example, a STEM faculty respondent may speak about themselves, groups that they belong to, and their institution when identifying factors that influence their careers. As a result, this framework does allow for descriptions of group-level phenomenon as experienced by individual respondents, but without an adequate sample does not support claims of generalizability to larger groups or units within an IHE.

Establishing institutional context and situating SCALE
Using this classification system, I then organized the primary themes from the initial analysis in order to construct a 'preliminary map' of the institutional context.

Phase 2: Explanatory

Coding all interviews using classification system
I then coded all of the interviews using NVivo qualitative analysis software, using a coding scheme based on the classification system. This coding scheme included 3 passes, the first being the institutional context and SCALE activities, the second being barriers and supports for SCALE activities as identified by respondents, and the third being changes in the context attributed to SCALE.

Refining institutional context
I conducted coding and matrix queries in NVivo to identify particularly salient factors within the institutional context (pass 1) in order to refine the 'preliminary map' and ensure its accuracy. Using documents to triangulate, used them to construct 1)a narrative account of the preliminary context, and 2) a graphic account.

Establishing network fragments for the network analysis
Using the results from the coding, I then began constructing graphical representations of these salient factors in a time ordered display in order to produce various fragments for a causal networks. A causal network is "an abstracted, inferential picture organizing field study in a coherent way" (Miles & Huberman, 1994:153). The finished causal network is a time ordered display that organizes the data by time and sequence, and posits mechanisms of change and behavior within the IHE context by linking the data points to a larger network of other variables, including SCALE program effects.

Using the preliminary context as 'antecedent,' their relationship to SCALE from coded barriers and supports (pass 2), I identified using NVivo each factor with a valence in order to denote a positive (+) or negative (-) influence on SCALE activities, and to what

SCALE activity it was linked. These mediating variables are comprised of SCALE activities, and any notable incident or factor that occurred during program implementation. I constantly referred back to the data when making these assignments. Each resulting contextual factor linked to a SCALE goal constitutes a network fragment that potentially entails a causal relationship. Then, referring to attributed changes (code pass 3), I identified elements of the context that changed as a result of SCALE. These findings were noted in a Word document, and logical steps documented.

Using these 3 sets of linked factors, I constructed four graphic network fragments using Visio for each of the SCALE goals areas related to higher education, with factors identified in the data organized according to the classification system on the y-axis, and the temporal frame comprised of antecedent, mediating, and outcome factors on the x-axis (See Figure 1). Then, I drew arrows denoting potentially causal linkages and inter-relationships among the assembled factors. I further ensured validity of our findings by using member checks and peer review, which entailed an active search for disconfirming evidence (Bernard, 2002).

Constructing the Case

Finally, I constructed a case study comprised of SCALE activities, a description of the institutional context, and an analysis of the network fragments.

Limitations

The sample of IHE faculty interviewed for this research does not constitute a random or representative sample of CSUDH overall, or of individual CSUDH colleges or academic departments. The regular staff turnover in both academic institutions and grant-funded initiatives makes the longitudinal analysis of individual change problematic. However, in instances where elements of the institutional context as experienced by individuals is the main focus, this factor is less important. Also, while this is a limitation, it is not a problem because this research is not intended to be generalizable to IHEs *or even to IHE faculty*. Rather, it is designed to explore only the respondent's experiences and sentiments and to investigate the initial impact of SCALE activities at one site, and generate a theoretical and practical approach for analyzing STEM education projects. An additional limitation to this study is that the findings are largely based on respondents' self-reported behaviors, and not verified with classroom observations or other data on individuals' actual teaching approaches or behaviors. However, this micro-level of analysis is precisely the strength of the ethnographic approach, and consequently, the interpretations and claims in this case study are carefully made to reflect the nature of the methods used and data collected. Finally, since the preliminary IHE Case Studies are also intended to provide feedback for SCALE administrators and practitioners, it is possible that these case studies influenced the outcomes of SCALE and the findings herein

Findings

The network fragment for STEM and education faculty collaboration resulted in a simplified graphic depiction of the influence of contextual factors on SCALE activities, and observed outcomes for this goal. The network fragment also illustrated the interactions among these factors over time. For this paper, a list of the antecedent,

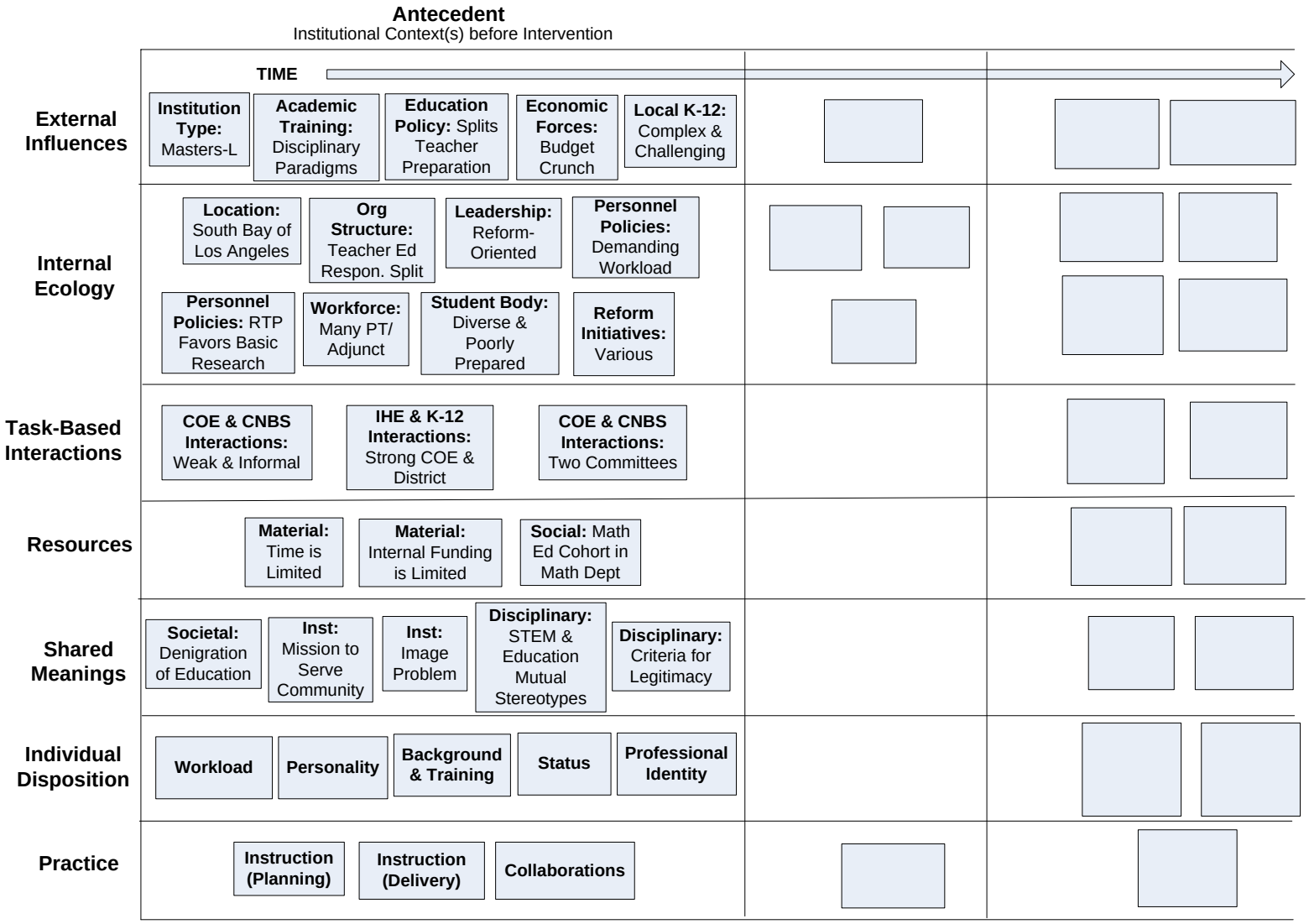
mediating, and outcome factors, a graphic of the entire network, and explanatory text regarding the effects of SCALE are presented. It is important to note that the factors that impeded or supported collaborative activities are included in each of the temporal frames, including the SCALE activities themselves.

These factors interacted to create an institutional culture that is generally unfavorable to STEM and education faculty collaborations, particularly on pre-service programs. **Despite an institutional identity that is closely tied to teacher preparation, and a widespread acknowledgement that many students across campus will become K-12 teachers, there persists a sentiment among many STEM faculty that they are not engaged in teacher preparation.** This sentiment is reinforced by the structure of the teacher preparation programs, and also the disciplinary traditions that typically view teaching and the K-12 sector as lacking in academic rigor. The structural and perceptual distance between the two colleges was further heightened by College of Education leadership prior to 2004, which severed ties with STEM departments.

Another factor that serves to discourage STEM faculty from participating in collaborations, is the growing demand for faculty to conduct research and publish, which is being reflected in the RTP process. Despite statements by university leadership that pedagogical scholarship will be acknowledged, very few faculty believe it and have seen evidence to the contrary. Since service activities, which is what most collaborations with education faculty or the K-12 sector would be categorized as, are relegated to a distant third on the RTP hierarchy, faculty have few incentives to participate in collaborative activities. This push for more research is viewed by many as an effort to elevate the status of the university to that of a research university, but without graduate students, reduced faculty workload, or significant external research funding.

There are some exceptions to this overall institutional situation, where collaborative activities do occur and faculty are predisposed to work with one another despite the aforementioned constraints. For example, university-wide committees exist for educator preparation and the liberal studies program, which provide a venue for inter-departmental interaction. Unfortunately, most science department representatives rarely attend these meetings. The Math department is also unusual in that half of its faculty are experienced in math education, which means that they are sympathetic to and conversant in pedagogical matters. The intent of the math faculty in this sub-group was to avoid disciplinary conflicts, and instead carve out “territory” for math education much like other sub-fields in math, such as number theory. This cautious approach points to the predisposition of STEM disciplines to be hostile to such an endeavor.

The Institutional Context Prior to SCALE/QED



The Institutional Context After SCALE/QED

Antecedent
Institutional Context(s) before Intervention

Mediating
SCALE/QED Intervention

Outcome
Institutional Context(s) after Intervention

TIME →

External Influences

Mediating: K-12 Professional Development

Outcome:
- **Institution Type:** No Change
- **Academic Training:** No Change
- **Education Policy:** No Change
- **Economic Forces:** No Change
- **Local K-12:** No Change

Internal Ecology

Mediating: Science 'Waiver' Program; STEM Course Changes

Outcome:
- **Location:** No Change
- **Org Structure:** New Courses/ Sequences
- **Leadership:** New Ed Dean
- **Personnel Policies:** Narrowly Averted Strike
- **Personnel Policies:** No Change
- **Workforce:** No Change
- **Student Body:** No Change
- **Reform Initiatives:** New Projects

Task-Based Interactions

Outcome:
- **COE & CNBS Interactions:** New Connections
- **IHE & K-12 Interactions:** New Connections

Resources

Outcome:
- **Material:** Release Time & New Funding
- **Material:** No Change in Internal Funding
- **Social:** New Science Ed Cohort

Shared Meanings

Outcome:
- **Societal:** No Change
- **Inst:** No Change
- **Disciplinary:** Reduced Stereotypes for SCALE/QED participants
- **Disciplinary:** No other changes

Individual Disposition

Outcome:
- **Workload**
- **Personality**
- **Background & Training**
- **Status**
- **Professional Identity**

* Various changes were reported among individual SCALE/QED participants in some of these areas

Practice

Mediating: STEM Faculty Professional Development

Outcome:
- **Instruction (Planning)**
- **Instruction (Delivery)**
- **Collaborations**

* Various changes were reported among individual SCALE/QED participants in some of these areas

Mediating Contextual Factors

For this analysis, mediating factors are comprised of the intervention activities, which in turn become part of the institutional context. Other developments that occur during program implementation, such as changes in regulations or staff turnover, are accounted for in this section.

In this challenging institutional context, SCALE/QED created 5 new opportunities for STEM and education faculty to interact. These new structures provided either release time for faculty or additional pay, which somewhat mitigated the effects of the already demanding workload. In addition, faculty motivations for participating were linked to the institutional mission of serving the local community – several faculty strongly identified with this mission and the need to improve math and science education in the public schools of the area. Faculty were also amenable to participation if the activities had some direct application or relevance to their immediate jobs.

For each of the activities, STEM and education faculty interacted in different roles, including as advisors (waiver programs, course re-design), co-facilitators (K-12 professional development), and instructors (faculty workshops). In each context, the education faculty served as pedagogical experts, while the STEM faculty served as both content experts and as students learning about pedagogical issues. In each case, the focus of attention regarding teacher preparation was on the STEM department's role.

Given the weak status of STEM and education faculty collaborations at the outset of the SCALE program, the flurry of activity observed during the program constituted a 'sea change' in the institutional context. Yet, because there are few structures for these interactions to continue over the long term, and because so few changes were made to the teacher preparation programs, it remains to be seen if and how these new interactions will persist, if at all. While most respondents noted that they would continue to work with their newly found counterparts in writing new grants for in-service activities, there are few program-based opportunities for substantive collaboration on existing pre-service programs. Given the demanding workload and the push for increased research activity in both colleges, it is even less certain that faculty would seek to create opportunities to collaborate on pre-service programs unless this work is redefined as part of their current responsibilities.

It is also evident that altering deeply held beliefs and preconceptions about the 'other' was achieved, as least to some degree. In exposing STEM faculty to pedagogical principles through the faculty development workshops, and to the realities of the K-12 classroom through the waiver program and K-12 PD efforts, many participating STEM faculty have new conceptions of the value and role of education. In my view, this is no small feat, and may plant the seeds for future collaborations or at the very least, result in colleagues who are sympathetic rather than irrevocably hostile to educational issues. Interestingly, several STEM faculty observed that their education counterparts had difficulty modeling active learning strategies, or 'constantly cited educational literature' in group settings. This tendency made some STEM faculty feel that they weren't the only ones requiring pedagogical training.

Conclusions

SCALE implemented a multi-faceted effort to improve math and science teacher training at a comprehensive university on the west coast. It fostered interactions that chipped away at some resilient and persistent disciplinary biases and traditions that impede collaboration, including STEM faculty denigration of the field of education and the disputed location of K-12 educator preparation within the university. Through these interactions SCALE was successful in (1) fostering a nascent cohort of STEM and education faculty, influencing some STEM faculty's pedagogical practices and perspectives regarding the value of pedagogy and educational research, and (2) changing some structural elements of the teacher preparation program. **Perhaps the most meaningful outcome of SCALE is in shifting STEM faculty's meaning systems regarding the role of educator preparation, and the value of pedagogy and educational research.** SCALE accomplished its goal in leading STEM faculty to realize that many of their students are future math and science teachers, and that their instruction and courses need to change to meet these students' needs. **Coming to this point, from one of little knowledge or respect for the efforts of their colleagues in the College of Education, is an important accomplishment, and created relationships in which faculty may collaborate on grants and co-teaching efforts in the future.**

However, SCALE was unable to influence external factors that invariably shape individual practice and group meaning systems. These include the state regulations that foster division between STEM and education disciplines, the persistence of the disciplinary biases and traditions that in some cases support these regulation-induced divisions, and university structures that discourage collaboration and serve to strengthen stereotypes and reinforce the respective roles that each group of faculty plays—that of content or pedagogy expert. In addition, as part of the NSF MSP program, this effort was largely focused on engaging STEM faculty in the teacher preparation process, and in specifically improving their pedagogical skills so that they could model effective content based pedagogy for future math and science teachers. Given this focus, the involvement of College of Education faculty was primarily to provide their pedagogical expertise in improving STEM pre-service programs in STEM departments. As a result, STEM and education faculty collaborations were focused on only one component of teacher preparation at this campus. In bifurcating the responsibilities for preparing teachers, the state and university have created structures that are not amenable to collaboration, and actually serve to accentuate the respective roles that each group of faculty play: that of content expert, or pedagogy expert. Except in cases of a small blended program, and the math educators in the Math department, there are no program-based opportunities for STEM and education faculty to work together on existing and ongoing pre-service programs. SCALE did not change this situation.

Through this analysis it became apparent that if institutional culture is operationalized as the meaning systems of groups of people, as shaped by the interaction of external influences, internal ecology, structured interactions, and as instantiated by group and individual practice in these venues, then SCALE/QED has succeeded in identifying key leverage points in changing the culture. By creating new structured interactions, new

meaning systems, new external influences by way of new funding and affiliation with high-status universities, and new practices, SCALE successfully fostered a new sub-group of STEM and education faculty who likely will continue to model a new approach to teacher preparation. It will be truly remarkable if this phenomenon persists despite institutional policies and structures that discourage collaborative activities, very demanding workloads, and increasing pressure to not participate in service activities.

Generalization/Educational or Scientific Importance

Findings from this research can be used to improve the design phase of teacher preparation reform efforts, and collaborative arrangements between STEM and education faculty. Attention to issues such as the structural constraints of different departments, and the role of meaning systems may increase the chances that a collaboration will succeed. As a respondent noted, paying attention to the practices, activities, and dispositions of a potential collaborator, whether it be an individual faculty member or an entire department, should result in a collaborative effort that avoids basic misunderstandings over resources, goals, and beliefs.

In addition, this paper's exploration of the "organizational culture" concept contributes to the literature by identifying a theoretical construct that is congruent with the unique organizational structure of higher education. Previous uses of the culture concept in higher education include typologies of institutions or departments that don't adequately account for individual agency or variability within different institutional settings. Individual agency is one of the defining characteristics of the academic profession, and how an individual's disposition allows them to negotiate their institutional setting is a critical question. By employing Bourdieu's theory of practice (1977), and Van Maanen's approach to organizational culture (1985), I was able to identify how an institutional setting both constrains and shapes individual behavior, while also accounting for the personal and professional influences a faculty member brings into the institutional context. In this formulation, organizational culture is loosely shaped by institutional and disciplinary characteristics, but is constantly negotiated and evolving based upon individual faculty member's actions and dispositions.

This study also raises questions regarding future research needs. In particular, it is clear that if collaboration is a goal of an initiative, then it should be defined and its parameters clarified in order to gauge if, in fact, a collaboration did occur. Since funding agencies such as NSF are requiring grantees to engage in activities such as collaboration and partnership, the lack of a clear definition makes evaluation and program enhancement difficult (Clifford et al, 2006). This research also underscores the importance of accounting for contextual factors when investigating the effects of an intervention, and points to the prospect of extending such an analytical approach to other elements of the teacher preparation continuum, especially those of the induction period and the K-12 school context. Such analyses would further illuminate the effect of different institutional contexts and conditions on instructional practice and other topics of interest.

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