**WCER Working Paper No. 2007-7**
**September 2007**

# A Preliminary Case Study of SCALE Activities at the California State University, Northridge: Factors Influencing Change Initiatives in STEM Undergraduate Education, Teacher Training, and Partnerships with K–12 Districts

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> Hora, M. T., & Millar, S. B. (2007). *A preliminary case study of SCALE activities at the California State University, Northridge: Factors influencing change initiatives in STEM undergraduate education, teacher training, and partnerships with K–12 districts* (WCER Working Paper No. 2007-7). Madison: University of Wisconsin–Madison, Wisconsin Center for Education Research. Retrieved [e.g., September 15, 2007,] from http://www.wcer.wisc.edu/publications/workingPapers/papers.php

The research reported in this paper was supported by a grant from the National Science Foundation to the University of Wisconsin–Madison (EHR 0227016) for a Mathematics and Science Partnership project called System-wide Change for All Learners and Educators (SCALE), and by the Wisconsin Center for Education Research, School of Education, University of Wisconsin–Madison. All opinions, findings, or conclusions expressed in this paper are those of the authors and do not necessarily reflect the views of the funding agency, WCER, or cooperating institutions.

# A Preliminary Case Study of SCALE Activities at the California State University, Northridge: Factors Influencing Change Initiatives in STEM Undergraduate Education, Teacher Training, and Partnerships with K–12 Districts

**Matthew T. Hora and Susan B. Millar**[1]

## EXECUTIVE SUMMARY

This report of the National Science Foundation–funded SCALE Institutions of Higher Education (IHE) Case Studies line of work provides preliminary findings about SCALE activities at the California State University, Northridge (CSUN). This interview-based study ($N$ = 19) includes a descriptive analysis of SCALE activities and an exploratory analysis of the relationship between the institutional context and SCALE activities. The exploratory analysis focuses on the structural and behavioral dynamics influencing the implementation of the four core SCALE strategies for effecting change in IHEs: (a) improve science, technology, engineering, and mathematics (STEM) undergraduate education; (b) improve collaborations between STEM and education faculty regarding preservice programs; (c) improve collaborations between IHE faculty and K–12 districts regarding in-service training; and (d) improve institutional policies and practices at the IHE level that support faculty engaged in pre- and in-service activities.

The case study methodology used attends closely to the diverse contexts that influence individual faculty practice within an IHE and analyzes observed program effects and outcomes in light of these contexts. We provide information about the following contexts in which SCALE operates at CSUN:

1. The external environment
2. IHE-specific contexts organized into four subcontexts:
    a. Institution-wide structures and policies
    b. Academic programs
    c. Reform initiatives
    d. Cultural elements
3. Individual practice and sense-making

It is assumed that individual faculty members and administrators operate within these external and IHE-specific contexts as they go about their daily lives at CSUN, and as individuals

[1] The authors would like to thank faculty and administrators from the California State University, Northridge, for participating in this case study. We extend special thanks to Mark Connolly and to members of the SCALE Research and Evaluation Team for their support and suggestions, especially Andrew Porter, William Clune, Matthew Clifford, Natalie Tran, Eric Osthoff, and Paula White.

"make sense" of their environment and make decisions about how to act. This view of practice in higher education holds that individuals' behaviors are governed first by their own sense-making processes, as informed by their personal background, disposition, and motivating structures, and second, by the policies and practices of both the IHE-specific contexts and the external environment in which the IHE is embedded.

Preliminary findings indicate that through summer professional development institutes that are co-constructed and co-facilitated by IHE faculty and K–12 personnel, SCALE is expanding upon and enhancing existing reform efforts under way at CSUN. Through the science immersion institutes and the math institutes for Los Angeles Unified School District (LAUSD) teachers, SCALE is engaging STEM faculty in both learning and modeling inquiry-based pedagogy. Moreover, by actively training STEM faculty in these pedagogical methods, SCALE is beginning to influence participating faculty's conceptions of their own teaching and of K–12 issues. Although CSUN has a long tradition of K–12 involvement, SCALE brought a new type of collaboration between the IHE faculty and K–12 personnel. Where previously STEM faculty provided content expertise for professional development or outreach programs, with SCALE they were forced to model a new pedagogical approach that merged content and pedagogy. And where previously education faculty had mentored preservice teachers or conducted research in K–12 venues, they too were placed in the unusual position of modeling a STEM-based active-learning pedagogy. Another difference from previous professional development experiences that a respondent observed was the close collaboration with LAUSD science experts as equal partners in designing and facilitating the science institutes.

Another preliminary effect of SCALE was to further develop and foster a cohort of STEM disciplinary faculty who are engaged in pedagogical reform and K–12 education. The effects of a cohort of like-minded colleagues also include providing faculty with the benefits of professional networks and resources. While these changes cannot be attributed to policy change, both respondent testimony and related research findings indicate that the presence of collegial support and professional communities is a crucial aspect of institutionalizing a "culture" of reform.

A preliminary assessment of the approaches to change that SCALE leaders are enacting at CSUN suggests that instead of radical reform, they are focused on "planting small seeds" of change at various points in the system. These points include individual faculty members, whose exposure to new pedagogies may bear fruit in later years and in unforeseen ways, where change is a long-term proposition and actors are just now putting in place pieces that they believe will affect change in coming years. It also is evident that SCALE is benefiting from a synergistic dynamic among existing reform efforts at CSUN, including the Carnegie Corporation of New York–funded Teachers for a New Era (TNE) project and the CSUN Learning-Centered University (LCU) initiative. With the LCU initiative in its 2$^{nd}$ year and the TNE grant in its 4$^{th}$ year, existing reform efforts to improve undergraduate education in general and STEM instruction in particular had made deep inroads in some STEM departments. Furthermore, the presence of a cohort of STEM faculty who were committed to improving their teaching practices and contributing to preservice programs and in-service professional development meant that SCALE had a ready and willing audience at CSUN prior to its arrival on campus.

Despite the reform-ready atmosphere at CSUN, there remain significant institutional barriers to improving STEM instruction that may limit the ultimate efficacy of SCALE and similar efforts. The high teaching load at CSUN and an increasing pressure to conduct research and publish scholarly articles make participation in "service" activities such as SCALE challenging. While recruitment, tenure, and promotion policies at CSUN allow for pedagogy-based research and publications in STEM departments to satisfy the scholarly accomplishments requirement, there is trepidation on the part of faculty regarding the effects of participation in programs like SCALE. This concern is based on the length of time required to conduct education research relative to STEM research and the historical denigration of "soft" and applied research among their disciplinary colleagues. Other factors that may inhibit the long-term efficacy of SCALE include the limited number of STEM majors, a complex regulatory atmosphere regarding teacher certification and professional development in California, and contentious faculty relations within and between some CSUN departments.

Based on these findings, the researchers offer a few recommendations. First, a key leverage point that would facilitate the recruitment of other STEM and education faculty stands out: reduce the teaching load through released or assigned time. Second, if SCALE hopes to make an immediate impact upon designated preservice teacher candidates and their existing course sequences, SCALE leaders should identify and seek to engage those STEM faculty who are most involved in the liberal studies program or in STEM major courses with state-approved subject matter competency programs. Third, there is reason to believe that the California Beginning Teacher Support and Assessment (BTSA) program is the most propitious leverage point for both institutionalizing the SCALE math and science institutes at LAUSD and reaching the maximum number of teachers within LAUSD.

## A. INTRODUCTION

System-wide Change for All Learners and Educators (SCALE) is a comprehensive Math and Science Partnership (MSP) project funded from 2003 to 2007 by the National Science Foundation (NSF). SCALE is a systemic reform initiative involving institutions of higher education (IHEs) and K–12 partners to improve math and science teaching and learning through the entire educational spectrum. The SCALE theory of change posits that the entire continuum of teacher training and professional development must be improved, with particular attention to improving the role that science, technology, engineering, and mathematics (STEM) faculty play in designing and implementing preservice curricula and in-service programs.

This document, the preliminary report of SCALE activities under way at the California State University, Northridge (CSUN), is part of the IHE Case Studies line of work of the SCALE Research and Evaluation Team. The primary purpose of this line of work is to evaluate SCALE activities at each of the participating IHEs in SCALE: the University of Wisconsin–Madison (UW–Madison), the California State University, Dominguez Hills (CSUDH), and CSUN. The secondary purpose of this research is to assess the efficacy of the SCALE theory of change in different higher education institutional contexts, and to identify policies, processes, and strategies that are effective in achieving the goals of SCALE and the MSP program.

## The NSF Math and Science Partnership Program

### *Rationale*

The performance of U.S. students in math and science has become an increasingly pressing problem, particularly in light of the implications for the future competitiveness and employability of U.S. residents. As numerous studies and reports attest, the problem is systemic, with challenges including public policy, funding, and curricular strategies 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 [NRC], 2000; Project Kaleidoscope, 2006; U.S. Department of Education, 2005; U.S. Department of Education, 2006a, 2006b; U.S. Office of Science and Technology Policy, 2006). Most recently, researchers and policymakers have been focusing on the importance of a teacher workforce that is more highly trained in science and math (Levine, 2006; U.S. Department of Education, 2005). Indeed, the 2006 COSEPUP report suggested that an appropriate goal for address the eroding U.S. advantages in math and science is to produce 10,000 qualified teachers annually. This goal addresses the growing shortage of qualified K–12 teachers that researchers have been warning policymakers about for several years (Seymour, 2001). This shortage is illustrated by the fact that in 2000, 93% of students in Grades 5–9 were taught physical science by an instructor who lacked a college major or certification in the physical sciences (National Center for Education Statistics, 2004). The Bush administration's No Child Left Behind Act (NCLB; 2002) mandate that all school districts must employ only "highly qualified teachers" is further evidence that the issue of teacher workforce quality in science and math is a critical national issue.

One of the many challenges in reforming teacher preparation and professional development practices in the U.S. is the complex nature of the preparation process. For example, in order to qualify for certification to teach at the K–12 level, most future math and science teachers must navigate both teacher preparation programs in schools of education and disciplinary requirements in STEM departments at accredited IHEs. Then, they participate in professional development programs that are governed by state and/or district policies and offered by an array of providers including private vendors, district specialists, and IHE faculty. Thus, individual K–12 teachers obtain their math and science content and pedagogical training from multiple institutions and stakeholders, whose programs are governed by diverse policies that operate in isolation and with little coordination. As a consequence, the quality of this 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, Spector, Stiles, & Loucks-Horsley, 1999). In 1998, the National Research Council addressed this multi-institutional problem by establishing a Committee on Science and Mathematics Teacher Preparation (CSMTP). The CSMTP report (NRC, 2000) states that a significant restructuring of the relationship between K–12 schooling and higher education, including new partnerships to collaboratively design and implement high-quality professional development programs, is required to adequately prepare and train effective teachers.

This growing focus on improving the alignment of the teacher training continuum is among the reasons NSF has invested substantially in teaching improvement and organizational change in higher education—through its MSP program, among others—and on fostering improvement in this continuum of teacher preparation and professional development. These concerns reflect an increasing focus on the role that higher education plays in preparing future teachers, expanding beyond long-held critiques of teacher preparation programs to include a closer examination of the role of disciplinary faculty in the STEM disciplines.

The NSF MSP program aims to improve the coordination among STEM undergraduate education, teacher preparation programs, and K–12 professional development by fostering mutually beneficial partnerships between IHEs and K–12. Specifically, it hopes to encourage partnerships between STEM disciplinary 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, p. 5). The MSPs are based on the premise that IHE/K–12 partnerships should draw on disciplinary expertise of STEM faculty, undergraduate STEM (including preservice) students, and STEM graduate students in developing strong math and science content knowledge and pedagogical methods. 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).

## *Issues in Higher Education*

### *STEM Undergraduate Instruction*

Critiques of the quality of teaching in higher education began in the 1980s with *A Nation at Risk,* by the National Commission on Excellence in Education (NCEE, 1983). Since then, we have seen a cascade of criticisms of higher education, culminating in the U.S. Department of Education's *A Test of Leadership* (2006b). Critics note that many STEM undergraduate majors graduate with substantial deficiencies in their content knowledge (e.g., Handelsman et al., 2004). Researchers have identified high rates of attrition among undergraduate science majors as one of the consequences of poor undergraduate instruction and academic assistance (Seymour & Hewitt, 1997). Because in most states students seeking to earn secondary school teaching credentials are among these science 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 preservice candidates in disciplinary content and modeling pedagogical methods. For example, the *Shaping the Future* report by NSF (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.

### *Teacher Preparation Programs*

The 2006 COSEPUP report suggests that an appropriate goal to address the eroding U.S. advantages in math and science is to produce 10,000 qualified teachers annually. However, achieving this goal will also require addressing the long-standing critiques of teacher preparation programs and the colleges of education that operate them. In particular, critics charge that their curriculum for preservice candidates is poorly designed and insufficiently grounded in rigorous content courses and/or pedagogical instruction (Larabee, 2004; Mundry et al., 1999). Increasingly, researchers are also questioning if teacher preparation programs are adequately preparing their students for the reality of a multicultural classroom (Ladson-Billings, 2005). And policy bodies such as CSMTP (NRC, 2000) and NSF-funded practitioner reformers (Millar & Alexander, 1996) urge greater collaboration across departments and colleges within an IHE with respect to teacher preparation. In response to these critiques and recommendations, many initiatives both within and outside of IHEs are under way to improve how teachers are prepared and trained (Robinson, 2006). Among these initiatives are several, including NSF's Collaboratives for Excellence in Teacher Preparation program (Millar & Alexander, 1996) and MSP program, that focus on the role of STEM and education faculty in organizing and delivering a solid curriculum. As previously noted, these improvement initiatives are increasingly being examined in light of their impact on math and science student outcomes.

### *IHE Participation in Professional Development Programs*

In-service training in disciplinary content and pedagogical methods, which authorities suggest should occur on a regular basis (U.S. Department of Education, 2005), is another key venue for enhancing K–12 teacher math and science knowledge. There is a large body of research on the efficacy of professional development programs, and researchers are increasingly questioning the efficacy of the traditional model of professional development, where IHE faculty or other "experts" deliver "knowledge" to K–12 teachers (Garet, Porter, Desimone, Birman, & Yoon, 2001). This approach is considered ineffectual because it is decontextualized, treats teaching as a routinized and technical activity, and stresses "additive rather than transformative change" (Carlone & Webb, 2006, p. 545). Possible solutions to this problem include paying closer attention to the context of professional development design (Ball & Wilcox, 1989), fusing content and pedagogy by involving both disciplinary and education IHE faculty (U.S. Department of Education, 2005), and more explicitly building on novice teacher's prior experiences or knowledge (Mundry et al., 1999).

### *Challenges to Higher Education Reform*

The MSP program is facing the extremely difficult undertaking of fostering change in higher education, a sector known to be very resistant to change (Cuban, 2000). 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 and autonomous cultures" (Schroeder,

2001) as characteristics of IHEs that make them resistant to change efforts. Furthermore, historic divisions between STEM and education faculty, and between higher education and K–12 education, may inhibit collaborative activities (Larabee, 2002; Gilroy, 2003). 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 were occurring at IHEs across the MSPs, but with a majority of the changes in preservice 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). An analysis of STEM faculty engagement in the MSP program similarly found little evidence of institutional change, but significant individual-level shifts in STEM faculty knowledge of and participation with K–12 education (Zhang et al., 2006). This study also found that the effect of STEM faculty engagement in the teacher training continuum was difficult to ascertain and that effects on student learning were even more elusive.

### *SCALE Theory of Change and Goals Regarding IHEs*

The SCALE theory of change is based on a systemic understanding of the educational systems that inform and support K-20 math and science education. The theory highlights the impact of poor teacher preparation on student outcomes and the cycle of underachievement that ensues. With respect to IHEs, this theory holds that if improvements in IHE participation in teacher preparation and professional development in mathematics and science are to be sustainable and significant, then it is necessary to achieve the following goals:

1. Reform undergraduate STEM courses;

2. Promote collaboration between STEM and education departments regarding preservice teacher education;

3. Promote collaboration between IHEs and K–12 districts regarding in-service professional development; and

4. Improve institutional policies and practices at the IHE level that support faculty engaged in pre- and in-service activities.

## Methodology of the IHE Case Studies

### *Research Questions*

The research questions for the IHE Case Studies line of work are informed by the dual need to evaluate the SCALE MSP and to more deeply examine the reasons why SCALE did or did not achieve its goals and objectives. The evaluation includes an assessment of the status of SCALE's goals and objectives, at both individual and institutional levels. This type of multisector, multilevel evaluation requires an understanding of the IHE institutional contexts in which SCALE activities are taking

place and of the specific mechanisms by which these contexts influence SCALE activities. Hence, we pose these research questions—which mirror the SCALE theory of change—about each IHE studied:

1. How does the institutional context influence the core strategies of SCALE?

2. Are SCALE activities contributing to changes in SCALE's primary goal areas? If so, how are these activities:

    a. improving STEM faculty instructional practices;

    b. improving collaborations between STEM and education faculty on preservice program curricula and structure;

    c. improving collaborations between IHE faculty and K–12 personnel in designing and delivering in-service professional development; and

    d. supporting changes in policy and/or institutional culture at IHEs to support these reforms?

3. Under what conditions are change initiatives, including SCALE, accepted and incorporated at the institution?

## *Research Design*

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, 1989, p. 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). Given the complex nature of researching change processes in higher education as set forth in our research questions, and the fact that SCALE and other NSF-funded projects frequently operate under broadly stated goals with few specific objectives or outcomes in order to permit maximum flexibility for project staff, qualitative case study methodology optimally suits our research needs.

Moreover, to closely attend to how contextual variables affect individual projects, the IHE case study employs an analytic framework adapted from cultural ecology and complexity research, which we offer as a model for evaluating STEM education reform programs (Katzenmeyer & Lawrenz, 2006; Axelrod & Cohen, 2000). This framework allows the evaluator to catalogue the contexts that influence individual faculty practice within an IHE and to analyze the observed program effects and outcomes in light of these contexts. This research employs a mixed-method, interpretive methodology in order to produce a rich, contextualized portrayal of a situation by investigating individual behaviors within their complex matrix of political, economic, personal, and social realities (Cernea, 1991; Bernard, 2002).

We are undertaking data collection and analysis for this study in two phases. The preliminary phase includes collecting background information on the institutional context, collecting initial data on SCALE participants, conducting a formative assessment of SCALE operations to establish *network fragments* for a network analysis, and analyzing individual and institutional change mechanisms. In this phase, we also identify issues that require further examination to address the research questions. The second phase will include collecting follow-up data on SCALE participants, field-testing the network fragments, conducting a summative assessment of SCALE operations, and conducting a final network analysis. After completing the second phase for each IHE, we will complete a cross-case analysis.

## *Data Collection*

### *Site and Sample*

We selected CSUN as a case by virtue of its involvement with the SCALE MSP. The unit of analysis is the individual embedded within the complex institutional environment of CSUN. The case study is bounded by the topics of STEM undergraduate education, teacher preparation programs, and K–12 involvement among the faculty at CSUN. Given the complexity of these areas, and the aforementioned attention to the broader environmental and institutional context of the IHE, the boundaries of the case study are defined by the topic area and not by traditional administrative divisions. To select interview participants, we used the snowball sample approach, in which respondents suggest other individuals who would be of value to the research. While most respondents are participating in SCALE and other similar reform projects, we also sought out and interviewed respondents with no involvement in these efforts.

### *Data Types*

In evaluating systemic change initiatives in higher education, it is particularly important to pay attention to issues of construct validity, such that specific areas of change are delineated and measured with the appropriate instruments (Yin, 1989). We constructed the research questions and data collection methods with this in mind, but remained open to unanticipated findings, which are the hallmark of an interpretive research approach. (For a chart presenting the intended use of each type of data gathered, see Appendix 1.)

***Semistructured interviews.*** We conducted interviews with 19 participants, including (a) SCALE participants at CSUN (3), (b) non-SCALE CSUN faculty (8), (c) CSUN administrators and staff (5), (d) UW-Madison staff (2), and (e) another SCALE leader (1). We used a semistructured interview protocol to obtain systematic information about the SCALE project, the CSUN institutional context, and personal observations about the teacher training continuum.

***Document review.*** We collected and analyzed official and unofficial university documents, reports, and literature relevant to the research question.

***Observations.*** We observed a meeting of a SCALE professional development session at CSUN in order to obtain a firsthand understanding of the experiences of IHE faculty in the science and math institutes.

## *Analysis*

We used a four-stage analytical process: (a) analysis of interview transcripts, observation, and document-based data; (b) assessment of the institutional context for individual faculty practice; (c) formative evaluation of effects of SCALE activity to establish network fragments for the network analysis; and (d) analysis of individual and institutional change mechanisms.

### *Stage 1: Analyzing Interview, Observation, and Document Data*

We used a grounded theory approach to analyze the interview, observation, and document-based data. The mechanics of grounded theory include identifying potential themes in the data, constantly comparing the emerging categories, and constructing an explanatory model with exemplars from the data (Bernard, 2002). Themes were identified based on their numerical occurrence, topical relevance, and respondent-identified importance (Ryan & Bernard, 2003). The constant comparative method of analysis was then employed to assess the validity of the emerging findings. This step enabled triangulation across different types of data sources. Extensive notes were taken to document this analytic process to establish the chain of evidence that supports our conclusions. Using multiple sources of evidence in this manner enhances validity and reliability (Miles & Huberman, 1994). We further ensured validity of our findings by using member checks and peer review (Bernard, 2002). It is important to note that while the research questions and interviewer's personal style certainly shaped the type and quality of data collected, we did not begin this analysis with a priori assumptions of key themes or theoretical frameworks other than the context categories described below.

### *Stage 2: Assessing the Contexts for Individual Faculty Practice*

The primary themes from the initial analysis were then slotted into analytic categories that comprise the contexts for individual faculty practice within an IHE. This typology was developed through an earlier analysis of a SCALE IHE, UW-Madison (Hora & Millar, 2007), and is based on a combination of methods and theory used in organizational studies of higher education (Birnbaum, 1988; Kuh & Whitt, 1988), rapid assessment studies in development anthropology (Bernard, 2002; Cernea, 1991), and social practice theory in anthropology (Bourdieu, 1977). For this research, we conceptualize the contexts in which SCALE operates at CSUN in terms of the following elements:

1. *External environment*: political, economic, demographic, and cultural (e.g., academic, disciplinary) contexts that exist outside of the administrative boundaries of CSUN but exert an influence on CSUN

2. *IHE-specific contexts:*

    a. *Institution-wide structures and policies:* policies and administrative structures

    b. *Academic programs*

    c. *Reform initiatives*

    d. *Cultural elements*: practices and conceptions shared by groups of people within an institution (which may be convergent or divergent)

3. *Individual practice and sense-making*: processes of individual decision making and prioritizing within the institutional and cultural context of CSUN.

Individual faculty members and administrators operate within these external and IHE-specific contexts as they go about their daily lives at CSUN and "make sense" of their environment and make decisions about how to act. This view of practice in higher education holds that an individual's behaviors are governed first by the third context, their own sense-making processes, as informed by their personal background, disposition, and motivating structures, and second, by the policies and practices of both the IHE-specific contexts and the external environment in which the IHE is embedded.

### *Stage 3: Conducting a Formative Evaluation of SCALE at CSUN and Establishing Network Fragments for the Network Analysis*

We aggregated all of the evidence pertaining to SCALE activities at CSUN—including activity descriptions, participant data, and participant experiences—and analyzed these data in terms of the stated goals and objectives of SCALE for a formative evaluation. We then related each of the main outcomes that emerged to the above institutional context typology and assessed each theme's influence on SCALE goals and activities. This analytic approach, which goes beyond more traditional formative evaluation, links observed program effects and outcomes to specific barriers or supports within the institution and provides insights into the *how* and *why* of SCALE operations at CSUN. Based on our findings about how each SCALE activity and outcome was influenced by each level of the context typology, we assigned a positive or negative valence to the theme. Although in most cases, the valences were suggested by the respondents, we further analyzed each outcome by triangulating respondent opinion with other data sources. We acknowledge that our assignment of valences to complex institutional and sociocultural phenomena provides a rough assessment, at best. Each contextual variable linked to a SCALE goal constitutes a network fragment that potentially entails a causal relationship (Miles & Huberman, 1994). These fragments will be field-tested in Phase 2 of our data collection to ascertain their validity. We believe this exercise helps develop an understanding of how the CSUN context supports or inhibits SCALE activities.

### *Stage 4: Analyzing Change Mechanisms and Next Steps*

Finally, we analyzed the individual and institutional change processes we observed at CSUN. For individual-level change, we assessed the efficacy of the SCALE theory of change; for institution-level change, we assessed the alignment of educational systems influencing CSUN.

## *Caveats*

### *Attribution*

Evaluating complex programs that aspire to effect systemic change across a broad spectrum of individuals and organizations is challenging, particularly when it comes to attributing effects to specific activities. For some SCALE activities with (a) clearly stated goals and objectives and (b) unmistakable causative influences on an effect, it is relatively easy to attribute an effect to SCALE. In other cases, however, in which SCALE activities have more ambiguous goals and/or the nature of the change involves a complex set of factors whose influences are not clear to the evaluator, it is more difficult to attribute effects to SCALE. Furthermore, the nature of the SCALE goals is such that many effects or outcomes may not be visible for several years or may work their way through the IHE bureaucracy and organizational culture and emerge in an unrecognizable form. In this case study, effects are attributed to SCALE only when (a) the actors identify that SCALE has led to an impact or effect on individual or institutional policies and/or practices; or (b) the analysts identify effects that are corroborated by at least two types of data sources.

### *Limitations*

The sample of IHE faculty interviewed for this research does not constitute a random or representative sample of CSUN overall or of individual CSUN colleges or academic departments. 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 STEM and education department sentiments, investigate the initial impact of SCALE activities, 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 are not verified with classroom observations or other data on individuals' actual teaching approaches or behaviors. Finally, since the preliminary IHE Case Studies are also intended to provide feedback for SCALE administrators and practitioners, we anticipate these case studies may influence the outcomes of SCALE and the findings gathered in Phase 2 of this research.

## B. SCALE AT CSUN

This section provides a description of the primary activities of SCALE at CSUN, including goals and objectives, participant data, and participant experiences. The data are based on the in-depth interviews described above.

When SCALE began (2003), its partner organizations were UW-Madison, the University of Pittsburgh, and four urban school districts (Denver Public Schools, Los Angeles Unified School District, Madison Metropolitan School District, and Providence Public Schools). CSUDH became a partner early in 2004. In the fall of 2004, a CSUDH math faculty member who was active in SCALE met with both a math and a science faculty member at CSUN to explore the prospect of SCALE activities at CSUN. CSUN's active involvement in SCALE began in spring 2005 as faculty began designing professional development institutes for K–12 teachers.

## SCALE Activities at CSUN

SCALE activities at CSUN have centered on summer professional development institutes for Los Angeles Unified School District (LAUSD) K–12 teachers in math and science. In the summer of 2005, CSUN hosted four science institutes (5 days long). In the summer of 2006, CSUN hosted five science institutes (5 days long) and two math institutes (15 days long), which are described in this section.[2] In the summer of 2007, eight science institutes and two math institutes were held at CSUN. SCALE leaders informed us that SCALE, and CSUDH's Quality Educator Development (QED) project (funded by the U.S. Department of Education's Teacher Quality Enhancement Project) are joined in a collaborative effort to design and implement these institutes at CSUN and elsewhere in the LA Basin.

### *SCALE/QED Science Institutes*

The goals of the SCALE/QED science institutes were to develop and implement high-quality professional development for K–12 teachers using an inquiry-based methodology. Teams of local IHE faculty, K–12 personnel, and UW staff have collaborated in designing professional development sessions that are focused on topic-specific *immersion units*. An immersion unit is a carefully selected and designed learning opportunity in which students are engaged in the scientific inquiry process over an extended period of time (4 weeks), focusing intensely on a particular concept or big idea in the content area (Lauffer, 2004). Each immersion unit provides a coherent series of lessons designed to guide students in developing deep conceptual understanding that is aligned with key science concepts and the essential features of classroom inquiry specified in the state standards of the district for which each is designed. In each unit, students learn academic content by working like scientists: making observations, asking questions, doing further investigations to explore and explain natural phenomena, and communicating results based on evidence.

#### *Science Institute Design Process*

A key mechanism for designing the immersion units during 2005–06 was the Leadership Study Group, which was composed of representatives from UW, CSUN,

[2] Math institutes were held at CSUDH in 2004 (2), 2005 (3), and 2006 (2). Science institutes were held at CSUDH in 2005 (3) and 2006 (7), and at CSU Los Angeles in 2006 (3).

CSUDH, and LAUSD. The goal of this group was to pool expertise and resources to design a high-quality professional development curriculum and to collectively learn how to implement the unit for the upcoming summer institutes. During 2004–05, UW staff and other SCALE leaders intended to bring the STEM and education faculty together to collaboratively design a high-quality unit, with the focus on K–12 teacher learning and instructional improvements. As a result of working on immersion units and modeling active-learning pedagogies, UW staff and SCALE leaders soon realized that they could also use this immersion in-service project as an opportunity to help STEM and education faculty improve their own approach to undergraduate teaching.

> What happened was that as we were developing the immersion units, [one UW staff person] came up to me and said, the most important aspect of this is not so much the product that we will prepare, the unit itself, but in the process of preparing it, the professional development that has occurred among the [IHE] faculty and the [K–12] teachers in working together to do this. We also realized that once we did the institutes, we needed [more] professional development for the professional developers. (SCALE leader)

As a result, the UW staff and SCALE leaders began to more explicitly develop the design process to engage all participants, including IHE faculty, as learners and practitioners. By asking the Study Group members to learn how to model the active-learning pedagogy embedded within the immersion units, SCALE leaders created a more intentional professional development experience for the CSU faculty and LAUSD teachers. This experience included learning both core elements of subject-specific pedagogical content knowledge and "tricks" of education, including classroom management.

### *Goals and Objectives Pertaining to IHEs*

While respondents clearly articulated the larger science institute goals for IHE participation and outcomes, they were less specific about the objectives and strategies for achieving those goals. SCALE leaders indicated that the larger goals for IHE faculty inclusion are:

1. To have STEM faculty ensure that content is accurate and education faculty to ensure that the pedagogical methods are accurate;

2. To engage all IHE faculty as learners and to impart a new understanding and appreciation of, and experience with, inquiry-based instructional methods; and

3. To develop local capacity for professional development by *training the trainers*.

No information about measurable objectives or resources for evaluating achievement of these goals is included in the data collected for this preliminary report.

### *Science Institutes at CSUN*

To date, SCALE staff at the Wisconsin Center for Education Research (WCER), STEM and education faculty at CSUN, and science experts and teachers at LAUSD have collaborated on immersion units for four grades:

- *Rot it Right*: Grade 4 (two institutes, 40 participants)
- *Plate Tectonics*: Grade 6 (one institute, 28 participants)
- *Variation and Natural Selection*: Grade 7 (one institute, 13 participants)
- *Density and Buoyancy*: Grade 8 (one institute, 27 participants)

Total: 108 participants.

Table 1, below, provides facilitator data for the 2006 CSUN science institutes. The data include individuals from either LAUSD or a CSU campus who were actively involved in the facilitation of the institutes. UW personnel are not included in the table. As indicated below, a total of three CSUN STEM faculty, two CSUN education faculty, one CSUDH STEM faculty, and nine LAUSD science experts or teachers facilitated the CSUN science institutes.

Table 1
*Facilitators for 2006 CSUN Science Institutes*

| | **LAUSD** | | **CSUDH** | **CSUN College of Education** | | **CSUN College of Science and Math** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Science experts | Teachers | Physics | Elem. science ed | Secondary science ed | Math | Geo | Bio | Chem | Physics |
| 4th grade | | | | | | | | **1**[a] | | |
| 6th grade | **2** | **1** | | **1** | | | **1** | | | |
| 7th grade | **1** | **2** | | | | | | **1** | | |
| 8th grade | **1** | **2** | **1** | | **1** | | | | | |
| Totals | **9** | | **1** | **2** | | **3** | | | | |

[a]Denotes part-time faculty member.

### *SCALE/QED Math Institutes*

Along with SCALE and QED, the CSUDH Mathematics Department's Center for Math and Science Education and the CSUDH Mathematics Project collaborated to design and implement mathematics professional development institutes for K–12 teachers. The goals of these institutes were (a) to increase student achievement in and understanding of the mathematics contained in the California state standards in Grades 6–9 through implementation of a professional development program and (b) to better equip teachers to lead their students to a deeper understanding of mathematics. The advertisements for the institutes also noted that the institute designers hoped to develop a core community of K–

12 leaders to become resources for other educators. Furthermore, according to a respondent, a goal of the Pre-Algebra Institute was to depoliticize math education by focusing more on the commonly held goal of improving student learning and less on the ideological and/or political aspects of math curriculum.

### *Math Institute Strategies*

The math institute strategies were to use an inquiry-based methodology while focusing on the LAUSD mathematics curricula and instructional guides. During each of the 120-hour SCALE/QED mathematics institutes, the teachers worked with specially selected materials to increase the algebraic thinking and problem-solving capacities of the teachers in order to help them develop their own *mathematical explanation structures*. According to official advertisements, these institutes included unit development and lesson planning, discussions of current research addressing English language development and math issues, and explorations of assessment methods that could inform instructional practice.

### *Math Institutes at CSUN*

To date, SCALE staff at WCER, CSUDH and CSUN STEM faculty, and LAUSD teachers have collaborated on two math institutes held at CSUN:

- Institute for Pre-Algebra: Grades 6–8 (one institute)
- Institute for Algebra: Grades 8–12 (one institute)

According to respondents, the two math institutes were designed in slightly different ways. The Pre-Algebra Institute was largely modeled after a similar workshop used at CSUDH, while the Algebra Institute was loosely based on a CSUDH workshop but with significant modifications made by the facilitators. A respondent described the design process for the Algebra Institute as problematic, with insufficient time to work with co-facilitators and minimal guidance regarding unit structure, sequencing of activities, and the actual content of the institute.

Table 2, below, includes facilitator data for the math institutes held at CSUN in 2006. The data include individuals from either LAUSD or a CSU campus who were actively involved in the facilitation of the institutes. UW personnel are not included in this chart. As indicated below, a total of four CSUN STEM faculty, one Madison Metropolitan School District (MMSD) faculty, and one LAUSD math expert participated in the CSUN math institutes.

Table 2
*Facilitators for 2006 CSUN Math Institutes*

| | **LAUSD** | | **MMSD** | **CSUDH** | **CSUN College of Education** | | **CSUN College of Science & Math** |
|---|---|---|---|---|---|---|---|
| | Math | Teachers | Teachers | Physics | Elem | Secondary | Math |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | experts | | | | sci ed | sci ed | |
| $6^{th}$, $7^{th}$, $8^{th}$ | | | | | | | **3** |
| H.S. | **1** | | **1** | | | | **1**[a] |
| Totals | **1** | | **1** | **0** | **0** | | **4** |

[a]Denotes part-time faculty member.

## Respondent Experiences with SCALE

This section reviews the primary themes that emerged from respondent descriptions of the SCALE math and science institutes. In some cases, we do not specify which institute is referenced in order to ensure respondent confidentiality.

### *Experiences with the Institute Design Process*

#### *Theme: SCALE Represents a More Intensive Type of Interaction with K–12 Than Previously Experienced*

According to faculty respondents, the design process for the SCALE institutes represented a new type of collaboration with K–12 personnel. Where previously STEM faculty provided content expertise for professional development or outreach programs, they now were forced to model a new pedagogical approach that merged content and pedagogy. Where previously education faculty had mentored preservice teachers or conducted research in K–12 venues, they too were placed into the unusual position of modeling a STEM-based active-learning pedagogy. Another difference from previous professional development experiences that a respondent observed was the close collaboration with LAUSD science experts, with IHE and K–12 staff interacting as equal partners in designing and facilitating the science institutes.

> One of the advantages to SCALE for me has been the fact that I'm actually working side by side with people from LA Unified central offices and Science Branch. And though they have always supported our programs, they have not witnessed what we do and we haven't witnessed what they do, and I think that this has been a very good PR move for us in some ways and for them, because we are now in communication. Because I think what happens in some of these cases is people [in K–12] look at you like "You're a doctor, [you're an expert]," and therefore they get defensive, thinking "Well, I don't need somebody with a PhD to tell me how to teach." Again, that's a cultural thing and some of that is brought on by the [reputation] that some professors have with others, which I kind of resent. [Here,] that's wiped out. In other words, we've now got to know each other well enough for them to realize that we're not coming in as higher ed faculty to tell you how to do it, we're coming in to share and collaborate with you. (Life sciences faculty)

#### *Theme: One Institute Was Not Adequately Designed or Supported*

According to one respondent, one of the institutes had been not been optimally designed or supported, and as a consequence, some difficulties arose regarding its implementation. The challenge with the design of the institute was based on the lack of time and resources available to this respondent to adequately prepare.

> When I got there last summer, I had some expectations [that were not met]. I anticipated that there was a set program that was in some way [solidified], with a curriculum for the institutes. And I expected that I would have a facilitator's or teacher's binder with the outline of the institute I would be doing. When I got there, there was nothing. I knew the outline and structure, but none of the activities were organized or firmed up. There was a packet of readings, but no sequence or connection between them and instructional goals, and how that would connect to the [content] of the institute. (SCALE staff)

This respondent also noted that the institute did not have a UW facilitator like other institutes did, and thus the education faculty member, the STEM faculty member, and the LAUSD staff member were "completely on their own" when it came to mediating disagreements over roles and the structure of the institute itself.

### *Experiences with the Institute Implementation*

#### *Theme: SCALE Engages IHE Faculty as Learners*

As previously noted, UW staff had hoped that by asking the Leadership Study Group members to learn how to model the active-learning pedagogy embedded within the immersion units, the Study Group members would experience professional development themselves. This included learning core elements of subject-specific pedagogical content knowledge and "tricks" of education including classroom management. Several respondents reported that in their previous K–12 professional development experiences, they had been given only the role of content expert, which they performed in public lectures, study groups, or workshops. Faculty who participated in the SCALE math and science institutes, particularly the members of the science institute Leadership Study Group, reported a vastly different experience. In fact, several faculty reported that they had to shift between the roles of content expert and student of learning theory and inquiry-based pedagogies.

#### *Theme: Some Faculty Participants Resist Engagement with Institutes*

Systemic and individual barriers to successful adoption of improved instructional methods prevail at CSUN, despite the existence of an institutional culture that values teaching excellence and reform initiatives like the Learning-Centered University (LCU) initiative and Teachers for a New Era (TNE) project (see below). As a UW staff person noted, the first step in learning new methods of instruction is to be fully committed and "present in mind and spirit." This respondent noted that some CSUN STEM and education faculty who participated in the science institutes were not particularly engaged with the co-facilitation process and thus did not successfully learn how to model an active-learning pedagogy for the K–12 teachers.

> During one institute, a faculty member was up at the front lecturing about inquiry. As I watched, it was clear that he just didn't get what we were doing here. As if what we were training LAUSD teachers on had nothing to do with him. He seemed to know everything, theory-wise, about education. He was like a living textbook, and he delivered his [professional development] just like that. During our [English language learner] and learning styles session, the technique he used was to list the strategies down on the board

> for all the teachers to copy. No discussion. No valuing the teachers' prior knowledge. No involvement on the teachers' part at all. He didn't use any of the strategies on his own list. It was almost like there was no thought on his end that this work applies to him, too. (UW staff)

This respondent also emphasized the importance of self-reflection, where a learner is willing and able to assess his or her own instruction and critique it effectively. Again, some faculty were more amenable to this critical aspect of pedagogical improvement than others, and those who were not self-reflective included both STEM and education faculty. Another respondent noted that one faculty participant was not actively engaged in the facilitation of the workshops and did not even participate as a content expert. According to this respondent, the faculty member instead graded participant coursework and generally "faded into the background." For this institute, the respondent also questioned why a part-time faculty member had been selected to participate if a goal of SCALE was to influence the STEM department itself. Furthermore, the respondent noted that the faculty member was known to be antagonistic to constructivist pedagogies, which raised additional questions about why the individual had been selected.

### *Implications for IHE Faculty Roles*

#### *Theme: SCALE Gives Faculty Pedagogical Tools to Use in Their Own Classes*

Through participation in the math and science institutes, CSUN faculty have learned new pedagogical methods and tools that may be being transferred to their instructional practices at CSUN. In some cases, this has meant specific pedagogical methods. For example, one faculty member had used several of the problems from the math institute and also gained "well-grounded expectations" about how well students should be able to do and a new confidence in leaving students to do more mathematical work like explaining and organizing solutions. For that faculty member, the experience amounted to "evolution, not revolution," since he had been previously exposed to inquiry-based methods in math education. One life sciences faculty member who had used the Fast Plants[3] program in the past was considering adding an inquiry-based exercise and hadn't thought to do so until participating in the science institutes. In another case, UW staff noted that CSUN faculty reported using methods learned in the institutes.

> He was telling me that "I used a think-pair-share[4] in my class today." I said, "Oh yeah, on what?" And he said, "Well it doesn't matter on what, I used it, this is my first time, and it was great, they loved it. They were talking to each other and it was great." So it was kind of groundbreaking for him and that was before he'd even facilitated an institute. I mean that was just from what he'd learned from reading the immersion unit and talking with us and planning. (UW staff)

[3] Fast Plants is an internationally known K–12 science education program based on a rapid-cycling vegetable bred at UW-Madison by Dr. Paul Williams.
[4] Think-pair-share is a learning strategy developed by Dr. Frank Lyman to encourage student participation.

This direct transfer of institute-based methods to the CSUN classroom was corroborated by other faculty respondents. In other cases, institute participation has given CSUN faculty a new understanding of pedagogy. One respondent noted that the emphasis in the institutes on being "transparent" has helped her to become a better educator by encouraging her to examine pedagogy from multiple perspectives. Another respondent stated that the readings about pedagogical content knowledge spurred changes to pedagogical methods employed in IHE courses. In several cases, faculty reported that the institutional pressure to improve teaching practices, via the LCU initiative, helped make faculty more attuned to the potential applicability of new methods to their own courses.

### *Theme: SCALE Gives Faculty Assessment Tools for Use in Their Own Classes*

It is clear that SCALE is influencing individual faculty instructional practices through participation in the institutes. Yet without classroom observations or further investigation, it is impossible to assess the veracity or nature of these self-reported changes. Faculty noted that tools gained through immersion units directly address the mandate for student learning outcomes by the CSUN administration.

> [I have used] some of the assessment ideas to see if my students are actually beginning to take ownership of what I'm talking about during a lecture. That's something that I hadn't done in the past. I've been teaching for a while now and other than quizzes or exams, these assessments are very, very simple to determine understanding. It's an easy way for me to check where I am, where they are, determine if my class, the majority of my class, understands key concepts that we're talking about. (Life sciences faculty)

## C. CONTEXTS FOR INDIVIDUAL FACULTY PRACTICE AT CSUN

This section provides an overview of various contexts that shape individual faculty practice within CSUN. As noted above, we structured the contexts in which SCALE operates at CSUN into external environment and IHE-specific categories (structures and policies, programs, reform initiatives, and cultural elements) and a third context of individual practice and sense-making. We then organized data associated with each of these contexts into themes, based on (a) frequency of occurrence, (b) degree of respondent-identified importance, and (c) our assessment of level of influence on SCALE goals and activities. We propose that each of these themes is important to consider when assessing the outcomes of SCALE activities and attempting to understand how and why these activities affected institutional policies or practices at CSUN.

### External Environment

For this paper, the external environment includes the political, economic, demographic, and cultural (e.g., academic, disciplinary) factors that operate outside of the administrative boundaries of CSUN and influence CSUN. Prominent themes associated with the external environment that emerged from our data include student demographics, the broad domain of higher education, California teacher credentialing policies, and the policies and practices of LAUSD.

### *CSUN Student Demographics*

CSUN is located in the San Fernando Valley of Los Angeles County, and its location in a large, ethnically diverse urban area exerts a major influence on the institution's identity, mission, student body, and academic programs. In fall of 2005, 72.6% (24,121) of CSUN students came from Los Angeles County. The demographics of the CSUN student body in 2004–05 were as follows: 32% White,16% Mexican American, 11% other Latino, 8% Asian American, 8% African American, 5% International, 3% Filipino, under 1% American Indian and Pacific Islanders, and 16% other (CSUN Office of Institutional Research, 2006). Some respondents noted that the numbers of Mexican American and Latino students at CSUN do not reflect the population at large, where over 47% of Los Angeles County residents consider themselves Hispanic or Latino (U.S. Census Bureau, 2006).

The fall 2005 enrollment at CSUN was 33,243, which makes it one of the largest of the 23 California State Universities (only smaller than CSU Fullerton, CSU Long Beach, and CSU San Diego). Of the total enrollment, only 76% (25,139) of the students were full-time, a fact that places CSUN at a disadvantage relative to CSUs with a higher proportion of full-time students, because state funding policy is based on "full-time equivalents" rather than "headcounts." The CSUN student body is 81% undergraduate and 19% graduate students, 60% female and 40% male. With the average age of undergraduate and graduate students at 23.5 years and 34.2 years, respectively, many students are of nontraditional age. The numbers of first-time freshmen (3,720) and new undergraduate transfers (3,745) are almost identical. Of the students transferring to CSUN as undergraduates, 85% come from California community colleges (CSUN Office of Institutional Research, 2006). The time to undergraduate degree at CSUN is 6 years, with some students taking as long as 13 years, according to some respondents. The CSUN student body, as some respondents noted, differs significantly from that of research universities, where most students matriculate directly from high school, live on or near campus, and graduate within 4 or 5 years.

### *Theme: Faculty and Administrators Are Aware of Local Educational Issues*

CSUN faculty and administrators often expressed awareness of and attention to the characteristics of the student body, paying particular attention to ethnic diversity, different preparation levels, and nontraditional student lifestyles. Most commonly, respondents noted that they had a high level of engagement with and commitment to students. In one case, a faculty respondent noted that because she lives in a poor neighborhood and hears feedback about LAUSD and other educational issues, she is acutely aware of the local education system and its challenges. Several respondents explained that the near-constant discussion of the problems facing public education in California keeps them closely attuned to K–12 issues and the preparation levels of their incoming students.

> Maybe I was just clueless or insulated [at previous institution], but we're sitting in LA, and you've got the LAUSD, and that's all you hear about, it seems like—the terrible state of the school district and the poor training that students get. (CSUN administrator)

### *Theme: Generally Poor Student Preparation Affects Faculty Work*

Several respondents raised the issue of student preparation as a major factor influencing their work at CSUN, in both positive and negative ways. Respondents viewed the generally poor level of preparation of incoming students not as a consistently negative factor, but rather as an unavoidable aspect of living in a large, urban area. While, according to a faculty respondent, some students come to CSUN well prepared by their high schools and "zip through the programs," most students struggle with basic writing and mathematical skills. One administrator noted that students who come to CSUN with no more than 10$^{th}$-grade math (Algebra 2, a California state requirement), or after having been out of school for several years, "generally flounder." This is supported by the fact that over 80% of incoming students fail the introductory math assessment. The respondent felt that a significant factor contributing to this situation is that high school and community college faculty and advisors provide inadequate information regarding CSU system requirements.

However, many respondents viewed the limitations of many of their students' math and science skills as necessitating an improvement in their own teaching skills and did not focus on the perceived failures of K–12. One respondent reported that his experience teaching at CSUN quickly showed him that "students may not bring the same tools and practice and exposure that I had." This realization spurred some faculty to want to understand learning theory and inspired others to begin conducting research on the nature of scientific misconceptions. In any case, most agreed that CSUN has had to address the "realities of student abilities" and thus teach many remedial courses and focus on improving success during the first year.

## *The Domain of Higher Education*

According to several respondents, the domain of higher education strongly influences college and university administrators, who must continuously address where their institution fits into the state and national IHE hierarchy, national and regional accreditation requirements, and various IHE policy trends. CSUN is clearly in the middle tier of California's three-tiered system of higher education, comprising (a) the research universities in the University of California (UC) system, (b) the master's-granting universities in the CSU system, and (c) the community college system. In terms of the influential Carnegie Foundation ranking of IHEs, CSUN is a Masters L (also known as comprehensive) university, a designation for large universities that do not grant doctorates but have master's-level programs (Carnegie Foundation for the Advancement of Teaching, 2006). Another marker of IHE hierarchy is research funding: CSUN is ranked 272$^{nd}$ in the nation for total research funding ($11.6 million). In its peer group of Masters L universities, CSUN is ranked second among 529 universities in the number of graduates (both bachelor and master's degree recipients) who go on to earn PhDs in the social sciences and psychology (CSUN, 2006).

Another important influence of the higher education environment is accreditation. For example, a respondent noted that the LCU initiative that was recently undertaken at CSUN was inspired in part by the encouragement of the university's accrediting agency,

the Western Association of Schools and Colleges to establish a student learning outcomes assessment system.

### *Theme: Research Universities Fail to Adequately Prepare New Faculty to Teach*

Respondents frequently cited the influence of the Research I universities on their professional lives. In particular, all faculty respondents noted that during graduate school they received no training in pedagogical methods and had to learn on the job. For example, one respondent said she had no training in teaching, despite her experience as a teaching assistant, other than a public speaking course she took in order to do research presentations. An administrator cited this feature of research universities, from which most CSUN faculty are hired, as having a significant—and unacceptable—impact on the quality of teaching at CSUN.

> There are good things that the R1 machine has done but then there are other things that it's not really . . . effectively done, and one of those things is preparing people to go on and teach in the massive institutions that they teach in, which are MA1s, MA2s, community colleges, and liberal arts colleges. (CSUN administrator)

### *Theme: CSU System Budget Crisis Reduces Hiring and Increases Class Size*

Several respondents observed that the CSU system is currently in the midst of a budget crisis, with current or impending cutbacks in hiring, increases in class sizes, and a general atmosphere of fiscal restraint. According to one respondent, CSUN is losing positions through attrition and reduced replacement rates.

> The state's not giving us enough money to hire faculty. In just talking to [faculty member] who has been here his whole academic career, he's 55 now, he said when he came here 25 years ago they had essentially the same number of faculty as they do now. And enrollment has gone up enormously. (College of Science and Math administrator)

Perhaps more relevant to individual faculty and the SCALE goals though, is the increase in average course size, which some respondents cited as a major constraint on using active-learning pedagogies. In addition, as class size grows, so too do the demands of office hours and grading, and some respondents felt that their time to devote to research and service activities was reduced by the demands of serving a growing student body.

## *CA Teacher Credentialing*

The teacher credentialing process in California is currently governed by the California Commission on Teacher Credentialing (CCTC). The CCTC operates independently from the State Board of Education, the superintendent of public instruction, and the secretary of education, making for a complex policy atmosphere (California Performance Review 2006). California currently offers three major types of teaching credentials: the *basic teaching,* the *specialist,* and the *service* credential. Basic teaching credentials include a multiple-subject (M/S) credential that authorizes the holder

to teach all subjects within a self-contained elementary classroom and a single-subject (S/S) credential that authorizes the holder to teach a specific academic subject in a departmentalized classroom in junior and senior high schools.

In addition, basic credentials are offered in two stages, the *preliminary* credential and the *professional clear* credential. The requirements for an M/S preliminary credential, which is issued for a maximum of 5 years, include having a baccalaureate or higher degree, passing the California Basic Educational Skills (CBEST) exam, passing the Reading Instruction Competence Assessment (RICA), and completing a multiple-subject preparation program. The S/S preliminary credential requirements include having a baccalaureate or higher degree, passing the CBEST exam, passing a subject matter exam or completing a CCTC-approved subject matter program, and completing a single-subject preparation program. Requirements for obtaining a professional clear credential include the following three options: (a) completing a CCTC-approved Professional Teacher Induction Program (through an approved school district, county office of education, or IHE); (b) completing a 5$^{th}$ year of study at an IHE; or (c) obtaining certification by the National Board of Professional Teaching Standards (CCTC, 2006). According to the most recent CCTC report on teacher supply (CCTC, 2006), the following data summarize key aspects of teacher credentialing in California for the 2004–05 academic year:

- In 2004–05, 28,039 credentials (preliminary and professional clear) were issued in California, and 24,149 were prepared by approved IHEs.

- Of the 24,149 prepared by IHEs:

    - 56% (13,584) were from the CSU system, 5% (1,177) from the UC system, and 39% (9,308) from private institutions; and

    - 13,805 were M/S credentials, 7,543 were S/S credentials (junior high and senior high schools), and 2,801 were education specialist credentials.

- Of the basic credentials issued by the CSUs, 3,761 were S/S credentials (50% of the state total) and 8,048 were M/S credentials (58% of the state total). Other credentials include specialist and intern credentials.

    - Of the basic credentials prepared by CSUN, 458 were S/S (6% of the state total) and 715 were M/S (5% of the state total), the most in the CSU system. (It is worth noting that CSU Los Angeles, CSU Long Beach, and CSUDH also issued similar numbers of M/S credentials, with CSUN and CSU Long Beach issuing the most S/S credentials.)

    - CSUN also prepared 144 S/S internship credentials and 24 M/S internship credentials.

- The only IHEs issuing more basic S/S credentials than CSUN (458) were Chapman University (534) and National University (1,102)—both private institutions—while

the only IHE issuing more M/S credentials than CSUN (715) was National University (1,284).

### *Theme: Many Students Receiving Credentials Through the CSU System Already Hold a Teaching Credential*

It is important to note an additional type of classification also governs California teaching credentials, a type that refers to the career stage of the applicant. A *first-time* credential is awarded to individuals who have received no previous California credential, and a *new type* credential is awarded to individuals who previously held a different type of credential, such as an emergency teaching permit. For the CSU system, 785 (21%) of the S/S credentials issued in 2004–05 were first-time credentials, and 2,976 (79%) were new type credentials. For M/S credentials, 1,968 (24%) were first-time credentials, and 6,080 (76%) were new type credentials (CCTC, 2006). These figures include individuals who receive both preliminary and professional clear credentials. These data indicate that a large majority of individuals who attend the CSU system in order to satisfy the requirements for a teaching credential already hold some sort of credential. Since teachers holding any type of credential must hold a baccalaureate degree in order to teach in California, the individuals obtaining a new type credential at CSUN already held an undergraduate degree.

### *Theme: Private Universities Play a Significant Role in Teacher Training in CA*

Since private universities in California recommend 39% of the teaching credentials in the state and most of these come from small IHEs with fast-track credentialing programs, some respondents noted the importance of these IHEs in the "big picture" of K–12 education.

> Competition for teacher education students is great. Some institutions use these programs as money-generating activities. As a result, sometimes programming options are employed that do not give full measure to the content to be learned, and that's not helping education at all. So you have a number of teachers in schools who are not as knowledgeable as they might be, and there is no real incentive for them to come back and get additional work—I don't really blame them. I guess I'd be the same way myself. These are realities of life in our society. This problem pushes itself all the way through the system. It's the weakest link concept. (College of Education administrator)

## *LAUSD*

LAUSD is one of the largest school districts in the country and hires a significant portion of its teachers from the CSU campuses. Teachers at LAUSD also participate in several CSUN-sponsored professional development programs, and many College of Education faculty have close ties with administrators and teachers throughout the system. The district and CSUN are further connected since most of the students at CSUN are from Los Angeles County and are graduates of LAUSD schools. LAUSD not only receives IHE-trained teachers, but also actively trains teacher candidates through its District Internship Program. This is a 3-year program that allows an individual to teach

full-time in a K–12 classroom while taking courses to satisfy preliminary credential requirements (an 18-month program) and professional clear credential requirements (an additional 18-month program). From July 2004 to June 2005, LAUSD recommended 183 M/S and 54 S/S (in math and science) professional clear credentials (CCTC, 2006).

LAUSD is also closely involved in the ongoing training of their teacher workforce; along with an array of private vendors and IHEs, the district offers professional development to its own staff. While teachers in LAUSD are required to participate in regular on-site professional development sessions, the primary policy incentives for teachers to participate are to receive "salary points" to increase their wages or to satisfy the CCTC requirements for a professional clear credential. Thus, once a teacher satisfies the professional clear credential requirements, the only remaining incentive to attend professional development sessions (other than those on-site sessions mandated by the district) is driven by financial considerations and not policy.

### *Theme: There are Few Policies Governing the Quality of K–12 Professional Development*

Based on review of documents, we learned that, although California has content standards and a curriculum framework for K–12 schools, it has few policies or regulations governing the type and quality of professional development offered to in-service teachers. Instead, districts, based on their own criteria, ultimately decide how best to provide instructional support and professional development. Since these criteria usually include compliance with state content and curricular standards, most professional development workshops and seminars used by a district closely align their content with these standards. The only two programs that have some policy leverage over professional development are California Beginning Teacher Support and Assessment (BTSA) and the National Board for Professional Teaching Standards, both of which have established professional development requirements for the completion of their respective licenses and issued general guidelines for professional development quality. In the case of BTSA, K–12 districts have the authority to select these approved vendors.

### *Theme: LAUSD Is Actively Hiring Math and Science Teachers for Secondary Schools*

Through review of documents and from respondents, we learned that there is currently a shortage of math, science, and special education teachers in Los Angeles County, and LAUSD is actively seeking teacher applicants in these areas. In fact, through the LAUSD Teacher Recruitment and Student Support Grant Program (TRSS), the district is offering prospective new hires incentives and reimbursements of up to $18,000 to teach in low-performing schools in these subject areas. This effort is emblematic of a widespread concern about the qualifications of many existing math and science teachers, particularly at the secondary level. According to respondents, many of these teachers have not been trained in the subject areas or completed an accredited credential program, and are simply "filling a gap" until a school can recruit teachers who satisfy the No Child Left Behind *highly qualified teacher* requirement.

> Every high school in the area I think was looking for math teachers this year, and we had so few, I mean our numbers are dropping, all my student teachers, would just get snapped right up if they wanted to teach. I guess they're filling their ranks, but I would say that [some] people probably aren't really well qualified. (College of Education faculty)

In other subject areas, however, respondents report a slowdown in LAUSD hires from the CSUN teacher preparation pathways. This is attributed in part to the repeal of a state law that kept K–12 class sizes low, which had created a sizable demand for new teachers in the past decade.

### *Disciplinary Culture*

We learned from respondents at CSUN and elsewhere that disciplinary traditions and practices exist independent of the various organizational cultures at a particular IHE. For example, while the field of chemistry or physics may take on a unique character at a given campus, the discipline itself carries with it certain tenets that are not subject to any particular IHE. As students become members of a particular scientific community, they join colleagues who learned from the same scientific models and practices.

#### *Theme: Acceptance of Pedagogical and/or K–12 Activities by Disciplinary Colleagues Is Important*

As previously noted, the widespread sentiment among many STEM faculty that pedagogy-based research is "soft science" and thus inadequate is still pervasive at CSUN. However, several STEM respondents at CSUN stated that sessions on pedagogy and education were becoming more common at professional meetings and that the growing acceptance of these sessions by their disciplinary colleagues made them feel less like mavericks and more like members of a professional community. Also, according to respondents, the solid disciplinary credentials of faculty members who are engaged in pedagogy research or K–12 activities are a factor that mitigates this judgment. As one life sciences faculty noted, "It probably helps that I have a doctorate from Caltech, but I just have a very supportive faculty group."

## IHE-Specific Contextual Elements

### *Institution-Wide Structures and Policies*

As used here, the term *structures* refers to the overall form and organization of an IHE, while the term *policies* refers to all policies, guidelines, and regulations that govern an IHE's decision-making processes.

#### *Structure of the University*

CSUN comprises nine colleges, including the Eisner College of Education and the College of Science and Mathematics. There are 56 departments within these colleges, which offer 60 baccalaureate degrees, 45 master's degrees, and 28 types of teaching

credentials. There are also numerous research centers and institutes at CSUN, including the Center for Research and Innovation in Elementary Education and the Interdisciplinary Mathematics-based Research and Education Center. The administration consists of a president, a provost (who is also vice president for academic affairs), and vice presidents for student affairs, administration and finance, and university advancement (CSUN, 2006). The administrator most directly engaged in SCALE-related activities is the provost and academic affairs.

### *Faculty Governance System*

Governance in the CSU system emphasizes departmental autonomy regarding the educational functions of the university. The critical role that departments play is further accentuated by the cherished tradition of faculty autonomy, which several respondents cited as a factor contributing to their career decision to become IHE faculty.

### *Retention, Tenure, and Promotion Policies*

The respondents all asserted that the reward and promotion system, also known as recruitment, tenure, and promotion (RTP) policies, is one of the most important and influential aspects of institutional life. At CSUN, these policies are governed by section 600 of the university's Administrative Manual (Academic Personnel Policies and Procedures). Section 621.1 of the manual states that in making appointments, the following factors should be considered: excellence in scholarship and training, interest and skill in teaching, promise of professional growth, and qualifications of personal maturity (CSUN, 2005). For tenure review, the procedure is that a department personnel committee reviews personnel files and submits a recommendation. Next, the department chair makes an independent evaluation, followed by the personnel committee of the college, the dean, and finally the president (who has the final word), each of whom submits a recommendation. Criteria for the awarding of tenure include the following:

- Professional preparation;
- Teaching effectiveness (with evaluation procedures determined by departments), which may include pedagogical innovations;
- Contributions to the field of study, including publications in either disciplinary or pedagogical publications; and
- Contributions to the university and community (CSUN, 2005).

***Theme: RTP policies reward teaching excellence and pedagogy-based research***. In reviewing official CSUN documents, we found evidence that RTP policies at CSUN encourage and support the practice of active-learning pedagogies and research activities on teaching and learning. As noted above, the university-wide RTP guidelines specifically identify both pedagogy-based research and discipline-specific research as acceptable forms of publication for tenure.

***Theme: Faculty are concerned about increasing emphasis on publications for RTP.*** Several respondents, including faculty and administrators, noted that across the CSU system faculty are experiencing increased pressure for research and publication productivity. As one respondent noted, the goal is to bring the standards of faculty scholarship more in line with research institutions. Faculty respondents generally felt that this shift in policy is placing further demands on their limited time and reducing their prospects for participating in service activities such as SCALE. As one respondent noted, "You don't get published for participating in a grant," and since many faculty use summer breaks as an opportunity to conduct research and write journal articles, summer professional development for K–12 teachers was cited as a relatively low priority. Furthermore, for faculty who are actively engaged in pedagogical research, respondents stated that administrators generally do not understand that education research takes longer than traditional scientific research, which means that faculty who participate in this type of research will be less productive than others in terms of articles submitted and published. Given these pressure on faculty, several respondents noted two types of desired support: (a) released time afforded primarily through grants and also through committee work; and (b) support and mentorship in writing articles and conducting research.

### *Faculty Development*

The goal of the faculty development office at CSUN is to help faculty improve their pedagogical skills and to hold faculty orientations and workshops that cover benefits, RTP policies, and the LCU initiative. The introduction to the LCU initiative includes a demonstration of active-learning strategies. According to one respondent, the faculty development office hopes to assist individual colleges and departments to develop specific strategies for improving faculty instructional practices. The respondent noted that these strategies are needed because only the "usual suspects" attend pedagogy-based workshops, and thus it would be beneficial to take the program "on the road."

### *Faculty Workload*

According to CSUN documents, the faculty workload at CSUN is governed by two policies, the California Faculty Association (CFA) collective bargaining agreement (CSU, 2006) and section 600 of the CSUN Administrative Manual (Academic Personnel Policies and Procedures; CSUN, 2005). The CFA agreement sets forth the broad parameters of faculty workload, benefits, and personnel policies that the CSU System must observe (CSU, 2006). The CSUN Administrative Manual further specifies that the "normal" faculty instructional load is 12 weighted units of instruction and the equivalent of 3 weighted units for advisement, committee assignments, and office hours. However, administrators may reduce this instructional load by assigning non-teaching responsibilities such as administrative duties, instruction-related activities, research or program development activities reimbursed by the university or external funders, and leaves of absences without pay (CSUN, 2005). Thus, each faculty member at CSUN is generally expected to teach the equivalent of four courses a semester and satisfy administrative and student support duties.

***Theme: Workload is heavy and not amenable to service.*** Several respondents, including both faculty and administrators, observed that the teaching load in the CSU system is extremely high compared to many IHEs, making research and service activities difficult to accommodate. Given the prominent role that research and publications play in tenure and promotion considerations, faculty usually allocate any time beyond their teaching responsibilities to research or writing. One respondent who recently relocated to CSUN from another university called the mix of teaching load and research expectations at CSU a "worst nightmare." Several respondents described their workload as overwhelming and used words like *frazzled* and *a struggle* to describe their professional lives. A common element across all of the respondents was a perceived lack of time to accomplish all of the tasks that they wished to. Some faculty also expressed some anger towards the CSU and CSUN administration, explaining that with class sizes growing and students jostling for courses to satisfy degree requirements due to the current budget crisis, and with increasing demands on faculty to publish scholarly works, they also were expected to participate in the LCU initiative and to focus on assessment issues. As one respondent stated, "You can't get blood out of a turnip." Another criticism expressed by some respondents was that, while administrators stated that they would treat pedagogy-based research as scholarly work, they did not understand that education research generally takes longer and is less "tidy" than traditional scientific research. Thus, a TNE faculty member or others who are conducting pedagogy research may not be as productive as other faculty when it comes to publications.

***Theme: Assigned or released time is indispensable for service activities.*** According to several respondents, faculty are usually only able to accommodate service activities such K–12 professional development workshops into their heavy workload when they receive released, or assigned, time from department or college administrators. Generally, assigned time is granted for administrative duties, such as serving as department chair, or through grant or university funding that buys out a portion of the faculty member's teaching load. This enables faculty to participate in activities such as TNE or SCALE without putting forth an unsustainable level of effort. In cases where assigned or released time is not available, faculty generally participate in service activities only during the summer break, which is also an ideal time for research activities.

***Theme: CSUN increasingly relies on non–tenure track full-time, part-time, and adjunct faculty.*** Of the 2,021 faculty at CSUN in fall 2005, 1,181 were part-time (58%), and 840 (42%) were full-time. Several respondents noted that the growing trend in U.S. higher education to hire non–tenure track faculty, especially to teach lower division courses, has important implications for reform efforts such as SCALE, since the MSP focus is on full-time faculty. However, some respondents noted that many lecturers and adjunct faculty have been at CSUN for several years and are deeply integrated into departmental operations.

## *Programs*

This section describes degree programs, course sequences, and K–12 partnerships at CSUN. Of particular interest to SCALE are the teacher preparation pathways at CSUN, which are explored in detail below.

### *Degree Programs*

As previously noted, about 80% of CSUN students are enrolled as undergraduates. Of the 26,854 undergraduates enrolled in fall 2005, 14,423 had not declared a major. That same year, the top undergraduate majors were liberal studies (2,053 students), general psychology (1,837), business administration (1,660), sociology (1,118), radio/TV broadcasting (1,112), and biology (953). That year, 6,389 graduate students were enrolled, of whom 3,712 were not enrolled in a specific degree program. The top graduate degrees that year were educational administration (795), counseling (418), and special education (388) (CSUN Office of Institutional Research, 2006).

***Theme: Low enrollment in the sciences (excepting biology) is a major concern.*** Several respondents stated that low enrollments in chemistry, physics, and geology created concern about funding and the long-term health of the departments. Furthermore, as described in the next section, the relatively low number of science majors planning on becoming high school teachers was cited as a serious problem. As a result, many faculty and administrators in the CSUN STEM departments are focused on recruiting students from area high schools and community colleges. Respondents noted that these recruitment efforts are going beyond traditional science fairs and other K–12 outreach to a more targeted focus on aligning the "pipeline" of students from community colleges and high schools to CSUN. For example, as one respondent noted, CSUN is exploring a dual admission system with community colleges where students take the correct introductory courses while working directly towards a CSUN degree.

***Theme: Lack of science majors contributes to a small pipeline for future K–12 teachers.*** According to some respondents, while the lack of science majors at CSUN severely restricts the pipeline of future high school science teachers, more alarming is the low number of existing science majors who are considering teaching K–12 as a career option. One respondent observed that while math has a large cohort of students who plan to teach high school math, there is not a similar population for science. In the sciences, students generally plan on becoming doctors or entering industry in some fashion.

> It must be strongly stated at the outset that single-subject science faces a unique challenge in the preparation of teachers in secondary education compared to those in mathematics, the arts and humanities, and social sciences. The population of baccalaureate candidates whose stated career goal is to become a high school teacher of science is very small in the departments of biology, chemistry and biochemistry, geological sciences, and physics and astronomy. Because of the small numbers, it is currently not feasible to create a curriculum specifically for prospective teachers of high school science. The problem is not unique to CSUN. The severe shortage of high school teachers of science is a highly publicized national problem. The number of students majoring in science is dwindling,

> and most of these majors are planning careers as professionals in industry or higher education. (CSUN TNE Single Subject Science Report, 2006)

Other respondents corroborated the sentiment that students generally "don't come to choose a science major to be a teacher."

### *Teacher Preparation Pathways*

Of particular relevance to SCALE and the MSP program are teacher preparation pathways, since it is here that future K–12 math and science teachers receive their training in disciplinary content and pedagogy. The elementary and secondary teacher education programs at CSUN are administered by the College of Education, but there are numerous examples of STEM and education faculty collaboratively planning and implementing the preservice curriculum. The major pathways that lead directly to students receiving a teaching credential at the conclusion of their CSUN coursework are described below. While data for each pathway were not available at the time of this report, several respondents stated that the traditional credential program and the liberal studies program are by far the largest teacher preparation pathways at CSUN.

- Graduate-level pathways
  - *Traditional Credential Program (5$^{th}$-year post-baccalaureate in College of Education):* This program is for students who hold a baccalaureate degree, take one year of coursework in the College of Education, and complete a clinical field experience. No STEM courses are required for this program.
  - *Accelerated Collaborative Teacher (ACT) Program:* The ACT program entails a collaboration between CSUN and LAUSD Local District 2 to provide a fast-track credential program for students who are placed immediately at an LAUSD school while taking education courses at CSUN. No STEM courses are required for this program.
  - *IHE internship:* The internship program is offered in partnership with local school districts and allows students who are already working full-time in a K–12 school to complete a preliminary credential while on the job. No STEM courses are required for this program (CSUN Office of Institutional Research, 2006).
- Undergraduate-level pathways
  - *Liberal studies teacher preparation options*
    - *Pre-credential option:* This option is a program for obtaining a bachelor's degree only and is intended for students who plan to enroll in a traditional credential program or the Integrated Teacher Education Program Junior Option.

- *Integrated Teacher Education Program (ITEP) Freshman Option:* This is a program for obtaining a bachelor's degree in liberal studies and an M/S credential concurrently. The students are placed in cohorts for this full-time program. Students take five courses in STEM departments.

- *ITEP Junior Option:* This program is identical to the ITEP Freshman Option except that students must have completed lower division requirements and have junior standing. Students take five courses in STEM departments.

- *Four-Year Integrated Program (FYI):* This freshman-only program is for obtaining a bachelor's degree and an S/S credential concurrently in English or mathematics. In most courses, students are organized into cohorts and field experiences are included. Math FYI students take several courses in STEM departments.

Students can follow other pathways to satisfy the state requirements for subject matter proficiency (which is required to obtain an S/S teaching credential). These programs are called *subject matter programs*, and at CSUN, the math and geology departments offer students a specialized 4-year program that has been approved by the state. Several respondents noted that enrollment in these programs is relatively small. After receiving a baccalaureate degree from CSUN, students must enroll in one of the graduate-level options for further coursework in the College of Education if they elect to pursue a teaching career. Since these pathways lead to a baccalaureate degree and not to a teaching credential, they are not included in the list above.

***Theme: STEM faculty do not participate in graduate-level preservice programs.*** The above figures indicate that the largest cohort of preservice teacher candidates at CSUN are either in the 5$^{th}$-year traditional program or in the liberal studies ITEP program. In the case of the graduate-level programs, students are not required to interact with STEM faculty at all, as this respondent notes.

> One of the odd and frustrating things at this university is the gigantic gap between the undergrad [coursework and graduate] credential programs. Despite all this work together [on TNE], it may actually not do a thing for our teacher candidates, [because] as undergrads all they're doing is majoring in their subject. So they're a math major. And they can opt for this math education strand, but it doesn't mean anything credential-wise. It just means that they're taking a set of courses that's more oriented towards education than others, but when they walk out of the door they've got a math BA or BS and nothing else. Now, they can then choose to enter a credential program, which if they come to CSUN is in the College of Education. And they only get one math-specific course at that point, and that's the math methods course. It's unusual for an undergrad to come out of a CSUN math major and go right into the credential program. We don't see that continuity at all. It's more likely that they've come from the workforce where they've been for the last 10–15 years. It's a pretty small pipeline immediately back to us. (College of Education faculty)

***Theme: STEM faculty have significant contact with undergraduate-level preservice programs.*** In the case of the liberal studies program, students in the teacher

preparation options are required to take only the following five courses in the STEM disciplines:

- Basic Number Concepts—MATH 210 (also known as Math for Teachers);
- Introductory Biology—BIOL 100 (plus lab), General Biology—BIOL 101 (plus lab), or Biological Concepts—BIOL 102 (plus lab and taken concurrently with Seminar in Children's Learning in Science—LRS 296F);
- Introduction to Physical Science—PHSC 170;
- Liberal Studies Science Experience Capstone—GEOL 406LRS;
- Basic Concepts of Geometry, Probability, and Statistics—MATH 310 (plus lab and taken concurrently with Math Curriculum and Methods—EED 472).

(Source: CSUN 2004–2006 Catalog)

In addition, students on these tracks are required to take a Teacher Preparation Concentration course sequence, which includes a combination of these lower division requirements and selected upper division courses (300 level or higher). Concentrations in the STEM disciplines are available in general science and math. Given the structure of the degree requirements, these students come into close contact with several STEM faculty in the course of their degree programs at CSUN. However, because the liberal studies program leads to an M/S credential for teaching in elementary school, the students are not subjected to as lengthy or intensive STEM coursework as students who plan to teach in secondary schools.

***Theme: Waiver and 4-year blended programs offer the most intensive STEM faculty contact with preservice candidates.*** One of the requirements for obtaining an S/S teaching credential in California is to prove subject matter proficiency, which can be done by completing an approved IHE subject matter sequence or by passing the California Subject Examinations for Teachers (CSET). As noted above, only two departments at CSUN, math and geology, have subject matter programs. Essentially, these 4-year programs build in all of the coursework required to pass the CSET. One respondent stated that without this type of preparation, a student with a math or science baccalaureate would need to take another semester of coursework in order to get the adequate breadth in their subject area. Another respondent noted that CSUN used to have more subject matter programs in the sciences but found that few of the students enrolled in the programs planned to get their bachelor's degrees at CSUN or to obtain a teaching credential. Instead, they were using CSUN as a "fly-by" to avoid taking the CSET and thus consumed considerable administrative resources in the process. Regardless, these programs entail close collaborations between STEM and education faculty in creating course curricula and pay close attention to fusing content and pedagogy. As a result, these programs represent probably the best example of a "blended" program leading to a secondary science or math teaching career, and some respondents hope that the eventual success of these programs will be a major recruiting point in the future.

***Theme: The liberal studies ITEP and waiver programs require intensive inter-college collaboration.*** Several respondents cited a cordial and active collaborative relationship between STEM and education faculty, particularly for liberal studies, which has several active cross-college faculty committees that successfully design curriculum and develop programs. For example, an earth sciences faculty member teaches a biology course for the ITEP freshman cohort and coordinates with an education faculty member who teaches a concurrent science education course that is required for the students. Together, the two courses are intended to fuse the disciplinary content with appropriate pedagogical methods. However, respondents indicated that outside of the liberal studies program, STEM faculty have limited opportunities to participate substantively in preservice programs. This is especially the case for the S/S credential, for which there is little to no collaboration between the two colleges. According to several respondents, this lack of collaboration is due not to overt hostility between the colleges, but rather to lack of a rationale for collaboration. Two exceptions are in the math department: the FYI math program and the math education option for undergraduate math majors. For these programs, a cohort of math faculty works with math educators in the College of Education to revise courses, infusing pedagogical content knowledge into courses.

### *K–12 Outreach*

Respondents made clear that there is a strong tradition of engagement with K–12 schools and districts at CSUN, which many respondents cited as a historical consequence of being *the* university for the San Fernando Valley. CSUN is also the training school for future teachers in LAUSD Local District 2; preservice and in-service professional development field training offered by CSUN faculty has created strong ties with the district and individual schools. Other outreach activities tend to focus on recruitment, such as bridge programs that bring promising high school students to CSUN to participate in IHE-level scientific research. Along these lines, CSUN faculty commonly participate in field days at schools or public events, operate programs to engage K–12 teachers in laboratory research, and conduct recruiting trips to local high schools and community colleges. Generally speaking, according to respondents, these efforts are intended not to recruit future math or science teachers, but rather to raise the profile of CSUN in the wider community and to encourage promising students to attend CSUN and go on to further graduate work.

We list below a few of the many K–12 outreach programs that respondents described or mentioned. This list, which is based on document review and information respondent information, is not intended to be exhaustive, but rather is offered here to illustrate the types of programs in place at CSUN.

- K–12 activities involving mostly STEM faculty
    - *Tomorrow's Scientists:* The goals of this oft-cited program are to (a) recruit and train future science teachers in the liberal studies ITEP program and (b) provide an opportunity for them to teach a real science lesson to seventh-grade students from a nearby LAUSD school. The students are selected on the basis of their

science teacher's participation in a CSUN-based professional development program.

- *California Science Project (CSP):* The California Subject Matter Projects, of which the CSP is an element, are well-established K–12 professional development programs funded by the state and the UC system. CSP professional development activities are led by IHE faculty and generally focus on disadvantaged schools and districts throughout the state. The CSP site in which CSUN faculty participate is the San Fernando Valley Science Project, which includes summer institutes in inquiry-based science with Saturday follow-ups throughout the school year.

- K–12 activities involving mostly education faculty

  - *Individual faculty projects:* Several faculty noted that they or colleagues in the College of Education were partnering with individual LAUSD local districts, schools, or even teachers in research or other projects. These collaborations appear to be quite common, are generally not publicized, and involve individual faculty and K–12 partners.

  - *Mentoring of student teachers:* Students in several CSUN programs, including the traditional 5$^{th}$-year credential program and the ACT program, must complete a student teaching requirement in an LAUSD school as part of their pedagogical training. Faculty in the College of Education (except in the case of the internship program) serve as mentors to these students and provide supervision and counseling to these students.

***Theme: CSUN is strongly identified with teaching and serving the K–12 sector.*** As described above, there are several examples of long-term programs at CSUN that involve K–12 educators and/or students in one way or another. These programs, especially the teacher preparation programs in the College of Education and professional development programs such as CSP, are key elements of CSUN's reputation as an IHE that is intimately involved with the K–12 community. According to respondents, awareness of and identification with this reputation is widely shared by the faculty, and STEM faculty, who themselves are not engaged in K–12 activities but who are acutely aware of their institution's reputation and mission.

***Theme: Faculty question the efficacy of professional development.*** Some respondents questioned whether the traditional professional development model, in which IHE faculty serve as content experts who deliver "knowledge" in a lecture setting, is truly effective in increasing the content knowledge of K–12 teachers. One faculty member noted that the increased emphasis on assessing student learning through the LCU initiative made him begin to question the efficacy of professional development workshops as currently designed.

## *Reform Initiatives*

As at many IHEs, a variety of grant-funded programs at CSUN are aimed at reforming some aspect of institutional life and practice. These reform initiatives are distinct from programs in that their primary intent is to change existing policies, structures, or programs. As it is not feasible to list all of the past and current education reform initiatives, we consider only the two (in addition to SCALE) that were frequently mentioned by interview respondents.

### *Learning-Centered University (LCU) Initiative*

At the time of this research, CSUN was in the midst of a university-wide transformation effort known as the Learning-Centered University (LCU) Initiative. The LCU initiative comprises three major elements: (a) maximizing experiential learning opportunities for students, especially in the first 2 years; (b) building a learning community among students; and (c) fostering a sustained and purposeful effort to educate high school students about career tracks. The last element, according to a respondent, is "one of the major gaps that haunts the relationship of K–12 to universities," since many high school students have little sense about the variety of possible careers and ways to select an educational track to acquire the appropriate training. According to respondents and documentary evidence, the LCU initiative permeates many aspects of institutional practice at CSUN, including announcements for position openings (as previously noted), many CSUN official documents and publications, and the orientation session for incoming faculty. At this session, faculty are introduced to inquiry-based teaching methodologies through a demonstration lesson and background materials. Another highly visible manifestation of the LCU initiative is the requirement that each department develop student learning objectives for each course.

***Theme: Faculty have mixed reactions to the LCU initiative.*** Reactions among faculty respondents to the LCU were generally supportive regarding the intent of the initiative, but mixed regarding its implementation and ultimate impact on faculty life. Some reported that they and their colleagues are still not sure precisely what it means, and others view it as an additional burden imposed by the administration. Considering the "overwhelming" workloads, one respondent stated that some resistance is not surprising and that change does not happen in higher education without resistance. This respondent noted that "at first blush, the LCU shifts responsibility to the student, but it requires significant work by faculty." Despite these challenges, most respondents reported that there was significant buy-in from the faculty for the ultimate goals of the initiative. They explained that this buy-in was concomitant with the knowledge that current CSUN students might soon be teaching future CSUN students, and thus faculty had a vested interest in ensuring that they were taught well.

Another way that the LCU initiative had an impact on faculty life was through the student learning objectives that each department is required to develop in order to institute an outcomes-based teaching and learning evaluation system at CSUN. One respondent noted that the progress departments are making towards these goals varies wildly and that departments with TNE faculty or others predisposed to K–12 education

are making the most progress. Indeed, a TNE research project is administering Deborah Ball's Content Knowledge for Teaching Mathematics instrument to math sections devoted to liberal studies majors. Another faculty member stated that "assessment is a nasty four-letter word" but went on to say that "It's a good thing in an evil way, I guess."

### *Teachers for a New Era (TNE) Program*

According to CSUN documents, Teachers for a New Era (TNE) is a project funded by the Carnegie Corporation of New York, the Annenberg Foundation, and the Ford Foundation as a response to critics who charge that IHEs are failing to prepare quality teachers (CSUN, 2006). Since teacher training programs are a significant aspect of the mission of the CSU system in general, and CSUN in particular, the university and the TNE initiative have a shared goal to improve the quality of the teacher preparation pathways at CSUN. The major design principles governing TNE include a focus on training future teachers in assessment methodology, creating strong clinical practice experiences for future teachers, and strengthening the collaboration between STEM and education faculty in designing and overseeing teacher preparation programs (CSUN, 2006). CSUN was awarded a 5-year TNE grant in 2002 that will continue until 2009 using carryover funds from the first 5 years of the award (CSUN, 2006). TNE is a comprehensive initiative with many different lines of work, and to adequately account for these activities is not within the purview of this case study. However, because TNE and the MSP program have almost identical goals for improving preservice programs in IHEs, we describe here TNE activities that are relevant to the SCALE goals.

- TNE faculty fellows: Beginning in 2003, the TNE grant enabled CSUN to hire five new faculty members in arts and sciences departments. The TNE faculty are hired to both tenure-track positions and 3-year lecturer positions, all of which are guaranteed funding by CSUN after the TNE grant expires. TNE faculty have been hired in the geology, chemistry, math, and biology departments. These faculty pursue scholarship and teaching activities in their disciplines while also focusing on pedagogical issues, teacher training, and K–12 education. Most faculty also have special memoranda of understanding for their tenure and promotion guidelines to explicitly account for the pedagogical orientation of their research and their increased levels of service. Furthermore, these faculty generally have reduced teaching loads (as low as six units), as their time has been bought out by the grant.

- *TNE subject matter study groups:* More than 65 arts and sciences faculty participated in TNE subject matter study groups. Activities have included seminars and lectures on pedagogical content knowledge in the math department and evaluation of newly introduced curriculum.

- *TNE CSU system-wide activities:* The CSU deans of education initiated a program for the evaluation and assessment of teacher training programs, linked to TNE principles. Faculty from four CSU campuses also created *A Handbook for Master/Cooperating Teachers* that will be refined and distributed by each campus (CSUN, 2006)

***Theme: TNE is having mixed results in hiring faculty in STEM departments.*** By hiring tenure-track faculty, the TNE project is guaranteeing itself a long-term presence and influence at CSUN, particularly since most of the hires have unique memoranda of understanding that officially sanction their focus on pedagogical research and K–12 activities. These faculty serve as the pedagogical experts in their departments and make up a growing cohort of education-minded STEM faculty at CSUN. However, some respondents noted that being identified as "the K–12 expert" has negative consequences. According to these respondents, some TNE faculty have felt that they have not been adequately supported by their departmental colleagues and that they are looked down upon as "the K–12 expert." In addition, some departments have had problems in hiring TNE faculty as a result of disagreements about the responsibilities of the position or even the basic premise of the TNE project.

> Already some people in the department weren't particularly excited about TNE and don't really feel as if it's their department's business to be worrying about making teachers. Then, they're unwilling to give up, let's say, a position to bring someone in whose research work is going to be education. Now, interestingly, I don't think it's giving up a position, I think that position was extra. (College of Science and Mathematics faculty)

It is interesting to note that some respondents felt that an initiative like TNE would never "fly" at a major research university, speculating that the disciplinary and departmental cultures would not allow for a tenure-track faculty member to focus on K–12 education.

***Theme: TNE is paying particular attention to single-subject science issues.*** According to a respondent, the TNE project began to explore issues related to single-subject science only in the 4$^{th}$ year of the 5-year grant. This respondent was motivated to examine the reasons behind the lack of a student population in the sciences, particularly those who intended to become high school science teachers, after being asked to consider designing a curriculum for preservice students. While the respondent agreed with the "build it and they will come" philosophy of recruiting students, she felt that it made little sense to create courses for which there were no students, particularly during a budget crisis. She explained that, in response, a TNE science committee conducted a survey of the major feeder high schools and community colleges in the San Fernando Valley. Reviewing the report on this study, we learned that over 2,000 high school students were surveyed about their knowledge of teaching as a career, their feelings about science, and other questions that explored the reasons for the shortage of science majors at CSUN.

***Theme: TNE is attempting to engage STEM faculty in pedagogical improvement.*** Respondents explained that one of the TNE committees is focused on engaging STEM faculty in improving their instructional practices. The committee has formed study groups for faculty to become familiar with the literature on teaching and learning and to form a professional community for support and information. A respondent familiar with this activity stated that many of the faculty who have been approached believe that teaching and learning is important but have the "sense that they have nothing to offer." This respondent stated that assessment issues are particularly problematic for STEM faculty, who feel that these issues are very hard to grasp and

believe that few tools exist for them to easily utilize in their courses. Furthermore, this respondent noted that advising or guiding young faculty interested in these issues is difficult, since their understanding of pedagogical content knowledge and assessment is limited.

### *Cultural Elements: Institutional, College, and Departmental*

Here, we present a set of themes that respondents identified, and that we corroborated through documents or observations, that pertain to influential aspects of the institutional culture. While respondents used the term *culture* in various and sometimes contradictory ways, for this paper *cultural elements* refer to the observed practices and conceptions of groups of people within an institution, which may be convergent or divergent. It is our view that these cultural elements serve not as a passive backdrop to the SCALE goals, but as an active force that shapes the attitudes, values, and practices of many faculty.

#### *Theme: CSUN Has a Strong Sense of Institutional Mission and Values*

As the former San Fernando Valley College, CSUN has a strong history of connection with the local community, which has made its way into accounts of the institution's history. Several respondents explained that CSUN has a historic and primary identity as a community-based institution and that this history and identity give the university pervasive influence in the community. A respondent who recently relocated from a research university found a strong "culture of teaching" and was a bit "blindsided" by the intensity and coherence of the faculty and administration's commitment to its students and teaching. Many faculty also expressed the sentiment that the institution has a historic and moral obligation to serve the needs of K–12 schools in the area. Despite this feeling, we heard conflicting perspectives about the viability of realizing this obligation, due to workload pressures and complications arising from working with as complex and politicized a district as LAUSD.

#### *Theme: Dynamics Between Education and STEM Faculty Exhibit Divisions*

Attempts to engage STEM and education faculty in joint efforts to improve the curriculum and pedagogy for preservice teachers are hampered by a historical and persistent mistrust between these groups. This division is evident in the way one responded explained that TNE faculty in STEM departments use the TNE initiative as a "way to give cover to someone in Arts and Sciences to work on education." Most respondents in the College of Education observed that throughout their academic careers they have regularly been treated as sub-par, mostly because education is viewed as a "soft" and applied science. The persistence of this division at CSUN was apparent when some faculty noted the lower levels of support that TNE faculty received in their STEM departments. On the other hand, several respondents stated that the division between the two colleges was not as bad at CSUN as at their previous institutions, where STEM faculty rarely interacted with education faculty. The existence of several inter-college

collaborations, particularly for the liberal studies program, is testimony to the existence of a cohort of faculty from both colleges who have overcome this division.

### *Theme: Mathematics Department at CSUN Exhibits Considerable Divisions*

An example of the influence of departmental culture is the controversy over constructivist pedagogical strategies in mathematics, also known as the Math Wars, about which many CSUN mathematics faculty have very strong opinions. Numerous respondents noted that the atmosphere in the Mathematics Department is "tense" due to the political and ideological nature of the debate, which some felt had long ago ceased being a "collegial" discussion over methodology. One respondent observed that the division, which is not unique to CSUN, is sad because all of the faculty are committed to math education and the improvement of student learning. The division manifests itself in two ways relevant to SCALE: (a) the revision of the liberal studies math curriculum and (b) relations between IHE faculty and K–12 personnel. It should be noted that many respondents were heartened by recent collaborations between the College of Education and the small cohort of pedagogy-minded math faculty who are revising the liberal studies curriculum to infuse pedagogical content knowledge into the curriculum. However, several respondents reported that these efforts are being actively challenged by another cohort of math faculty who disagree with the constructivist approach. One faculty member stated that the best argument for "reforming" an entire STEM department is to avoid situations in which a group of faculty actively undermines the efforts of others. In addition, some respondents noted that the debate has resulted in real harm to IHE and K–12 relations, since it has left K–12 teachers feeling defensive about their own teaching styles and confused about the best pedagogical approach to employ in their classrooms.

### *Theme: A Critical Mass of Like-Minded Colleagues Is Important to the Reform Process*

Themes also emerged that were centered around faculty subcultures. Here, we use *subcultures* to mean groups that (a) regularly interact; (b) develop a distinct identity based on shared research interests, political persuasions, or beliefs, values, and attitudes; and (c) share conceptions of problems and their solutions. Our interview data indicate that subcultures defined in this way are more likely to be the locus of change efforts—or efforts to resist change—than groups defined by subdiscipline, roles, or personality types.

Several respondents noted that having colleagues, either in their own departments or across campus, who are supportive and knowledgeable about their activities is a key factor that keeps them engaged in reform activities. These collegial groups provide moral support, practical advice, and a community of professionals. Faculty respondents explained that their education reform community was as engaging and legitimate for them as their own disciplinary communities.

> One nice thing about CSUN is being in this Teachers for a New Era program, [where we have] 30 or 40 people [in science and math] who are dedicated to improving teacher education from all different perspectives and it's wonderful. It's a great place to be because there's nobody slamming the door in my face saying, "I can't be bothered."

> There are always people that want me involved because they have another idea and so, to me, it's a great place to be doing this right now. (College of Science and Mathematics faculty)

Cohorts of reform-minded faculty were enthusiastically encouraged by administrator respondents, who felt that these internal "agents of change" were far more effective than "external consultants." Regarding interdepartmental relations within these communities, several education faculty respondents stated that feeling that STEM faculty respected their training in pedagogy as much as their own content expertise went a long way in fostering collegial relations. Although our question about how many STEM faculty would need to be convinced of a learner-centered approach to achieve critical mass drew diverse responses, several respondents were clear about the importance of avoiding situations where an opposing faction actively seeks to dismantle the work of the reform-minded faculty.

## Individual Faculty Practice

As noted above, our analytic approach is to structure findings about CSUN into the five different types of institutional contexts described above, and also into the context that each individual member of the CSUN community brings. We postulate that individual faculty members and administrators operate within and "make sense of" all the institutional contexts presented above as they make decisions and otherwise go about their daily lives at CSUN. This view of organizational life holds that an individual's behaviors are governed first by their own sense-making processes, as informed by their personal background, disposition, and motivating structures, and secondly, by the objective rules and policies of an institution. This section includes data on how individual faculty make decisions and prioritize their activities within the institutional and cultural contexts of CSUN.

### *Factors Influencing Faculty Ability to Prioritize Their Workloads*

Faculty respondents stated that while they struggled with their various professional responsibilities, invariably their top priority was ensuring that they were adequately prepared to teach. They conveyed that the primary factor underlying this priority was a personal commitment to high-quality teaching, noting that explicit encouragement from the administration and the implicit pressure to adhere to the institutional culture of teaching also were factors. Some respondents also reported that their balance of teaching, research, and service responsibilities seemed to vary with time and seniority. One respondent reported that as she became more senior and thus more familiar with the institution and its administration, she was asked to participate in more committees and administrative work. Other respondents stated that junior faculty must focus on teaching first (in order to get through the day adequately) and research and publications second. Once tenure is achieved, respondents noted that the balance of responsibilities may shift again, as faculty either focus entirely on their research to the detriment of their teaching or become passionately engaged in teaching or service. The common theme here was that senior faculty with tenure have much more freedom to

decide how they allocate their time and resources. This said, faculty emphasized the importance of initiatives such as TNE (which reduces the teaching load) and SCALE (which provides stipends) as a factor that makes service activities possible for all faculty, regardless of seniority.

### *Factors Influencing Faculty Engagement with Pedagogical Reform*

While it is not possible to generalize about the factors that influence an individual's decision to become engaged in teaching and learning issues, we can provide the following list of factors that at least two respondents cited as either impeding or motivating faculty.

- Motivating factors
    - Personal belief that "content instruction is not enough";
    - Personal commitment to reducing math and science phobia gained from experience as a K–12 teacher;
    - Doubt about the current efficacy of their own STEM instructional methods;
    - Involvement with the TNE subject matter committee, which sparked interest in pedagogical content knowledge; and
    - Keen awareness that incoming CSUN students are often taught by graduating CSUN students, and thus that the faculty are directly engaged in a cycle of learning.
- Inhibiting factors
    - Lack of conviction that pedagogy-based research would actually be rewarded during tenure and promotion review; and
    - Older faculty members' lack of interest in or limited ability to adopt new instructional practices (this factor was cited by respondents referring to other faculty).

### *Factors Influencing Faculty Engagement with K–12 Issues*

Again, while it is not possible to generalize about the factors that influence an individual's decision to become engaged in K–12 issues, we provide the following list of factors that at least two respondents cited as either impeding or motivating faculty.

- Motivating factors
    - Children currently in the K–12 system;

  - Personal commitment to reducing math and science phobia gained from experience as a K–12 teacher; and

  - Personal conviction that the educational system in California needs to improve and that IHE faculty play a key role.

- Inhibiting factors

  - Pressures on junior faculty to conduct research and publish;

  - Perception that K–12 education is not part of the faculty job, and is also not rewarded; and

  - Lack of knowledge about teacher preparation pathways at CSUN and K–12 standards, which makes faculty reluctant to become involved in something that they "know nothing about."

## D. FORMATIVE EVALUATION OF SCALE AT CSUN

At this preliminary stage of the research, it is possible to make a few summary observations about the effects of SCALE at CSUN. In presenting these preliminary findings, we have considered respondent reports of behavior and/or institutional change in light of all our information about SCALE goals and activities and the CSUN context.

This analysis strengthens the more traditional formative evaluation by linking the observed program effects and outcomes to specific barriers or supports within the institution. In this way, it becomes possible to address the *how* and *why* of SCALE operations at CSUN. Based on the type of influence exerted on SCALE, we assign a positive (+) or negative (-) valence to each theme. (See Figure 1.) In most cases, the valences were suggested by the respondents. We indicate where we further analyzed each theme by triangulating the respondents' opinion with other data sources. While the attribution of valences to complex institutional and sociocultural phenomena is a rough estimation at best, we believe these estimations contribute to understanding how the CSUN context supports or inhibits SCALE activities.

In this section, we present findings pertaining to three SCALE goals: (a) improving STEM undergraduate education, (b) promoting interdepartmental collaborations between STEM and education faculty for preservice programs, and (c) promoting inter-institutional collaborations between STEM and education faculty for professional development. For each goal, we first consider the institutional context, identifying relevant institutional barriers and supports, and then describe the preliminary effects of SCALE.

## Improving STEM Undergraduate Education

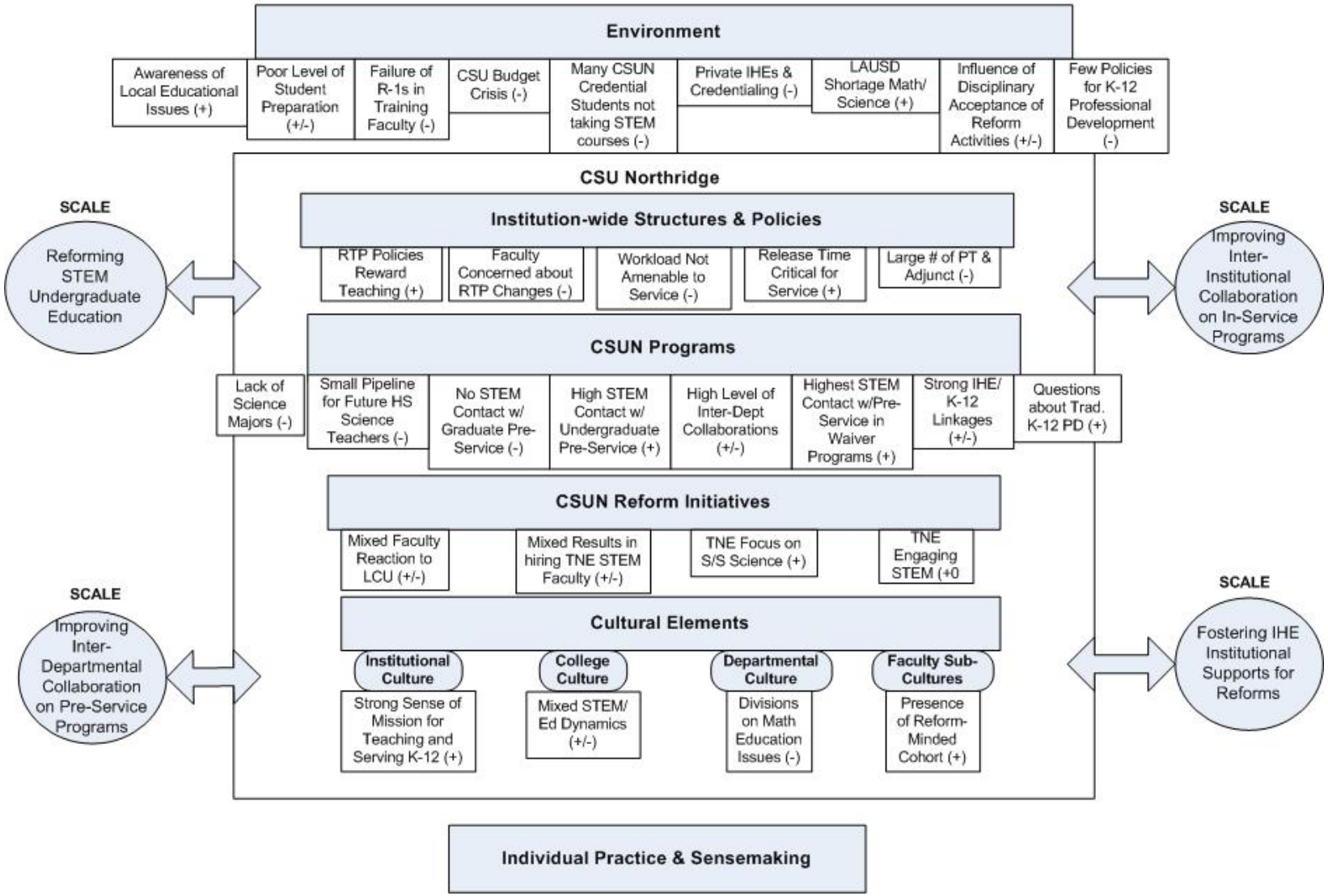
### *Institutional Context*

The SCALE goal of influencing STEM faculty instructional practices was not new to most CSUN faculty and administrators. With the LCU Initiative in its 2nd year and the TNE grant in its 4th year, existing reform efforts to improve undergraduate education in general and STEM instruction in particular had made deep inroads in some STEM departments. Furthermore, the presence of a cohort of STEM faculty who were committed to improving their teaching practices and contributing to preservice programs and in-service professional development meant that SCALE had a ready and willing audience at CSUN prior to its arrival on campus. Despite this friendly atmosphere, there remain significant institutional barriers to improving STEM instruction that may limit the ultimate efficacy of SCALE and similar efforts.

The institutional barriers and supports most relevant to this finding are:

- External environment:
    - Awareness of local educational issues (+)
    - Generally poor student preparation (+/-)
    - Failure of research universities to adequately prepare new faculty to teach (-)
    - CSU system budget crisis, resulting in limits on new hires and increases in class size (-)
- IHE-specific elements:
    - Institution-wide structures and policies
        - RTP policies rewarding teaching excellence and pedagogy-based research (+)
        - Faculty concern about increasing emphasis on publications for RTP (-)
    - CSUN programs
        - Low enrollment in the sciences (except biology) (-)

**Figure 1: SCALE and the Contexts of CSU Northridge**



- CSUN reform initiatives
    - Mixed faculty reaction to LCU initiative (+/-)
    - Mixed results in hiring TNE faculty in STEM departments (+/-)
    - TNE attention to single-subject science issues (+)
    - TNE attempts to engage STEM faculty in pedagogical improvement (+)

## *Preliminary Effects of SCALE*

### *SCALE May Be Influencing Faculty Instructional Practices*

Based on the available evidence, SCALE may be influencing individual faculty instructional practices through participation in the science and math institutes. In some cases, this has meant specific pedagogical methods. For example, one faculty member used several of the problems from the math institute and also gained "well-grounded expectations" about how well students should be able to do and a new confidence in leaving students to do more mathematical work like explaining and organizing solutions on their own. One life sciences faculty member who had used the Fast Plants program in the past was considering adding an inquiry-based exercise and had not thought to do so until participating in the science institutes. In other cases, institute participation has given CSUN faculty a new understanding of pedagogy. One respondent noted that the emphasis in the institutes on being "transparent" has helped her to become a better educator by encouraging her to examine pedagogy from multiple perspectives. Another respondent stated that the readings about pedagogical content knowledge spurred changes to pedagogical methods employed in his IHE courses. These direct transfers of SCALE institute-based methods to CSUN classrooms were corroborated by other faculty respondents. In several cases, faculty reported that the institutional pressure to improve teaching practices, via the LCU initiative, also helped make faculty more attuned to the potential applicability of new methods to their own courses. We note that without classroom observations or further investigation, we cannot assess the veracity of these self-reported changes.

The other primary effect of SCALE in this area was to further develop and foster a cohort of STEM disciplinary faculty who are engaged in pedagogical reform and K–12 education. The effects of a cohort of like-minded colleagues also include providing faculty with the benefits of professional networks and resources. While these changes cannot be attributed to policy change, both respondent testimony and research findings indicate that the presence of collegial support and professional communities is a crucial aspect of institutionalizing a culture of reform. The literature on faculty collaboration and interdisciplinary teams suggests a growing trend away from the "lone scholar" model that typifies much academic work, to a model based more on joint research, team-taught courses, and collaborative program work (Bohen & Stiles, 1998). Despite the many barriers to collaboration, Bohen and Stiles find that faculty are becoming motivated to collaborate based on intellectual curiosity, opportunities for personal gain, and desire for

improved collegiality. Researchers in management studies and other fields have found similar results in studying *communities of practice*, in which different professional groups achieve success by "working side by side and having common organizational values, which are important bases for knowledge transfer between professional groups that belong to different networks of practice" (Tagliaventi, 2006). Furthermore, "knowledge transfer across boundaries evokes new kinds of organizational citizenship and behaviors" (Tagliaventi, 2006). The observations of CSUN respondent that their cohort of reform-minded faculty provides an increasingly supportive environment for teaching improvement are consistent with these research findings. Of note, some administrators also believe that this cohort is an emerging asset to the university.

> Since we're hiring these TNE faculty, I hope that we can form a nucleus, so that we have people in different departments . . . my hope is that we're going to have representatives in each of the five departments and they'll form a nucleus and work together so that we can get more integration. (College of Science and Math administrator)

While TNE, LCU, and other initiatives in place prior to SCALE created and cultivated a cohort of faculty committed to improving teacher education, SCALE is further developing and possibly enriching this cohort by having faculty co-facilitate the immersion unit sessions. Respondents indicated that the type of engagement with one another that SCALE has promoted is qualitatively different than previous collaborations, involving more time, boundary shifting, and understanding of other perspectives.

### *SCALE Is Successfully Engaging IHE Faculty as Learners*

As previously noted, SCALE staff from UW had hoped that by asking the Science Institute Study Group members to learn how to model the active-learning pedagogy embedded within the immersion units, the Study Group members would experience professional development themselves. This included learning core elements of subject-specific pedagogical content knowledge and "tricks" of education, including classroom management. Several respondents reported that in their previous K–12 professional development experiences, they had been given only the role of "content expert," which they performed in public lectures, study groups, or workshops. Faculty who participated in the Study Group, which involved the same group of STEM and education faculty, UW staff, and LAUSD personnel in intensive planning and co-facilitation over a period of months, reported an experience that was vastly different from those in previous professional development efforts.

## Promoting STEM and Education Interdepartmental Collaborations for Preservice Programs

### *Institutional Context*

SCALE entered an institutional atmosphere where interdepartmental collaborations were commonplace for a specific cohort of faculty working on interdisciplinary programs (or course sequences that include the liberal studies program), TNE committees, the math waiver and 4-year integrated degree program, and the geology

waiver program. For each of these efforts, groups of STEM and education faculty regularly met and collaborated on a variety of topics.

The institutional barriers and supports most relevant to this finding are:

- External environment
  - Awareness of local educational issues (+)
  - Significant role of private universities in teacher training in California (-)
  - LAUSD active hiring of math and science teachers for secondary schools (+)
  - Acceptance of pedagogical and/or K–12 activities as important by disciplinary colleagues (+/-)
- IHE-specific elements
  - Institution-wide structures and policies
    - RTP policies rewarding teaching excellence and pedagogy-based research (+)
    - Faculty concern about increasing emphasis on publications for RTP (-)
    - Increasing reliance on non–tenure track full-time, part-time, and adjunct faculty (-)
  - CSUN programs
    - Prior teaching credentials of many students receiving credentials through the CSU system (-)
    - Lack of science majors and resulting small pipeline for future K–12 teachers (-)
    - Lack of contact of STEM faculty with graduate-level preservice programs (-)
    - Significant contact of STEM faculty with undergraduate-level preservice programs (+)
    - Intensive contact of STEM faculty with preservice candidates through waiver and 4-year blended programs (+)
  - Intensive inter-college collaboration required by liberal studies ITEP and waiver programs (+)
  - CSUN cultural elements

- Divisions between education and STEM faculty (-)
- Divisions within CSUN math department (-)
- Critical mass of reform-minded colleagues (+)

## *Preliminary Effects of SCALE*

The new element that SCALE brought to the reform-receptive CSUN environment pertains to a new type of collaboration. Whereas previous collaborations largely involved STEM and education faculty playing roles as content experts (STEM) or pedagogy experts (education), and engaging in activities familiar to most educators (i.e., curriculum design), the SCALE immersion units required a completely different approach to collaboration. Because it is so unusual for IHE faculty to co-teach across the STEM and education boundary, we have no research findings to help assess whether over time this change will affect faculty practices in courses taken by preservice teachers. We will consider this issue closely in Phase 2 of this case study.

### *SCALE Has Had Limited Effects on Fostering Interdepartmental Collaboration*

The CSUN faculty who participated in the math institute were exclusively from the math department, whereas the science institute involved faculty from two STEM departments and two College of Education departments. The math faculty were already engaged in interdepartmental preservice activities through the math education option. By contrast, the STEM faculty, while already involved in TNE committees and other K–12 professional development, were not as directly involved in preservice curricula or programming. While SCALE brought these STEM faculty into a collaborative arrangement with education faculty, it was to design and facilitate the institutes, and not to work on preservice issues. At this point, there are no new interdepartmental collaborations regarding preservice programming as a result of SCALE activities at CSUN, although these new professional relationships may prove to be influential on these programs.

### *SCALE Has Had Mixed Results in Engaging STEM Faculty Who Are Directly Involved in Preservice Course Requirements*

In evaluating the potential effects of SCALE on the quality of preservice course sequences and student learning, there are two ways to assess the impact of STEM faculty on students who are preparing for careers in teaching, and both involve identifying where faculty-student contact occurs. One way to identify faculty-student contact is to focus only on designated K–12 teaching career tracks. A second way is to assume that this contact might take place in any STEM course, as any student who takes STEM courses may eventually decide to prepare for a teaching career. We cannot assess the impact of this second type of faculty-student interaction because we have no way to determine which courses are taken by people who are likely to become teachers. We therefore must focus on those STEM courses that we know are included in designated teacher

preparation pathways. In particular, we consider the courses that a total of seven STEM SCALE faculty taught in fall 2006 that are included in the designated pathways described below.

***Traditional credential program, ACT program, internship program.*** As previously noted, the structure of the traditional 5th-year teacher credentialing programs in California and at CSUN effectively separates the content preparation conducted in STEM departments and the pedagogy instruction conducted in the College of Education. As a result, all of the 544 students enrolled in 5th-year credentialing programs in fall of 2005 had no coursework outside the College of Education. This situation also applies to the ACT program and the internship program. Thus, no SCALE STEM faculty were in contact with any of these students or programs.

***Liberal studies teacher preparation options.*** The liberal studies program is by far the most popular undergraduate major at CSUN, particularly the teacher preparation options including the pre-credential, freshman ITEP, and junior ITEP options. In numerical terms, the most significant point of contact between STEM faculty and preservice candidates at CSUN is in the lower division requirements of liberal studies majors. This means that STEM faculty are most directly involved in training future elementary school teachers, and not future high school math and science teachers. In fall 2006, four of the seven SCALE STEM faculty members taught the following courses (of the five required STEM courses) that were required of all liberal studies teacher preparation options:

- Basic Number Concepts—MATH 210 (also known as Math for Teachers);
- Basic Concepts of Geometry, Probability, and Statistics—MATH 310 (plus lab and taken concurrently with Math Curriculum and Methods—EED 472); and
- Biological Concepts—BIOL 102 (plus lab and taken concurrently with Seminar in Children's Learning in Science—LRS 296F).

For liberal studies students who select concentrations in general science and math, additional upper division STEM courses are required. In fall 2006, four of the seven SCALE STEM faculty taught the following courses (of the several required STEM courses) that were required of the general science and math liberal studies teacher preparation concentrations:

- Mathematical Analysis—MATH 150A;
- Basic Geometric Concepts—MATH 311; and
- Life in the Sea—BIOL 325.

Due to the structure of the program, SCALE is not engaging STEM faculty who are teaching courses required of students in the traditional 5th-year program who are on track to obtain an M/S or S/S teaching credential. However, SCALE is engaging STEM

faculty who are teaching six courses required of liberal studies students who are on track to obtain an M/S teaching credential.

***Math four-year integrated, math and geology subject matter proficiency programs.*** The FYI program in math and the subject matter proficiency programs in math and geology require students to take extensive courses in the STEM disciplines. The FYI program leads directly to a baccalaureate degree *and* an S/S teaching credential, while the subject matter proficiency programs lead to a baccalaureate degree and the satisfaction of the state requirement for subject matter expertise. In fall 2006, three of the seven SCALE STEM faculty taught the following courses that were part of these programs:

- Calculus Computer Lab—MATH 150AL; and
- Geological Sciences for Teacher Enhancement—GEOL 595.

It is important to note that the subject matter proficiency programs do not directly lead to a teaching credential. For example, the geology subject matter program prepares students to satisfy the subject proficiency requirement for an S/S credential, but there is no guarantee that students will continue on towards a 5$^{th}$-year program. In fact, a math education faculty member involved in the 5$^{th}$-year S/S math program stated that the pipeline from the CSUN math department to the CSUN 5$^{th}$-year credential program is negligible. Instead, students entering the 5$^{th}$-year program either are adult career switchers or received their undergraduate degree at another IHE.

As stated previously, it is important to note that STEM faculty outside of these designated preservice programs may also have contact with future K–12 teachers, since many students do not decide to become teachers until they are late in their undergraduate program or return to IHEs for additional coursework as adult career switchers. For example, the general studies option in the liberal studies program includes several STEM courses, and STEM undergraduate majors must take extensive coursework in their disciplines. In light of this fact, it can be argued that all STEM faculty may in fact teach students who eventually seek a teaching credential. Yet it remains impossible to verify or quantify the number of such students exposed to these courses and STEM faculty pedagogical approaches.

***Co-construction of activities.*** As previously noted, significant levels of interdepartmental collaboration between STEM and education faculty were fostered through the liberal studies program and TNE prior to SCALE's arrival at CSUN. What differentiates SCALE from these existing collaborations is the nature of the tasks undertaken by these prior committees or teams, which tended to focus on curriculum design or faculty development. There appears to be little precedent for collaborations such as those fostered by SCALE in which STEM and education faculty participate in pedagogical training sessions and co-facilitate professional development workshops for K–12 teachers. One of the outcomes of fostering professional communities is the creation of cohorts within institutions that have the capacity to continue similar efforts into the future. A primary goal that SCALE leaders hold for the science immersion units is to help K–12 curriculum designers develop the internal capacity to continue these efforts after

the SCALE grant expires. Based on preliminary findings, it appears that the faculty currently participating in SCALE, TNE, and the California Science Project constitute a population of skilled IHE faculty who represent the internal capacity of CSUN to carry out the SCALE goals in coming years.

## Promoting IHE and K–12 Inter-Institutional Collaborations for Professional Development

### *Institutional Context*

Similar to the above-mentioned goal areas, in the venue of IHE collaboration with K–12, there is a long and fruitful history of institutional and individual collaborations at CSUN. While the faculty workload and pressure to publish make participation in service challenging, the institutional environment and the presence of enthusiastic colleagues make it easy for many faculty to participate in programs such as SCALE.

The institutional barriers and supports most relevant to this finding are:

- External environment
    - Awareness of local educational issues (+)
    - Few policies governing the quality of K–12 professional development (-)
    - Faculty skepticism about the efficacy of professional development (-)
- IHE-specific elements
    - Institution-wide structures and policies
        - Faculty concern about increasing emphasis on publications for RTP (-)
        - Workload that is heavy and not amenable to service (-)
        - Assigned or released time that varies (+/-)
    - CSUN cultural elements
        - CSUN's strong identification with serving K–12 sector (+)

### *Preliminary Effects of SCALE*

#### *SCALE Is Influencing How IHEs Approach Their Interactions with K–12*

Despite the tradition of K–12 involvement at CSUN, SCALE represented a new type of collaboration. Where previously STEM faculty provided content expertise for professional development or outreach programs, with SCALE they were forced to model

a new pedagogical approach that merged content and pedagogy. Where previously education faculty had mentored preservice teachers or conducted research in K–12 venues, they too were placed in the unusual position of modeling a STEM-based active-learning pedagogy. Another difference from previous professional development experiences observed by a respondent was the close collaboration with LAUSD science experts as equal partners in designing and facilitating the science institutes.

STEM faculty at CSUN corroborated that through their participation in SCALE, they developed a better understanding of the diverse learning styles and abilities of K–12 students. While this realization itself may not translate into any immediate behavior changes, respondents noted that it brought to life the difficulties K–12 teachers face in improving math and science student outcomes, difficulties STEM faculty may also face with their undergraduate students. According to Carlone and Webb (2006), this type of understanding is a key element in defusing the hierarchy model of professional development.

### *SCALE Brings a New Type of Professional Development*

As previously noted, CSUN has a long history of involvement with professional development for K–12 teachers (e.g., the California Science Project). These K–12 interactions are institutionalized in that they are integrated into faculty workloads through grant-financed buyouts or summer stipends and accepted by the institutional culture. Thus, SCALE entered into an environment where professional development for K–12 was viewed not as an aberration, but instead as an essential and valued expression of the university's mission. However, SCALE is a new type of professional development, involving more time, energy, and participation as learners by the faculty. As noted above, traditional professional development utilizes IHE faculty as "experts" and rarely engages them as learners. One effect of the increased involvement through SCALE is the diffusion of science institute methods into existing professional development workshops on campus, thereby increasing the population influenced by SCALE.

### *SCALE Is Influencing Other Professional Development*

Since many of the same faculty participated in the California Science Project, SCALE, and TNE, there was ample opportunity for the diffusion of methods among programs. For example, two respondents who participated in SCALE one week and in the CSP the next reported using instructional methods learned from the immersion units in the CSP sessions.

## E. ANALYSIS OF INDIVIDUAL AND INSTITUTIONAL CHANGE PROCESSES

This assessment of SCALE's effects on the policies and practices of CSUN, as identified in previous sections, is intended to gauge the processes of institutionalization of the SCALE MSP. As previously stated, affecting change in IHEs is particularly difficult, and it is unrealistic to expect SCALE to affect change in core policies and practices at CSUN in only one year. Furthermore, it is of note that the longevity and

efficacy of externally funded change initiatives such as SCALE have been questioned (Tobias, 1992); it is not yet clear to what degree reform efforts such as these influence the core policies and practices at IHEs or merely operate on the periphery.

## Existing CSUN Change Processes

At CSUN, SCALE is not the only reform initiative, and the TNE project stands out in its explicit targeting of a core institutional structure—faculty positions—as a method to meet its reform goals. As such, TNE is already institutionalized and will continue to have an impact at CSUN long after its conclusion.

> This isn't like somebody got a grant and it's their isolated project. This is much bigger than that. We're hiring TNE faculty. These are permanent hires. This stuff isn't going to go away. (College of Science and Math administrator)

In contrast, SCALE is focusing its resources not on institutional structures, but on individual behaviors and attitudes through participation in the math and science institutes. Thus, SCALE may be having an impact on the attitudes and practices of individual faculty and affecting how STEM courses are taught. In Phase 2 of this case study, we will focus on the question of whether these SCALE effects are diffusing to other faculty or influencing curriculum policy.

## Assessment of SCALE Theory of Change

A preliminary assessment suggests that SCALE leaders are using the following implicit theory of change at CSUN:

> Plant small seeds of change at the points in the system deemed most likely to eventually yield large changes, and do so by building on and collaborating with other change initiatives (at CSUN and in other institutions) that complement SCALE goals and by identifying and working with individuals already interested in these goals.

Thus far, the key point in the system that we have identified is individual faculty, whose exposure to new pedagogies may bear fruit in later years and in unforeseen ways.

This approach to organizational change is known as the *campaign approach to change*, which involves mobilizing people around a strategic theme that has staying power at a particular institution (Hirschhorn & May, 2000). This approach commonly involves "piggybacking" on existing reform efforts, capitalizing on their resources and momentum. The strength of this approach is that the main actors involved in SCALE at CSUN are able to identify opportunities for when and where to leverage resources. These may include combining resources with those of other change efforts or institutions to achieve like goals or seizing an opportunity, such as a sympathetic new department chair or dean, to promote a reform agenda. The approach also presents challenges. First, leaders must have a deep understanding of the institutions involved and extensive collegial networks that enable them to constantly obtain information about new developments that may provide high-leverage opportunities for change. Second, leaders

must constantly adjust to the changing situations facing their K–12 and IHE partners. Third, leaders may get too far out in front of others as a result of moving too fast to allow for consultation and co-development processes. Finally, it is difficult to know if and when a project is meeting its own criteria for success if goals, objectives, and strategies are not clearly stated prior to implementation. For the purposes of evaluation, it is important to note where SCALE has decided to leverage its financial and human resources and to investigate the efficacy of its particular approach to systemic change for each of its activities. This preliminary phase of the research only sketches out the broad outlines of these efforts. Phase 2 of this case study will investigate in greater detail the outcomes and efficacy of these approaches to change.

### *Individual Faculty Practice*

The foci of the SCALE theory of change are individual faculty and administration members. As such, it is important to understand how IHE actors make decisions and function in their professional lives. A rational view of organizational behavior might lead to the conclusion that rules and polices are the primary determinants of individual behavior and practice, but researchers from a variety of fields have found that this is not the case. Birnbaum (1988) posited that different people have different perceptions about critical issues such as student performance, institutional goals, and pedagogy, based on differences in background, training, discipline, experiences, and roles. In the face of a constant stream of ambiguous stimuli, it is up to individuals to finally make sense of their environment and make decisions about how to act. According to Bourdieu (1977), this sense- and decision-making practice is governed both by an individual's habitus, or their personal disposition and background, and by the socially structured system of cognitive and motivating structures that constitute the individual's professional environment. This view of practice in higher education holds that an individual's behaviors are governed first by their own sense-making processes, as informed by their habitus and motivating structures, and second, by the objective rules and policies of an institution. We propose that faculty become engaged in teaching and learning issues upon making sense of many factors present in their immediate professional environment, ranging from all the contextual factors presented in the above sections (external environment, CSUN structures and policies, programs, reform initiatives, and cultural elements) to personal factors such as their educational backgrounds and personal views on K–12 education.

Efforts to improve STEM undergraduate education and promote K–12 partnerships should be understood in the larger context of the widespread perception by faculty that their professional lives are overwhelmingly busy with research, teaching, and service responsibilities (Millar, Clifford, & Connolly, 2004). Such efforts are especially pertinent in the CSU system, where the respondents believe the faculty workload is daunting. For this reason, we propose that faculty negotiation of the numerous demands on their time is one of the most important sense- and decision-making challenges they face, requiring that they prioritize activities based on political, economic, and professional reasons. For this reason, we also propose that this context is one of the most salient for SCALE administrators and practitioners to understand, as it exerts a tremendous influence on the ability of faculty to participate in reform activities.

### *Questions About the MSP and SCALE Theory of Action*

Several respondents, particularly from the College of Education, questioned a key element of the MSP theory of action—namely, that STEM faculty should be directly engaged in preservice, induction, and in-service teacher preparation activities. While the respondents agreed with the rationale behind this approach and with the proposition that STEM faculty need to be more substantively involved in teacher training, they disagreed with the lack of explicit engagement with education faculty.

> I don't necessarily feel like the answers to our K–12 educational problems, and we have many problems, are going to be found in the subject matter specialists at the university level. I mean, in some ways I don't like that premise, and of course, I'm in education so I sometimes find it insulting. I don't think that the problems are mainly content knowledge and that's really what the subject specialists have. I think that these efforts that directly link university professors and the K–12 teachers and kind of sidestep the whole teacher preparation process and group [of faculty engaged in that] are a big mistake. And it's a mistake on a big scale, because it is a mistake for political reasons because we're already under the gun and not valued particularly highly and efforts like that I think just feed that [perception]. (College of Education faculty)

An additional critique voiced by both STEM and education faculty is that the most viable and effective role for STEM faculty in improving math and science teacher training is in their own undergraduate courses, and not in preservice curriculum design or K–12 professional development. Other respondents were of the opinion that the answers were not yet clear and that easy solutions that distract researchers from better understanding the role of IHE faculty in the dynamics of learning should be avoided.

> We know that there are teachers really trying to teach mathematics but learning simply is not happening. Arts and science faculty should be in the schools— like math faculty, science faculty, sociology faculty, and psychology faculty, as well as the education faculty—to actually find out what inhibitors are impacting teaching and learning. Is it that families don't care about education? Is it that teachers don't know their content? Is it that the teachers don't know how to adapt their content to the environment they're in? Is it they don't know their environment? Yes, faculty in the arts and sciences needs to be involved, but they do not need to replicate what teacher education faculty are doing. They need to fill a vacuum. I'm not quite sure what that is, we are working on it. (College of Education administrator)

This sentiment echoes a question that several faculty voiced, as to whether involving STEM faculty in teacher training would necessarily result in improved student learning. Some respondents in both colleges cited other factors, such as support for teachers in disadvantaged schools and the student's family environment, arguing that a singular focus on STEM faculty and improved content knowledge is an inadequate response to a complex problem.

### *Questions About Which STEM Faculty to Engage*

There are two ways to view STEM faculty engagement in preservice programs. First, we may consider designated preservice teaching pathways as a way to identify

students who are on a K–12 teaching career track and focus pedagogical reform efforts intended to influence future K–12 teachers only on the few STEM faculty who teach courses in these programs or sequences. Alternatively, we may take the view that students who later enter the teaching profession may take any undergraduate STEM course that is offered and thus focus reform efforts on all STEM faculty.

The liberal studies program is the largest undergraduate major and pipeline for future elementary school teachers at CSUN. It requires only five STEM courses (unless a student elects to concentrate in a STEM discipline), and thus only a few STEM faculty have opportunity to influence these students. Our analysis indicates that six out of the seven STEM faculty participating in SCALE taught six courses required of liberal studies students who are on track to obtain an M/S teaching credential in fall 2006. It appears, therefore, that SCALE has made a judicious and highly leveraged choice for how to use its limited resources to influence future elementary level teachers.

Far more STEM courses are required for students in the designated preservice pathways to secondary-level math and science teaching careers and for STEM majors who may ultimately decide to become K–12 teachers. As a result, it is more difficult to identify specific STEM faculty and courses that would have an impact on this cohort of potential preservice candidates. In this case, the more diffuse strategy of engaging all STEM faculty may be more appropriate. However, as our analysis indicated, three factors should be considered regarding this strategy:

1. There are relatively few science majors at CSUN, and recruitment is a top priority.

2. Most S/S teaching credentials at CSUN are awarded through the traditional 5$^{th}$-year program operated out of the College of Education, in which no STEM faculty participate. Respondents indicated that the pipeline from undergraduate STEM majors to this program is minimal.

3. An increasing number of S/S credentials in California are being recommended by private universities.

Each of these factors leads us to question the effectiveness of the more diffuse strategy of engaging all STEM faculty in pedagogical improvement on the assumption that some subset of all students in all STEM courses will someday become K–12 teachers. In our view, this strategy is a less direct and effective approach than attempting to influence a designated cohort of students. In this regard, we agree with Treisman (as quoted in Millar & Alexander, 1996), who has argued that since most career switchers who choose to enter the K–12 teaching workforce completed their undergraduate degrees many years before making their switch, a more effective time to improve their math and science content and pedagogical knowledge would be during induction programs.

Another argument for focusing reform efforts at the individual faculty level has to do with the role that individual faculty leaders may play in effecting change at their IHEs. As one respondent noted, the cohort of faculty currently engaged in reform at CSUN were particularly inspired by an individual faculty member who made it acceptable and

even desirable to become engaged in K–12 education and pedagogical activities as an IHE faculty member.

> Steven Oppenheimer has done a tremendous amount in establishing the foundation, and then the rest of us are running with the ball that he tossed our way. Collaborations like TNE or the California Science Project and others happen because of the foundational efforts of established faculty. . . . He's been an important resource for many of us in these collaborative efforts. His contacts have become our contacts, using his well-established network has made things much easier, and it's given us a tremendous amount of credibility. He's established lines of trust with the community that I think we're taking advantage of. (Life sciences faculty)

This example underscores the role that senior faculty who have significant external funding, social status within their departments, and professional networks may play in SCALE and other reform efforts. Known as *radicalized seniors*, these faculty members are able to become STEM education innovators within an unforgiving institutional context. Their role bears further study (Millar, 2003).

### *Questions About Assumption That Pedagogical Problems Lie with STEM, Not Education, Faculty*

Most respondents either explicitly or implicitly conveyed the belief that improvements in instructional practice at CSUN were required in the STEM disciplines, but not in the College of Education. Some respondents assumed that education faculty were experts in theories of student learning and inquiry-based pedagogies and that this knowledge was sorely lacking among STEM faculty. As previously noted, a SCALE staff member contradicted this sentiment by observing a general lack of proficiency with active-learning methods among both STEM and education faculty. In fact, this respondent felt that only the K–12 teachers were skilled at modeling the inquiry-based pedagogy and that the education faculty were the most resistant to putting these methods into practice. Since College of Education faculty have the most intensive contact with preservice candidates, we consider this finding somewhat troubling, particularly because most efforts to improve preservice training are directed at STEM, not education, faculty.

## F. DISCUSSION AND ANALYST RECOMMENDATIONS

This section provides several analyst recommendations for SCALE program administrators and program planners. These recommendations are based entirely on the analysts' interpretations of the data collected for this report and focus on limitations and opportunities inherent within the institutional context of CSUN. As such, these recommendations do not reflect an intimate knowledge of specific SCALE program activities in the field and primarily are intended to illuminate key areas of the CSUN landscape that bear considering for the future.

### Recruit Other Faculty to the IHE Cohort Committed to Improving K–12 Education

The cohort of pedagogy-minded STEM and education faculty at CSUN, who have worked extensively through the liberal studies program, TNE, and SCALE, has been discussed at length in this case study. The importance of fostering a professional community among faculty engaged in teaching and learning issues cannot be overemphasized. In order to encourage the long-term viability of the SCALE goals at CSUN and develop the internal capacity of CSUN to enact further reforms, additional faculty and administrators will need to be recruited. In Phase 2 of this research, we will examine if and how this may be accomplished.

At this early stage, however, a single leverage point that would facilitate the recruitment of other STEM and education faculty stands out: reduce the teaching load through released or assigned time. As previously discussed, CSUN faculty are required to teach 12 units a semester, or four courses plus office hours and related administrative responsibilities. This high teaching load has made service activities for several non-SCALE respondents completely infeasible. If released time were granted to specific, well-placed faculty—much like the TNE project grants released time to faculty to work on pedagogical reforms and curriculum development—we believe more faculty would readily be recruited into the existing cohort. To further "sweeten the pot," guidance in how to write pedagogy-based articles or to participate in research that could result in publications would be particularly enticing for junior faculty. The academic community at large would also likely hold the professional community devoted to improvements in teaching and learning in higher regard if members of the latter community increased the number and quality of their publications.

### Improve the SCALE Points of Contact with Preservice Students

As previously noted, few STEM faculty are directly involved in designated preservice programs or courses. As a result, involving STEM faculty does not necessarily translate into affecting preservice students, unless a broader view of preservice students is taken. If SCALE hopes to make an immediate impact upon designated preservice teacher candidates and their existing course sequences, SCALE leaders should identify and seek to engage those STEM faculty who are most involved in the liberal studies program or in STEM major courses with waiver programs. By using the aforementioned strategy of offering released time and the prospect of research publications, SCALE can engage these individuals, plus education faculty who are deeply involved in the teacher preparation process, and thereby increase the chances for their active and prolonged participation.

### Make Activities Responsive to the Local Context to Maximize Institutional Adoption

By analyzing the institutional context of CSUN related to the four SCALE goals, we hoped to highlight the major issues of concern to local actors (e.g., low numbers of STEM majors, demanding workload). Paying attention to these concerns and the

configuration of the policy and program environment in which CSUN exists may improve the chances that SCALE and other reform initiatives will be adopted and institutionalized by the local partner institutions. We understand that current federal funding practices often foreclose the possibility of conducting needs assessments or institutional analyses such as the IHE Case Studies prior to program design and implementation. However, such knowledge would improve the likelihood of program success and sensitivity to local matters. For example, in the course of this research, we identified two critical elements—a local representative and sensitivity to LAUSD teacher needs—that would improve the sensitivity to the local context (see below).

### *Identify Faculty Member Who Could Act as Local CSUN Representative*

SCALE activities at UW-Madison and CSUDH are administered by IHE faculty members who are "experts" about their institutional settings and thus know the key individuals, emerging trends, and potential pitfalls. However, SCALE does not have a similarly situated leader at CSUN and thus is less likely to learn of many of the facets of institutional life analyzed in this case study. Perhaps the most beneficial role a local expert plays is identifying faculty who are most amenable to participating in a reform initiative and most well placed to effect change. Other benefits to engaging a local representative include the individual's familiarity with the actual teaching pathways at an IHE, understanding of which STEM and/or education faculty are in direct contact with preservice students, and knowledge of who is positioned to change program curricula or requirements.

### *Pay Attention to Issues Facing Beginning Teachers in LAUSD*

Several respondents in both STEM and education departments referred to the challenges facing beginning teachers as they enter the workforce. These respondents felt that there were considerable challenges beyond content expertise in math and science that should be addressed, and the most commonly mentioned topic was race. Respondents noted that the diverse student body of LAUSD, particularly in low-income areas of Los Angeles, presented teachers, and especially new teachers, with unique challenges, including non-English speakers, school and neighborhood violence, poor parental involvement, and schools with insufficient materials. Furthermore, some respondents stated that the ethnicity of the teacher workforce itself posed some challenges.

> Obviously, many of our local teachers are White, middle class individuals who are working in environments in which, sometimes, they are not comfortable—or more importantly, they do not understand. We are one of the 10 largest Hispanic-serving institutions in the country, but the percentage of students with Hispanic heritage in our teacher preparations does not reflect the diversity of students on our campus. Even we have a way to go on the issue of bringing underrepresented populations into the teaching profession. (College of Education administrator)

However, teachers and teacher educators have limited resources in preparing their students for these environments. Much of the literature in multicultural education is focused on addressing the attitudes of White preservice teachers, and is disjointed and

poorly developed regarding best practices in teacher preparation for culturally diverse classrooms (Sleeter, 2001). Solutions to these issues mentioned by respondents include properly mentored field experiences that enhance preservice teacher readiness for teaching diverse populations (Proctor, Rentz, & Jackson, 2001) and ongoing professional development efforts that provide continual support and strategies (Luft & Roehrig, 2005). This latter issue is particularly relevant to SCALE and points to the importance of ensuring that professional development programs include a focus on how to effectively teach and manage math and science content in today's ethnically diverse LAUSD classroom.

## Explore Synergies Between TNE and SCALE

Besides helping to create an institutional climate of reform conducive to SCALE, the TNE project is engaged in some activities that are remarkably aligned with the SCALE goals. One of these is the newly formed partnership between CSUN, CSUDH, CSU Long Beach, and CSU Los Angeles to work collaboratively on evaluation, field placement, and STEM faculty engagement in teacher preparation pathways. Since SCALE is engaged with both CSUN and CSUDH on similar topics and plans are in place to create a more formal CSU consortium in the Los Angeles Basin, this partnership represents an existing high-level beginning to this effort. Other activities already under way include (a) a longitudinal analysis of the effects of different CSUN teacher preparation pathways on pupil achievement and (b) surveys that assess the pedagogical content knowledge of students in course sections of physical science and math for teachers. Findings from these research activities will contribute to the knowledge base on the efficacy of different pedagogical approaches to teacher training and their long-term impacts on K–12 student outcomes. This information will illuminate aspects of the IHE environment as they pertain to SCALE goals that are not being analyzed by the SCALE Research and Evaluation Team (or other MSPs, to our knowledge), and thus will be of great import for the ultimate evaluation of the MSP initiative.

## Explore Aligning the SCALE Institutes with the BTSA Program

Currently, there are few regulations requiring, or incentives encouraging, K–12 teachers to participate in professional development trainings. While teachers in LAUSD are required to participate in regular on-site professional development sessions, the primary policy incentives for teachers to participate are the award of "salary points" that will increase their wages and satisfaction of the CCTC requirements for a professional clear credential. The only two programs that have some policy leverage over professional development are the California Beginning Teacher Support and Assessment (BTSA) program and the National Board for Professional Teaching Standards, both of which have established professional development requirements for the completion of their respective licenses and issued general guidelines for professional development quality. Thus, once teachers satisfy the professional clear credential requirements, beyond the mandated district professional development sessions that occur on-site, the only incentive for them to attend a professional development session is driven by financial considerations and not policy. According to our analysis, the BTSA program is the most propitious leverage

point for both institutionalizing the SCALE math and science institutes at LAUSD and reaching the maximum number of teachers within LAUSD. Additional study will also need to be conducted about the decision-making processes within LAUSD regarding the selection of professional development providers and curriculum in order to adequately understand the supports and constraints governing this important aspect of the teacher training continuum.

## G. NEXT STEPS

The next phase of this research will include field-testing the preliminary findings presented in this report. Specifically, the "network fragments" composed of the contextual variables influencing the SCALE goals will be tested with CSUN respondents to ascertain their accuracy. The final case study will also focus on investigating several questions raised in this study. These include:

1. How are the systems of preservice, induction, and in-service training for K–12 teachers aligned among the relevant organizations and/or agencies? What impact does the degree of alignment have on SCALE activities?

2. What impact does the growing presence of part-time and adjunct faculty have on SCALE and its goals?

3. Do faculty and administrators regard the communities of practice emerging around pedagogical reform with the same respect as research communities?

4. Are additional STEM and education faculty being recruited for SCALE activities? If so, are they becoming part of the cohort of reform-minded faculty?

The final case study of SCALE activities at CSUN will also include a summative evaluation of the SCALE MSP at CSUN.

## Appendix 1: IHE Case Studies Data Sources for Measures

Kinds of Data for Units of Analysis

| | Kinds of Data / Unit Being Characterized | Document Analysis: Review of Environmental Data | Document Analysis: Review of IHE Policies & Official Documents | Document Analysis: Review of Academic Program Structure & Data | Document Analysis: Review of Reform Initiative Documents | Document Analysis: Review of Mission Statement, IHE Official Documents | Observations: Observation of IHE Events | Observations: Observation of SCALE Meetings | Interviews: Interviews w/IHE Faculty, Staff, & Administrators | Interviews: Interviews w/SCALE Participants |
|---|---|---|---|---|---|---|---|---|---|---|
| SCALE MSP Partner IHE | 1. External Environment | Environmental Properties | | | | | | | Environmental Properties | Environmental Properties |
| SCALE MSP Partner IHE | 2.1. Institution Wide Structures & Policies | | Structural & Policy Properties | | | Structural & Policy Properties | | | Structural & Policy Properties | Structural & Policy Properties |
| SCALE MSP Partner IHE | 2.2 Academic Programs | | | Program Properties | | | | | Program Properties | Program Properties |
| SCALE MSP Partner IHE | 2.3 Reform Initiatives | | | | Reform Initiative Properties | | | | Reform Initiative Properties | Reform Initiative Properties |
| SCALE MSP Partner IHE | 2.4 Cultural Elements | | | | | Cultural Properties | Cultural Properties | Cultural Properties | Cultural Properties | Cultural Properties |
| SCALE MSP Partner IHE | 3. Individual Practice & Sensemaking | | | | | | Individual Practice Properties | Individual Practice Properties | Individual Practice Properties | Individual Practice Properties |
| MSP Project | SCALE | | | | SCALE Properties | | | SCALE Properties | Self-Reported Experiences & Outcomes | Self-Reported Experiences & Outcomes |

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