# Leadership and Commitment to Educational Innovation: Comparing Two Cases of Active Learning Reforms

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*Several studies have shown that student-centered instruction can help improve student success and persistence in STEM-related fields (e.g., Freeman et al., 2014). Despite this, institutional change can be difficult to enact. Accordingly, it is important to understand how departments both initiate and sustain meaningful change. For this paper we use interview data collected in Spring 2017 to examine how institutional and departmental factors affected reform efforts at two different institutions. In particular, we compare how two universities' leadership and commitment to educational innovation contribute to the initiation, implementation, and sustainability of active learning in the undergraduate calculus sequence (Precalculus through Calculus 2).*

*Keywords:* Active Learning, Institutional Change, Calculus Reform, Undergraduate Mathematics, Case Study

## Introduction

Universities are increasingly concerned with student retention, graduation rates, and overall student success. While much more is known now about effective instructional practices and campus structures to support student success, institutes of higher education are slow to change (Kezar, 2014) and faculty have not widely adopted such research-based practices (Stains et al., 2018). Student-centered instructional practices that address not just student learning but also attitudes, beliefs, motivation and goals, are connected with increased student success and persistence in mathematics and related fields (e.g., Freeman et al., 2014). However, some faculty and some universities are changing, exhibiting culture shifts that value instructional improvement efforts.

We present two cases of large land-grant universities that have transformed instruction in lower-level mathematics courses via a comprehensive approach to cultural and instructional change. In both cases, these reforms started with a focus on Calculus 1, and then grew to encompass Calculus 2, Precalculus-level courses, and other multi-section courses. The changes included attention to instruction and instructors; this case study focuses specifically on the department and institution level changes. These cases are drawn from a larger set being developed by a collaborative National Science Foundation project: Student Engagement in Mathematics through an Institutional Network for Active Learning (SEMINAL). SEMINAL is studying how mathematics departments successfully incorporate active learning into their calculus sequence courses and how to guide other departments looking to institute similar reforms.

## Literature and Theoretical Framework

Change efforts to improve student outcomes necessarily include a classroom instruction focus. However, to achieve cultural change, instructional improvement efforts also need to have components at the department, campus, and community levels (Elrod & Kezar, 2016). When faculty seek to improve instructional practices, they rightly tend to focus on instructional materials, activities and tasks, assessments, mathematical coherence and structures that allow students to communicate their reasoning (e.g., MAA, 2017). They may also focus on developing norms for mathematical discussions (e.g., MAA, 2017; Smith & Stein, 2018). Departments focused on instructional improvement and equitable student outcomes may initiate or refine course coordination efforts (Bressoud, Mesa, & Rasmussen, 2015) and provide instructional training and mentoring. All of these changes require significant investment of time and other resources, along with a commitment to improvement; lack of widespread support for such efforts will undermine them (Kezar, 2014).

The foundation of effective change efforts is the development of a common vision among stakeholders (Elrod & Kezar, 2016). Stains et al. (2018) summarize effective instructional practices as ones that focus on actively engaging students. The heart of the transformation efforts enacted by these two departments of mathematics is the effective use of active learning strategies, defined as: (1) students learn mathematics by engaging in challenging, cognitively demanding tasks; (2) students routinely communicate (orally and in writing) their own reasoning and engage with the reasoning of others; (3) instructors attend to and make use of student thinking to advance the mathematical agenda; and (4) instructors are explicitly attending to issues of diversity, equity, and inclusion (Laursen & Rasmussen, 2018). While not explicitly labeled "active learning," these principles are also embodied in the recommendations of the MAA's recent *Instructional Practices Guide* (2017).

At both the department and campus levels, when the culture supports instructional innovation, the environment is more favorable for faculty and departments to invest in course improvements (Kezar, 2014). Bergquist and Pollack (2008) suggest culture is a lens through which faculty members understand their universities: "A culture provides a framework and guidelines that help to define the nature of reality - the lens through which its members interpret and assign value to the various events and products of this world" (Bergquist & Pawlak, 2008, p. 7). Culture as lens can be a useful framework, but to capture the dynamic aspects of culture, additional dimensions are necessary.

Apkarian and Reinholz (2018) provide a higher education adaptation of four frames through which to understand institutional culture: *people*, *power*, *symbols*, and *structures*. The symbolic frame of culture includes the values, beliefs, and attitudes of the various stakeholders in the system. By also considering the power dynamics, the people involved, and the structures of the institution, this framework can support understanding of educational cultures and cultural shifts.

In this paper, we focus specifically on two cross-cutting dimensions of institutional culture: leadership and commitment to educational innovation. Both of these dimensions span the four frames (Apkarian & Reinholz, 2018). Leadership includes the people in formal and informal positions (*structures*), their beliefs and values (*symbols*), and the interrelated *power* dynamics of leadership relationships. The value placed on instructional improvements by a campus includes the values and beliefs related to the importance of improving teaching and learning (*people* and *symbols*) and resources to support instructional improvements (*power* and *structures*).

## Purpose and Research Questions

The SEMINAL project's overall research question is: What conditions, strategies, interventions and actions at the departmental and classroom levels contribute to the initiation, implementation, and institutional sustainability of active learning in the undergraduate calculus sequence (Precalculus through Calculus 2—P2C2) across varied institutions? The purpose of this research is to compare the commitment to reform efforts focused on active learning strategies, and the particular leadership roles of departmental and campus administrators in the initiation, implementation and sustainability in improvements in P2C2 courses. Thus, the research question guiding this study is:

> *How do leadership and commitment to educational innovation contribute to the initiation, implementation, and sustainability of active learning in the undergraduate calculus sequence (Precalculus through Calculus 2) compare between Big State University 1 and Big State University 2?*

## Methods

SEMINAL is a 5-year NSF-funded mixed-methods research project studying the initiation and sustainability of active learning in mathematics in two phases. Phase 1 focused on retrospective case studies of institutions that have sustained active learning reforms for at least three years. Phase 2 focuses on incentivized case studies of institutions in the midst of reforms. Data for this paper draw on two of the Phase 1 institutions: Big State University 1 (BSU1) and Big State University 2 (BSU2).

Data was collected at site visits in Spring 2017. During these visits four researchers collected qualitative data including audio-recorded interviews with campus administrators, tenure track and non-tenure track faculty within the math department, postdocs, graduate students, course coordinators, faculty from client disciplines, and undergraduate students. Each interview was transcribed and coded in MAXQDA 12. The initial framework for code categories (e.g., coordination, department leadership, professional development, etc.) was drawn from the grant proposal, which in turn was informed by Bressoud, Mesa and Rasmussen (2015) and institutional change literature. This same framework was used to design the project's data collection plan, including interview protocols. Researchers used an iterative process to generate sub-codes for each category. Each transcript was individually coded by at least 3 people, followed by reconciliation (Creswell & Poth, 2018).

After coding, individual researchers were assigned categories of codes (e.g., coordination) and constructed reports of facts and emerging themes (Creswell & Poth, 2018). Researchers then exchanged reports and codes for additional reconciliation. Using these reconciled reports, and other documents provided by each site, researchers drafted thick descriptions for both institutions to make a side-by-side comparison for this comparative case study (Stake, 1995).

## Findings

In this section we describe the initiation, implementation and sustainability of reforms through the lens of leadership and commitment to educational innovation.

### Initiation of Change and Implementation of Reforms

**Stimulus for Change**. In order to incorporate active learning into their P2C2 programs, both math departments began with Calculus 1. BSU1's motivation for change came internally: two department leaders wanted to change the structure of the Calculus 1 recitations after observing graduate students solving problems in front of disengaged students. Therefore, these two leaders

initiated reform efforts focused on increasing coordination of recitations; making recitations more meaningful by transforming them into sessions with active learning where students would work cooperatively on common projects; many of these projects focus on building conceptual understanding by incorporating high cognitive demand tasks (Stein et al., 2000).

Unlike BSU1, the BSU2 department received top-down pressure to "fix" Calculus 1 due to student complaints and low pass rates. While motivation was, in part, external, the reforms were initiated in large part because the department was willing to change; one campus administrator noted other departments had been similarly pressured without comparable positive results. The department chair and a faculty member who was interested in technology planned the changes they wanted to make, and purposefully sought external resources to support their plans. The latter worked with two other faculty to apply for an NSF grant, which they received in the early 1990s. The grant was used to pilot Hughes-Hallett et al.'s (1994) *Calculus* and introduce new technology into the classroom.

**Leadership and Commitment Following the Initiation.** Since BSU2's initial reform efforts, the math department has benefited from "departmental support [which] has been unwavering." At the time of initial reforms, other departments on campus were not trying to "fix" their courses in the same ways as BSU2's math department. After early pilots, leaders in the reform became "vigilant" in attending workshops on effective implementation with technology and active learning. These leaders were described as "evangelists," people who were able to articulate and defend positive outcomes of this type of model for teaching. When state appropriations for higher education declined, these "evangelists" were able to help "sway" the department and college to keep reform changes in place. Thus, while the college and department were supportive, early leaders had to make a strong effort for this support.

Prior to BSU1's changes to Calculus 1, science departments on campus had successfully implemented similar educational reforms. As a result, campus administrators were already on board with supporting change. As described above, this context was different from BSU2's neighboring departments and colleges. Leaders in the math department at BSU1 had a particularly positive relationship with one campus administrator, who was formerly an academic dean within the college. In their role as a dean, the administrator supported reform efforts by approving and allocating resources for the math department to hire a full-time coordinator to oversee the calculus sequence and protecting resources to maintain small class sizes. One mathematics faculty member stated that this administrator "in essence made the resources available to us for everything we've done in the last 4 years." This administrator supported leaders' reform efforts not only because Calculus 1 was designated a gateway course, but also because the leaders had a well-developed proposal and were "truly dedicated to improvement." Thus, while leaders from BSU1 and BSU2 received support from their departments and colleges, the difference in institution innovation at the time of changes may have impacted how leaders were able to obtain that support.

## Sustainability

For this study, we operationalize the concept of sustainability as evidence of maintaining and extending reforms, institutionalizing change, and addressing ongoing issues related to these reforms. Table 1 is a brief summary of findings related to sustainability.

*Table 1. Comparing two universities' reforms*

| | Extending Reforms | Institutionalizing Reforms | Facing Challenges |
|---|---|---|---|
| BSU1 | Calculus for Life Science | refining coordination system | mixed value of teaching |
| both | Calculus 1-3, Precalculus | hiring more coordinators, instructor meetings | initial buy-in, leadership turnover |
| BSU2 | other multi-section courses (e.g., Differential Equations) | adding pedagogical focus to instructor meetings | efforts ahead of campus shift to value teaching |

**Extending Reforms.** Reforms at both universities began in Calculus 1 then extended to other courses. Both universities followed a similar trajectory of reforming Calculus 2 next. For BSU1, leaders received an external grant which allowed them to extend active learning in Calculus 1 from one day a week to all class periods, which motivated them to change Calculus 2 in similar ways. One interviewee mentioned that some students who experienced active learning in Calculus 1 and 2 expressed a desire for similar experiences in Calculus 3, and at the time of data collection leaders were in the process of extending active learning to Precalculus and Calculus 3. BSU2 followed a similar trajectory as BSU1; at BSU2 some upper level courses were already taught with the Moore method, which perhaps allowed active learning strategies to infuse other multi-section courses more quickly than at BSU1.

**Institutionalizing Reform.** Leaders at both universities have helped implement lasting structural changes to ensure the uptake of active learning reforms. At BSU1, coordinating classes was essential to sustaining reform efforts because coordination makes it much harder for any one individual to undo reforms. The first full-time coordinator became a key leader in structuring and implementing the coordination system, and was given free rein to do so. Multiple interviewees cited them as a leader in implementing the reforms, going above and beyond what was originally envisioned for the position. This coordinator took charge of the professional development for GTAs, making it "pedagogically sound", and helped educate faculty members about active learning through an inquiry-based learning (IBL) workshop. Eventually the department hired multiple coordinators to help support the P2C2 courses.

BSU2 has also hired additional coordinators since beginning the reforms. At first, there was only one director, and regular faculty members served as coordinators on a rotating basis. "There was no official team," and "it wasn't a dedicated job, so those courses that had rotating coordinators were more variable." Eventually, more permanent coordinators were hired, which helped with the continuity and consistency of the courses. These coordinators were given significant autonomy, and one coordinator described the coordination in P2C2 courses as a "self-sustaining system."

**Facing Challenges**

Both departments have faced challenges to sustaining active learning reforms. Both departments experienced pushback from GTAs and other instructors when reforms were initiated. At this point, BSU2 experiences very little pushback compared to BSU1, perhaps due to the longer duration of reforms. In addition to buy-in, nearly all leaders at both universities have changed since reforms began. Throughout the leadership turnover, critical aspects of the

reforms have been sustained and expanded. The core reformers and outgoing leaders actively worked to ensure the sustainability of efforts with the new leaders.

Another challenge in sustaining reform is creating a culture that supports and rewards leaders in educational innovation. At BSU1, the promotion process for instructors, including the coordinators, is based on years of experience rather than merit. Unlike BSU1, BSU2 does have a path to promotion for full-time coordinators and instructors based on teaching excellence. Consequently, the coordinators at BSU2 have stayed in their roles longer, providing continuity and institutional memory. Coordinators at BSU1 mentioned feeling like "second-class citizens" at times, yet overall have maintained enthusiasm for the departmental mission.

## Discussion

### Application of the Four Frames

The institutional changes at both universities can be viewed through Apkarian and Reinholz's (2018) four frames: *people*, *power*, *symbols* and *structures*. When the math departments initiated changes, they did not just make one or two changes, but sought to understand the larger system and improve it. Such a view of the change process is aligned with what is known about effective and sustainable changes (e.g., Kezar, 2014). Both universities have exhibited strong commitments to educational innovation; such commitment is embodied in the symbolic dimensions of culture: the beliefs and values of those involved. This commitment translates into support of *people* and *structures* that perpetuate and refine the reform strategies.

Reforms at BSU1 and BSU2 started for different reasons, but it was the leadership (*people*) at both universities who utilized their *power* to create *structures* incorporating active learning in P2C2 courses. These *structures* embody leaders' personal values and commitment to educational innovation (*symbols*), and perhaps challenge other *people*'s values (*symbols*) related to teaching and learning. As mentioned in the findings, the contexts for the initial implementation of reforms were different at the two universities. BSU2's math department was one of the first departments on campus to incorporate active learning. Therefore, their commitment to educational innovation (*symbols*) was not yet widely shared with other departments. In contrast, BSU1's math department benefitted from other departments' prior efforts to improve education (*structures*) and shared values (*symbols*). Thus, it is possible that the *people* at BSU2 had to utilize their *power* and *structures* differently than at BSU1 in order to implement reforms.

We contend that sustainability is a careful balance between *people*, *power*, *structures*, and *symbols*. In particular, a reciprocal relationship between *symbols* and *structures* is apparent in the process of extending reforms. Extending reforms to multiple courses (*structures*) could influence common values (*symbols*) of students and department members. Yet, the influence of initial reforms on common values (*symbols*) could, in turn, prompt the extension of *structures* supporting reform. For example, students at BSU1 expressed interest in Calculus 3 having the same *structures* as those present in Calculus 1 and Calculus 2, perhaps because they developed a shared value (*symbol*) of those *structures*.

When institutionalizing reforms, leaders (*people*) must focus on creating lasting *structures* which embody their values and commitment to educational innovation (*symbols*), and empower others to support those *structures*. For example, at BSU2, leaders (*people*) gave coordinators the *power* to support and maintain coordination *structures*, which makes lasting change possible. Challenges to sustainability may arise and create conflicts between the four frames. When making changes to *structures*, those in *power* must carefully consider the needs of the *people*

supporting and participating in reform efforts to avoid conflicts in values (*symbols*). For instance, when instructors at BSU1 feel like "second-class citizens," despite the department's belief that they are valuable, there is a conflict in values (*symbols*), which has the potential to derail reform efforts.

**Limitations**

One limitation to our study is that BSU1 and BSU2 are not representative of all institutes of higher education. However, the experiences of these two departments who have sought to improve student outcomes via implementing active learning strategies can still be informative to other departments considering similar changes. Another limitation is that reforms at BSU2 happened in a different decade than BSU1, so it is important consider the differences in external contexts when making direct comparisons between the two departments.

**Implications**

In our analysis we focused on how leadership and commitment to educational innovation influenced reform efforts at both universities. From this discussion, it is clear that their effects cannot be fully understood by focusing on just one of the four frames. Leadership is not just about *people*. Commitment does not relate only to *symbols*. Departments seeking to make similar reforms need to broadly consider the complex systems that created the current state of affairs, as well as the interplay among *people*, *structures*, *symbols*, and *power* inherent in these systems. Effective change strategies address **all** of these dimensions, particularly at the initiation of reform efforts, and careful consideration of sustainability from the start can help ensure the long-term success of reform efforts.

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