Understanding and Enacting Organizational Change: An Approach in Four Frames

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This paper reports on an instance of change in a university mathematics department which revitalized and improved their precalculus/calculus program by implementing a series of strategies, techniques, and programs which are supported by educational research. Using the Four Frames perspective for organizational culture (Bolman & Deal, 2008; Reinholz & Apkarian, 2018), we explore how the dimensions of structures, symbols, people, and power support a rich understanding of how the department's culture supported and constrained the change initiative. We do so both generally speaking, for the entire initiative, and more in depth, regarding the development of a course coordination system. Furthermore, this case study suggests the utility of these four frames for change agents elsewhere as a tool to support the design and enactment of successful and sustainable change towards the improvement of, specifically, undergraduate mathematics education.

Key words: Institutional change, departmental culture, course coordination

Objectives & Purpose

For decades, education researchers, professional societies, and government agencies have called for educational reform in introductory undergraduate STEM courses. Many of these calls point specifically to the implementation of research based instructional strategies and programs (National Research Council, 1999, 2013; Saxe & Braddy, 2015). Although there are numerous examples of improvement initiatives, they have not had a sustained impact at the desired scale. Commonly cited reasons for the lack of success are inadequate attention to theories of change and local cultural context (Borrego & Henderson, 2014; Elrod & Kezar, 2016; Henderson, Beach, & Finkelstein, 2011; Kezar, 2014).

This paper has two main goals: (1) to help introduce the RUME community to research from organizational change, and (2) expand such research by further contextualizing it to the discipline of mathematics, which is not a typical research area for organizational change. Through these goals, we hope to contribute to a conversation with the RUME community on how to sustainably improve undergraduate mathematics education. To achieve these goals, we present a case study of change in a university mathematics department which implemented research-based programs to support student success over a period of several years. We present a story of this change which attends to the cultural aspects of the department which supported and constrained the initiative using the four frames model (Bolman & Deal, 2008). Our results suggest strategies for enacting sustainable changes in undergraduate mathematics.

Theoretical Framing & Perspective

The *Four Frames* perspective originated in organizational science (Bolman & Deal, 2008) and was adapted for undergraduate STEM department contexts by Reinholz and Apkarian (2018). In this perspective, culture is defined as "a historical and evolving set of *structures* and *symbols*, and the resulting *power* relationships between *people*" (Reinholz & Apkarian, 2018, p. 3). This definition highlights four interrelated dimensions of institutional culture as well as acknowledging that culture is historical and ever-evolving. Table 1 summarizes the definitions of each dimension and how they can relate to both the products and process of change – analytically

and for design purposes. In general, *structures* refer to observable mechanisms which determine how members of a community interact (e.g., meeting structures, teaching assignments, committees). *Symbols* include espoused beliefs, underlying assumptions, and shared values (e.g., mathematics is the purest discipline; precalculus is taken by non-majors) which are generally used by community members to guide their reasoning and give purpose to structures. The *people* frame focuses on the importance of recognizing individuals within a community, who bring their own lens, goals, needs, and identities to bear on their interactions with others in the community. The *power* frame brings to the fore ideas of how explicit hierarchies and implicit status or positioning influence community interactions and decision making.

Table 1. Definitions and aspects of the products and process of change according to the four frames perspective. Adapted from Reinholz and Apkarian (2018, p. 6).

	Description	Aspect of product	Aspect of process
Structures	Roles, responsibilities, routines, etc. which organize how people interact	A new *thing* that addresses an issue in an ongoing and sustainable way	Create incentives and support for individuals to engage in the change process and new things
Symbols	Cultural artifacts, language, myths, and values that community members use to guide their reasoning	Attitudes and beliefs that support a proposed change so that it is optimally taken up	Use language, data, and evidence that align with present ways of thinking
People	Individuals within the community and their individual needs, goals, and identities	Solutions that embody a shared vision which attends to the needs goals, and identities of many within the community	Afford individuals agency and ownership of the direction of the change initiatives
Power	Status, control, position, control, and political coalitions which mediate interactions between people	Leadership structures that promote equity by attending to the needs of diverse stakeholders and participants	Use concrete signs of success to develop and maintain the sanction of key stakeholders

In this study, we use the four frames to understand the products and process of change in a single department during a major improvement initiative. This allows for a robust story which addresses many interrelated aspects of change and culture, and how various aspects of departmental culture supported or constrained the efforts of change agents. Our experience suggests that the four frames perspective is valuable for change agents when planning and evaluating their own initiatives to increase the likelihood of sustained success.

Methodology

This three-year study took place in a mathematics department at a large public university (LPU) while the department enacted a major change initiative to align their precalculus and calculus courses with the findings of a national study of successful programs in college calculus (Bressoud, Mesa, & Rasmussen, 2015; Rasmussen, Ellis, Zazkis, & Bressoud, 2014). This paper reports on one part of a deep case study of the change initiative. Data for this paper comes from 30 interviews with 22 members of the department and university at large, several of whom were

interviewed at yearly intervals. These were semi-structured interviews, consisting of a core set of questions related to each participant's role in and perception of the mathematics department, introductory mathematics sequence, and ongoing change initiative. Observations of departmental meetings and online surveys served to contextualize each interview.

Interviews were analyzed using thematic analysis (Braun & Clarke, 2006; Miles & Huberman, 1994). The first phase of data familiarization, informed by the four frames perspective, provided a starting list of codes. Iterative rounds of tagging and coding data served to revise the coding scheme by developing new codes as ideas emerged across interviews, then to merge and combine these codes into a refined set. Once code clusters were developed, the data was re-examined to identify themes. The validity of these themes was examined using multiple qualitative validity testing procedures. This included triangulation with other data sources from the study, member-checking with a subset of the study's participants, peer debriefing for sensibleness of interpretation, and searching through the interviews for confirming and disconfirming evidence (Creswell & Miller, 2000; Lincoln & Guba, 1985; Miles & Huberman, 1994). These themes were then turned into thick descriptions, rich narratives of the themes which include quotations and context supporting each of the major ideas. The emerging themes were also considered in light of the four frames perspective, and a condensed version of these framed narratives is presented next. We also include a more detailed review of the implementation of a course coordination system, a complex undertaking which connected to many different structures.

Results – General Overview

The change initiative at LPU aimed to implement new *structures* to better support students. These included a new course coordination system, more systematic review and use of local data, the development of a GTA teaching preparation program, the implementation of active learning in GTA-led recitation and lab sessions, a new adaptive computer system for placing students into appropriate courses, and the development of a new and more dedicated tutoring center specifically for mathematics. These structures were successfully implemented. The pre-existing structures at LPU included high enrollment precalculus/calculus courses, which were taught primarily by lecturers with some tenure-track faculty involvement. During the change, each course was assigned a dedicated coordinator who holds a tenured or tenure-track position in the department of mathematics and teaches the course each term, alongside lecturers and other faculty. Change agents at LPU took advantage of the registrar's regulations to re-define the course as a lab course, which provided an extra contact hour a week in addition to the weekly recitation section without increasing the credit load of the course, so as not to interfere with credit limits that affect tuition. The implementation of a coordination system, consisting of uniform course elements (e.g., textbook, homework, exams) is one of the central changes to the ways in which the department functions in relation to the precalculus/calculus course sequence at LPU. The new structures have been implemented as a system, and the interlocking pieces of the system amplify the effectiveness of each program for supporting student success. The interlocking nature of the new system also increases the likelihood of sustainability, as the pieces depend on each other so discontinuing any one feature will affect the others.

There was no explicit attempt to change what Reinholz and Apkarian (2018) consider to be *symbols*, though some department members indicated that they hoped some shifts might occur organically. A pervasive belief that students in mathematics courses at LPU were unprepared at every level supported the implementation of a change initiative, as generally everyone in the department agreed that something needed to be done. Attitudes toward the calculus sequence are

that it is a service sequence, primarily taken by non-mathematics majors and offered as support for other STEM departments. Some department members take this up as a duty to support applied science students, while others see their duty as "weeding out" those who will not succeed in rigorous scientific programs. This attitude means that department members do not have as much interest in the details of how precalculus/calculus are taught as compared to graduate courses or upper division courses taken by majors, which limited the intensity of pushback to the initiatives. Another major aspect of the department culture from the symbols perspective is a strong belief in pedagogical autonomy and instructor independence, which made the implementation of a course coordination system more challenging. However, this was mitigated by the large number of lecturers teaching in the course sequence, and by strategic teaching assignments which moved resistors to other courses. This belief about pedagogical autonomy impacted the nature of the coordination system as well, in that the system primarily focused on uniform course elements while instructional change was pushed to graduate students teaching recitation sections.

The *power* frame highlights hierarchies within LPU and the effect of these on the change initiative. Change agents positioned their intentions in line with the university's strategic plan, and thus leveraged institutional power to gather resources and support from stakeholders in the administration. Within the department, contingent faculty have less power and respect than tenured and tenure-track faculty. One effect of this power dynamic is that, although some lecturers frequently teach multiple sections of precalculus and calculus, they were not included in the initial discussions nor planning phases of the change initiative. That these faculty bore the brunt of the coordination system reduced pushback from tenured and tenure-track faculty about the coordination, and in fact the few tenured faculty who taught in the new coordination system were the most difficult for the coordinator to keep in line. Graduate students are at the bottom of the teaching hierarchy, and they have been a major part of the change initiative – perhaps in part because they are the most pliable due to their roles in the department. The new coordination system has added to the positional leadership hierarchy, as they control over many aspects of the teaching of precalculus/calculus courses and their input on teaching assignments is taken under consideration by the department chair.

Finally, the *people* frame brings into focus the roles of individuals within the collective department community. Pre-tenure faculty have increased pressure and expectation to publish, and it is generally agreed that they will spend less time working on instruction or teaching professional development, particularly in regards to lower-division undergraduate courses. Contingent faculty at LPU are primarily part-time, and have external pressures as many of them work at other jobs (e.g., local two-year colleges). Additionally, they do not have service expectations at LPU. These contribute to their identity as not being LPU-centric, and they are less likely to participate in decision-making or committee service. There are also idiosyncratic power issues. For example, one coordinator feels strong ownership of the course he coordinates, responsibility to the students, and works tirelessly to achieve and share successes with the new initiatives. Another coordinator feels this is simply another service assignment, has little belief that the changes will make a significant difference, and does not dedicate as much time to the role. This has affected the perspectives of other faculty teaching the respective coordinated courses, and highlights the importance of clear and dedicated leadership. In light of the wide variety of people and opinions within the department, the change initiative was first outlined by a group of faculty with diverse research interests and attitudes about students, teaching, and learning. This task force negotiated many details of the planned initiatives before a departmental

vote, and in doing so avoided some of the pitfalls which might have led to a shutdown. This included the initial scope of the coordination system, and who would take on the bulk of the new strategies for instruction.

Course Coordination

The implementation of a course coordination system at LPU was a major feature of the change initiative under study, and provides a rich context for exploration using the four frames. Course coordination is also of particular relevance to mathematics departments across the country, with many universities expressing interest and recommendations for increased coherence from research and policy documents (Apkarian, Kirin, Vroom, & Gehrtz, under review; National Research Council, 2013; Rasmussen et al., in press, 2014; Saxe & Braddy, 2015). Prior to this change initiative, the P2C2 courses at LPU were entirely under the purview of individual instructors, to the extent that when multiple instructors taught a particular course in a single term they might each select a different textbook. Therefore, the implementation of a coordination system including uniform textbooks, common assignments, and common exams was a major change to the status quo for instructors. In terms of *structure*, the coordination system changed how people in the department interacted around P2C2 courses; cultural *symbols* affected how and how quickly this system could be implemented; individual *people* and their personal histories were leveraged in the design and roll-out of the system; and the leveraging of *power*, both formal (in the case of the chair) and informal (in terms of relative status).

When the idea of coordinating the P2C2 courses was first floated in the department, it was met with heavy resistance. Some of this resistance came from a widespread and entrenched belief in the importance of instructor autonomy. There were also individuals in the department whose personal identity and individual experiences impacted their ideas about coordination – some were open to the idea of insisting that others use their materials, but were unwilling to use others'. There were also a variety of opinions related to change in general. The department generally agreed that students were entering and exiting the P2C2 courses without the desired conceptual understandings and procedural skills, so were somewhat open to the general idea that some improvement was needed. Individuals within the department viewed the problems through their own idiosyncratic lenses, leading to a range of proposed strategies for improving outcomes. The department chair organized a calculus task force, composed of faculty representatives of several viewpoints, which counted as departmental committee service for those involved. This group considered various suggestions and concerns related to each proposed new structure, including the implementation of course coordinators, uniform course elements, and regular meetings for instructors in the P2C2 courses. As a group, they rejected, accepted, and adapted these ideas to find something palatable to all. The development of a shared conception, agreed upon by so many already, smoothed the path to a wider departmental vote in favor of coordinating Precalculus, Calculus 1, and Calculus 2. The lower status of lecturers also contributed to the implementation of course coordination, as it was suggested that faculty coordinators would make decisions that lecturers needed to follow, rather than faculty telling other faculty what to do. It seems that this contributed to the passage of the faculty vote. A final contributing factor to the task force, and then the department, agreeing to course coordination courses was the general view of the P2C2 sequence as a set of service courses taken primarily by non-mathematics majors. As the major impact would be to non-majors, faculty in the mathematics department were less concerned about what topics needed to be covered and how than they might be for courses which directly lead students into upper-division mathematics electives. Thus, the design of a new *structure* (coordination system) involved the development of

a shared vision across many *people*, leveraging an existing *structure* (department committees). It came to be, in part, because of the existing *power* dynamics (relative status of lecturers) and beliefs and values that are highlighted by the *symbols* view (P2C2 as service courses, frustration with existing course outcomes).

In the first implementations of P2C2 course coordination at LPU, there were areas for improvement. For example, during the first term, the course coordinators did not yet have a robust system for communicating with the other instructors about the content and format of the exams they were writing, which resulted in drastic differences in scores from section to section. As a result, instructors refused to abide by a common grading scheme and made adjustments to their students' scores to reflect the variation in what had been covered and how in their respective courses. The lines of communication between coordinators, instructors, and GTAs allowed this issue to be brought up quickly and discussed openly, leading to a new protocol for sharing and collaborating on the writing of midterm and final exams. Communication was a general challenge during the roll-out of the changes at LPU, one that is increasingly being addressed. Aside from the course coordinators, all of whom were tenured faculty, only three faculty members taught P2C2 courses in the first two years of coordination (in total, there were three coordinators, three other faculty, and nine lecturers). Two of these three were unhappy with their lack of control, and refused to go along with all the coordinators' decisions. In response, the department chair (who promoted the change initiative) has made efforts to assign those faculty to other courses in the foreseeable future, leveraging his official powers in the department.

Given the previous discussion of concerns, one might assume that the effort to implement course coordination would fail. To date, however, the coordination is in place. Certain aspects of the department and institution's culture were strong enough to overcome the concerns of a few. The aforementioned belief that the pre-existing P2C2 courses were not sufficiently preparing students was part of this, with many faculty members willing to test the new system thoroughly, especially as one of the coordinators repeatedly voiced his belief that students were doing better, on harder exams, than they did previously. His insistent presentations to the department of early wins and markers of success, including better attendance, fewer instances of cheating, and increased performance helped the initiative maintain its course. The course coordination system also supported the work of GTAs and the tutoring center, as all students in a given course were grappling with the same material at the same time. This did not go unnoticed by those working with the GTAs or at the tutoring center. Additionally, instructors noted that the consistency of the P2C2 courses made teaching any course with P2C2 prerequisites more straightforward, as they could be assured that students had seen certain material presented in a certain way, and using the same textbook. Administrators, who had been supportive and secured some of the necessary funding for the larger initiative, have also continued to support the coordination of courses for a variety of reasons – all of which contribute to the department-at-large's interest in maintaining course coordination. Over the next few years, the effects of the overall initiative, and course coordination, on long-term metrics such as persistence, completion rates, and time-to-degree will be measured and use to more appropriately gauge the successfulness of these changes.

Discussion & Significance

This brief paper provides an example of how the four frames can be used to capture the complexity of department-level change over a number of years. The change initiative we studied was largely successful, making numerous and, as yet, lasting changes in the department. The change process began with a taskforce that helped create a common vision for the department.

This vision was enacted through a variety of structures and the creation of an integration coordination structure. Rather than quick fixes, these large structural changes are new aspects of the department that modify its basic operation. The frames also highlight that department members paid less attention to symbolic aspects of change, such as focusing on the beliefs about the purpose of teaching (i.e. supporting students vs. weeding out students). There was also no explicit focus on equity as far as the role of lecturers. The four frames draw attention to these areas of symbols and power as key areas of focus for sustainable change and future efforts at LPU. These particular beliefs and power issues are a part of academia generally, and specifically mathematics (i.e., in terms of a weed-out culture). Thus, we see that the four frames theory can draw attention to the types of things one should attend to in a change initiative, but deep contextual knowledge also helps support how the theories are applied to mathematics in specific. Conversations with change agents about this study's findings suggest that they will make efforts to address these aspects of the department as they continue to move forward and improve the LPU mathematics department. This shows how the four frames theory can help change agents attend to areas of focus that they otherwise may have not considered, which is a tool to support holistic, sustainable change.

Here we have provided an example of how the four frames are a useful tool from organizational change that can be adapted to the context of educational change. These frames help organize an understanding of what has happened at LPU, how that process has played out, and the impact of existing and evolving departmental culture on the products, enactment, and process of change. Crucially, the frames also reveal gaps in the change initiative, areas for growth and cultural factors which potentially affect the enactment and sustainability of the new system. The four frames, therefore, are a tool for other researchers, change agents, or university administrators to increase the likelihood of implementing sustained changes. The four frames can be used by internal and external members of a community to identify supports (e.g., stakeholders, institutional goals, champions) and constraints (e.g., weed-out mentality, power differentials) to better navigate the pathways of change. Leveraging this framework to identify aspects of departmental and institutional culture that can be used to individualize and personalize the generic products and processes of change found in the literature, thus addressing one of the primary obstacles to sustainable improvement initiatives.

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