More Than the Sum: A Four Frames Analysis of Mathematics Departmental Teaching Culture

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Understanding departmental teaching culture has been recognized as a useful starting point for implementing instructional and institutional change. However, there is a lack of consistency in the literature with respect to how teaching culture is operationally defined and systematically measured. In order to begin addressing this gap, we highlight findings from a series of focus groups conducted within a math department in the Southeastern United States. Utilizing Reinholz and Apkarian's (2018) Four Frames model, we characterize the department's culture through the four interrelated frames of structures, symbols, people, and power. These frames provide a snapshot of the unique math departmental teaching culture, which can be leveraged not only to assess the effectiveness of future change initiatives, but also to individualize such change initiatives to meet the unique needs of the department.

Keywords: Teaching culture, institutional change, departmental change, Four Frames model

Introduction and Background Literature

The teaching culture within an academic department is "hard to define, understand, and measure," yet plays a critical role in departmental change (Reinholz & Apkarian, 2018, p. 3). Changes in departmental teaching culture have the potential to improve instruction and learning, which in turn can positively impact student learning and persistence, especially within STEM fields (Couch et al., 2024; Henderson et al., 2011). Departmental teaching culture can also be leveraged as a metric through which educational reform can be guided and measured (Lau et al., 2022). Furthermore, teaching culture can be used as an evaluative tool for assessing teaching effectiveness (Dennin et al., 2017).

Despite the utility of teaching culture in departmental change initiatives, research examining departmental teaching culture is relatively inconsistent in both how teaching culture is operationally defined and systematically measured. A large proportion of the research relies on implicit characterizations of culture that draw on everyday language rather than from rigorous and established theoretical frameworks (Mohr et al., 2025). Without a clear definition of culture, these change initiatives leave little room for generalization to other contexts. This minimizes the potential for research in this domain to have broader impacts for institutional change.

This report seeks to address this gap by using an established framework – Reinholz and Apkarian's (2018) Four Frames model – to characterize the teaching culture of a mathematics department in the Southeastern United States. The Four Frames model serves as a powerful

methodological tool that can be leveraged not only to obtain a snapshot of a department's teaching culture, but also to facilitate targeted transformation within a department. We more specifically address the following research question: How do individuals perceive the roles of *structures*, *symbols*, *power*, and *people* within the math departmental teaching culture?

Theoretical Framework

We leveraged Reinholz and Apkarian's (2018) Four Frames model to characterize mathematics departmental teaching culture. This model uses four interrelated frames – *structures*, *symbols*, *people*, and *power* – as a lens through which to obtain a snapshot of culture (see Table 1). It is of particular utility for promoting change in the departmental change context, as it provides insight into both the product of change as well as the process of change.

Table 1: Description of the Four Frames (Reinholz & Apkarian, 2018; Couch et al., 2024).

Frame	Description
Structures	Roles, responsibilities, practices, routines, and incentives that organize how people interact.
Symbols	Cultural artifacts, language, knowledge, myths, values, and vision that department members use to guide their reasoning.
People	The uniqueness and diversity of the individuals in a department with respect to their goals, agency, needs, and identities.
Power	The interactions between people are mediated by power, status, positioning, and political coalitions.

Previous work using the Four Frames model includes analysis of department chairs' perceptions of teaching culture as it pertains to instructional change (Couch et al., 2024). Other work has compared culture across STEM departments (Reinholz et al., 2019) and examined the role of certain groups as potential agents of change, such as course coordinators (Williams et al., 2022).

Methods

Data were collected from focus group interviews conducted with math instructors at an R2 university in the Southeastern United States. In total, 10 instructors participated in a focus group, each containing between 2 and 5 participants as well as 2 facilitators. During each one-hour focus group, participants reflected on and discussed results from a prior departmental survey on teaching culture. In particular, discussion centered around three central themes: the perceived relatedness, competence, and autonomy of the department with respect to teaching. For each theme, participants were shown preliminary findings from their department's survey responses and prompted to discuss how their department's teaching culture could explain the findings. Then, additional data summarizing their overall college's responses to the same survey question was displayed, with prompting for comparison with the mathematics department's data. While the prior survey provided quantitative data related to perceptions of teaching culture, the focus groups provided an opportunity to further explore these data.

Data analysis was conducted by a team of six researchers. After cleaning the focus group transcripts, each transcript was deductively coded by a researcher using the Four Frames model (Reinholz & Apkarian, 2018). After this initial round of coding, the team discussed difficulties and revised the codebook to include more robust examples and details. Then, each coded

transcript was reviewed by a second researcher, with revisions made where appropriate to ensure consensus across the transcripts. Finally, the first two authors inductively coded each of the resultant four frames, focusing on identifying prevalent themes within each frame.

Results

In this section, we will present common themes which emerged from the focus group interviews. These themes will be organized along the Four Frames components.

Structures

Structures refers to the formal roles, responsibilities, practices, routines, and responsibilities which guide the actions and interactions of departmental members. Focus group participants reported on several departmental *structures* which impact instructors' teaching roles within the department, including time constraints and presence of mathematics education research faculty.

Instructors highlighted a lack of time to plan for their courses, contributing to a lack of autonomy and control. Jo, a tenured faculty in mathematics education, reported course schedules are often "not finalized until ... a week or two before the semester begins ... [sometimes] even later than that." Furthermore, instructors feel "a lot of pressure to have everything in its details [for their courses] ready by the first day." The lack of preparation time before the first day of class combined with pressure to finalize all details of a course by the first day resulted in instructors feeling rushed to prepare for their courses.

These time constraints were also experienced throughout the semester. Tenure-track faculty expressed the desire to support all students, but noted that it may be unrealistic to do so: "I want to be confident [in supporting all students], but can I realistically get there? No … I have other obligations." Such time constraints were reinforced by full-time temporary instructors (FTTs) and adjunct professors. Emmy described "it begins to get more and more difficult to find time… I teach 16 hours a week, which is a full load. So between planning, teaching, grading, it's hard to find time [to observe colleagues teach and discuss the observation]." Overall, instructors found it difficult to reflect and modify their teaching due to heavy teaching loads and other duties.

Another structural factor impacting instructors in their teaching role is the presence of mathematics education research faculty. Debbie, a graduate teaching assistant, described the university as being unique due to having "a heavy education presence ... especially in the mathematics department." Further, "there is a lot of ... collaboration amongst educators and mathematicians that does not always happen." Jo described the mathematics education group as not feeling "separate from the mathematics department in any way." The interviewed instructors hypothesized the unique collaborative relationship between mathematicians and mathematics educators resulted in a strong desire for instructors to consistently modify their course structure and teaching techniques to support all students.

Symbols

Symbols refer to the cultural artifacts and values – typically informal – which members of a department use to guide their reasoning. Common teaching *symbols* reported by members of the mathematics department include the nature of mathematics and the value of hard work.

The nature of mathematics refers to perceptions about what mathematics is and how mathematical knowledge is discovered or created. Some instructors described their perspective on the nature of mathematics and how it guides their teaching. For instance, Sophie, a lecturer, described some forms of mathematical knowledge as fixed, citing the Fundamental Theorem of

Calculus. Sophie therefore described difficulty performing iterative modifications of course content and structure due to most of the content taught being unchanged. Similarly, Cathleen, a tenured faculty, described mathematics as "more like music and art than ... the other sciences." Therefore, Cathleen teaches mathematics in a similar way to how she would teach music, as a "skill building discipline." These perceptions of the nature of mathematics sometimes created conflict with instructors' understanding of pedagogical practices. Debbie discussed department members needing to "learn how to balance what is recommended by other extant literature with ... what [we] believe mathematics is ... and what it looks like to effectively learn it."

Instructors also described hard work as a key value in the department. Dorothy, a tenured faculty in statistics, described "people in the [mathematics department] care and they are ... striving" to make a difference through their teaching. This deep level of care is reflected in Dorothy's observation in which members of the mathematics department are always "working hard," sometimes "working too hard." Dorothy elaborated by discussing "hard is not always smart" and that she may "not always [be working] smart to make the most efficient type of changes [which make impacts using] the shortest path." Despite the critique, Dorothy described the culture of hard work as a virtuous and encouraging value about the department.

People

People refers to the uniqueness and diversity of instructors which make up the department. In general, the sentiment regarding a diverse department is positive: "people [in the mathematics department] are different, and that's what makes it so great." Two ways the uniqueness and diversity of instructors are highlighted in the department include differences in teaching assignments and differences in background, training, and teaching preferences.

Dorothy described the mathematics department as having an "incredibly wide range of different mathematical disciplines that people are working in" such as "algebra, statistics, education, combinatorics" and much more. This naturally results in instructors teaching a broad range of courses. For instance, Spencer, a tenure-track professor who teaches theoretical math courses, described the content as "very difficult ... to teach" and it being "very challenging to get across certain material to students." Therefore, sticking to pedagogical suggestions from instructors teaching general education mathematics courses may not be effective for Spencer. Furthermore, being a large university, courses are typically offered in a wide variety of modalities. Dorothy, who teaches "a lot of online [courses]," found it difficult to reach students in the same way her colleagues teaching in-person courses do due to the nature of online courses.

The wide range of mathematical background is also reflected in the diversity of training and preferences with respect to teaching amongst instructors. The large education research presence in the department results in many instructors such as Debbie who have "read so much literature about what it means to be an effective teacher [by supporting] a student in learning." Some instructors also associate different styles of teaching with different types of people. For instance, Emmy described one of her colleagues as being "a math teacher [in the K-12 setting] for a long time and so she has taught in a particular way." In addition, Dorothy described some faculty in the department as being "more ... introverted in working on their projects and therefore less interested in being collaborative in their classes."

Power

Power refers to the political relationships between members of the department which may impact instructors' teaching roles. Aspects of *power* which emerged during the focus groups

include lack of autonomy due to power differentials between faculty based on position and experience as well as a chasm between mathematics and mathematics education researchers.

One FTT, Emmy, described FTTs as unable to "serve on committees or do research work or anything." Furthermore, "while … some [FTTs] have been here for over 25 years, [we are] still referred to as temporary." This power differential between FTTs and tenure-track faculty is further exacerbated by FTT's lack of instructional control and autonomy. For example, Emmy described FTTs not being "voting members of the faculty" and not being "decision makers, but ... get a lot of decisions made about [them]." Emmy reported "mandates" FTTs receive regarding teaching, such as implementing a common final exam in the college algebra, precalculus, and Calculus I courses. Although Emmy reported feeling "free to ask questions [and] challenge policies" which "might lead to modifications," she reported uncertainty in whether her suggestions are "actually changing anything at the departmental level."

Although the relationship between mathematics and mathematics education researchers were reported to be largely collaborative, power dynamics and implicit roles between these two groups impact how instructors view their teaching roles, especially mathematicians. Some mathematicians viewed mathematics education researchers as holding the power and authority with respect to pedagogy, deferring teaching-related judgements to these. For example, Cathleen described thoughts about making changes to the curriculum and her pedagogy, but because she is "not [a researcher in] math education," she does not seek to implement her thoughts.

Discussion

This study examined math instructors' perceptions of their departmental teaching culture through the four interrelated frames of *structures*, *symbols*, *power*, and *people.* Such a snapshot of a department's current teaching culture can be leveraged to individualize future change initiatives to meet the unique needs of the department. For instance, a change initiative in this department would need to require minimal time commitment in order to be responsive to the structural time constraints of instructors (Bleiler-Baxter et al., 2021). Further, due to the strong presence of and reliance on math education faculty within this department, such education-based faculty may be leveraged as early adopters and change agents that can support the diffusion of innovation to the department (Eddy et al., 2022). This snapshot also establishes a baseline measurement of departmental teaching culture that can be used to assess the effectiveness of a change initiative. While these findings are unique to the studied institution, they could serve as a roadmap to guide other institutions in characterizing departmental teaching culture within their own context. Further, the stories of these instructors may resonate and inspire other instructors, promoting relatedness and collaboration across institutions.

Preliminary Nature of Report

This report is exploratory in nature. Future work will dive further into unifying themes across the data. Future exploration of the data will also leverage additional theoretical frameworks such as Self-Determination Theory in order to broaden the impact of our findings. Further, we possess additional parallel data from other STEM departments (e.g., biology, aerospace, geosciences) that can be unified with the math departmental data reported here to form an overarching narrative spanning STEM departmental teaching culture.

During the discussion portion of the presentation, questions for the audience will include: (1) What other analytical frameworks might be useful lenses to explore this data? and (2) Which of these findings do you anticipate can be generalized to mathematics departments at other institutions and which do you think are unique to this math department?

References

Bleiler-Baxter, S. K., Hart, J. D., & Wanner, C.A. (2021). Teaching TRIOs: using peer observation to initiate department change. *PRIMUS*, *31*(3-5), 550-564.

Corbo, J., Reinholz, D., Dancy, M., Deetz, S., & Finkelstein, N. (2016). Framework for transforming departmental culture to support educational innovation. *Physical Review Physics Education Research*, *12*(1), 010113.

Couch, B. A., Prevost, L. B., Stains, M., Marcy, A. E., Whitt, B., Hammerman, J. K., & Spiegel, A. N. (2024). STEM department chairs' perspectives on navigating teaching culture to influence instructional change: a four-frames model analysis. *Frontiers in Education, 9,* 1383711.

Dennin, M., Schultz, Z. D., Feig, A., Finkelstein, N., Greenhoot, A. F., Hildreth, M., ... & Miller, E. R. (2017). Aligning practice to policies: Changing the culture to recognize and reward teaching at research universities. *CBE—Life Sciences Education*, *16*(4), es5.

Eddy, P. L., Hao, Y., Iverson, E., & Macdonald, R. H. (2022). Fostering communities of practice among community college science faculty. *Community College Review*, *50*(4), 391-414.

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of research in science teaching*, 48(8), 952-984.

Lau, A. C., Henderson, C., Stains, M., Dancy, M., Merino, C., Apkarian, N., Raker, J. R., & Johnson, E. (2024). Characteristics of departments with high-use of active learning in introductory STEM courses: implications for departmental transformation. *International Journal of STEM Education*, *11*(1), 10.

Mohr, C., Freeman, A. S., Bleiler-Baxter, S. K., Malone, A., Nkuah, A., Puente, A. R., Wang, C., Gardner, G. E., & Rushton, G. T. (2025, June 10). *Characterizing STEM Departmental Teaching Culture: A Literature Review of the How, the Why, and the What* [Conference presentation]. 2025 Transforming Institutions Conference, St. Louis, MO.

Reinholz, D. L., & Apkarian, N. (2018). Four frames for systemic change in STEM departments. *International Journal of STEM Education*, *5*(1), 3.

Reinholz, D. L., Matz, R. L., Cole, R., & Apkarian, N. (2019). STEM is not a monolith: A preliminary analysis of variations in STEM disciplinary cultures and implications for change. *CBE – Life Sciences Education, 18*(4), mR4.

Williams, M., Apkarian, N., Uhing, K., Martinez, A. E., Rasmussen, C., & Smith, W. M. (2022). In the driver's seat: Course coordinators as change agents for active learning in university Precalculus to Calculus 2. *International Journal of Research in Undergraduate Mathematics Education*, *8*(1), 121-148.