What’s the Norm? Instructors Justify their Active Learning Moves and Decisions

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As VITAL faculty continue to teach more university mathematics courses, departmental efforts to improve instruction and shift toward active learning should align with instructors’ teaching approaches and decisions. In this study, three instructors described their classroom norms and justified teaching moves via professional obligations. External factors, such as the physical learning spaces, interactions with students, and institutional constraints, influenced their pedagogy. This report emphasizes the support systems required within mathematics departments to sustain instruction improvement efforts among VITAL faculty.

Keywords: active learning, VITAL faculty, pedagogical decisions, classroom norms

Review of Relevant Literature

Recently, there has been a general effort in science, technology, engineering, and mathematics (STEM) departments across the nation to implement active learning strategies at the university level (Association of American Universities, 2017; Conference Board of the Mathematical Sciences, 2016). While there is evidence that active learning is more effective at facilitating student learning of mathematics than traditional lecture approaches (Freeman et al., 2014; Michael, 2006), the feasibility of implementing these interactive strategies is often challenged by faculty and instructors (Le et al., 2018; Michael, 2007). Instructors’ hesitancy or resistance to implement evidence-based teaching practices, such as inquiry-based learning (IBL), can be due to their personal perceptions of these practices, lack of support, institutional factors such as course coverage pressure and classroom layouts, or qualities of the innovative approach (Keller et al., 2017; Lund & Stains, 2015; Shadle et al., 2017).

This paper focuses on a specific group of undergraduate mathematics instructors: VITAL faculty. The term “VITAL faculty” was established by MAA leaders (Levy, 2019) to refer to Visiting and Instructional faculty (full- and part-time), Teaching assistants (especially graduate-level), Adjunct instructors, and Lecturers. As universities move toward hiring more non-tenure-track faculty, mathematics departments rely increasingly on VITAL faculty to teach courses that are required of both STEM and non-STEM majors (Blair et al., 2018; CBMS, 2016).

In the past decade, researchers in undergraduate mathematics education studying IBL practices and outcomes have focused primarily on upper-level courses, such as linear algebra, differential equations, and abstract algebra (e.g., Johnson et al., 2020; Kuster et al., 2017; Larsen et al., 2013; Rasmussen et al., 2018). In the recent Compendium for Research in Mathematics Education, Rasmussen and Wawro (2017) dedicated a chapter to post-Calculus research, which includes a review of teaching approaches at that level. Thus, many of the understood active learning approaches and classroom norms are in upper-level courses, which are typically taught by non-VITAL, tenure-track faculty (Blair et al., 2018). There is a lack of literature about how non-tenure-track faculty members, especially novice instructors (Speer et al., 2010), teach introductory-level mathematics courses via an active learning approach.

The focus on upper-division courses is apparent in research on instructor preparation and professional development as well. Studies that examine the preparation of instructors of introductory-level courses (e.g., Pre-Calculus) tend to focus on graduate teaching assistants rather than instructional faculty (e.g., Beisiegel, 2017; Ellis, 2016; Milbourne & Nickerson, 2016). What is unknown is how specific groups of VITAL faculty members learn about, implement, justify, and improve on active learning practices in their classrooms. The lack of research about the *practice* of teaching (Speer et al., 2010) leads to limited research-based support for VITAL faculty and other instructors who are beginning to shift toward evidence-based teaching practices.

The practices and pedagogical knowledge of post-secondary instructors are influenced by a multitude of factors and external demands (Bennett, 2020). While time spent in the classroom can have positive effects on instructors' experiential learning of teaching, it can be influenced by the demands and culture of their institution (Keller et al., 2017; Oleson & Hora, 2014). Additionally, even when instructors are experienced lecturers, this does not necessarily translate to a sense of confidence or expertise with active learning practices (Bennett, 2020). VITAL faculty may have other backgrounds, constraints, and obligations that influence their teaching which differ considerably from their full-time or tenure-track colleagues (Laursen, 2019; Levy, 2019).

Theoretical Framework

Instructors make pedagogical decisions based on demands imposed on them by external people and structures. In mathematics education research, factors that influence teaching decisions, that is, compel teachers to abide by certain instructional norms while breaching others, have been previously answered with internally-based notions, such as knowledge and beliefs (e.g., Philipp, 2007; Speer, 2008). However, I view teaching college mathematics as existing within the context of a didactical contract (Brousseau, 1984), which shifts the justification of actions to the practice of teaching, rather than to individual teachers. This shift necessitates an examination of external factors and environmental constraints on pedagogical decisions.

Herbst and Chazan (2003, 2011, 2012) established the practical rationality of mathematics teaching framework by drawing on the instructional triangle (Cohen et al., 2003) as an activity system to describe how teachers make pedagogical decisions based on their institutional environment (see Figure 1). The novelty of the practical rationality framework is that it describes the practice of teaching, and thus shifts the unit of analysis to the external factors and justification sources that influence instruction, rather than internal factors of the instructor.

Contractual Norms within Teaching

Within the practice of teaching mathematics, there are norms, or routines and actions that are common and expected. Norms are implicit behaviors that exist in social settings, such as learning environments, that demand recognition and responses from the participants in the setting. Didactical contracts are differentiated and described by the norms expected by the actors as they play out their roles. Different expected norms create different contracts. "Thus, the norms of a contract can be a source of justification for actions in teaching" (Herbst & Chazan, 2012, p. 605).

Norms within a didactical contract are *contractual norms*. Contractual norms have a large grain size, meaning two teachers can abide by the same norms yet carry out those norms in what appear to be very different ways (Herbst & Chazan, 2012). Here, I take up Herbst and Chazan's supposition that a finer analysis might reveal nuances within norms. I denote the actualization of contractual norms by *teaching moves*, which are the actions performed by the person in the role of teacher during a lesson. Because of their smaller grain size, teaching moves describe instruction in greater detail and allow for disparities in contractual norms across instructors. Thus, I draw on rationality theory to understand instructional decisions and extend practical frameworks that explain specific teaching actions.

Professional Obligations of Teaching Mathematics

The role of teacher exists in institutions of schooling, surrounded by societal stakeholders in education. To understand teachers' justifications within these institutions, Herbst and Chazan (2011, 2012) described four professional obligations that act as implicit norms and constraints within the institutional environment: disciplinary, individual, interpersonal, and institutional.

The four obligations acknowledge that teachers are members of a common practice, rather than individuals who disregard external factors of teaching. College instructors, as members of the practice of teaching undergraduate mathematics courses, are assumed to consider similar factors that are reasonable and relevant to their practice (Herbst et al., 2011). The obligations may create tensions; a teaching action that aligns with one obligation may not align with another. In this way, the obligations help researchers explore why some innovations are taken up while others are viewed as not feasible or not in alignment with the practice of teaching mathematics (Herbst & Chazan, 2003). In the following paragraph, I describe each of the four obligations.

The *disciplinary* obligation ensures that the instructor accurately conveys and represents mathematics content, practices, and qualities, as deemed fit by stewards of the discipline. The *individual* obligation ensures that the instructor attends to individual students' behavioral, cognitive, emotional, and social needs, as a client of instruction and complete human being. In other words, there are two ways to attend to the individual: academically as a mathematics student and emotionally as a complete person. The *interpersonal* obligation ensures that the instructor attends to society, interactions between instructors and students, and the use of shared resources, such as discursive, physical, and social spaces and times. The *institutional* obligation ensures that the instructor regulates and abides by components of the schooling administration, such as curriculum, schedules, spaces, and policies.

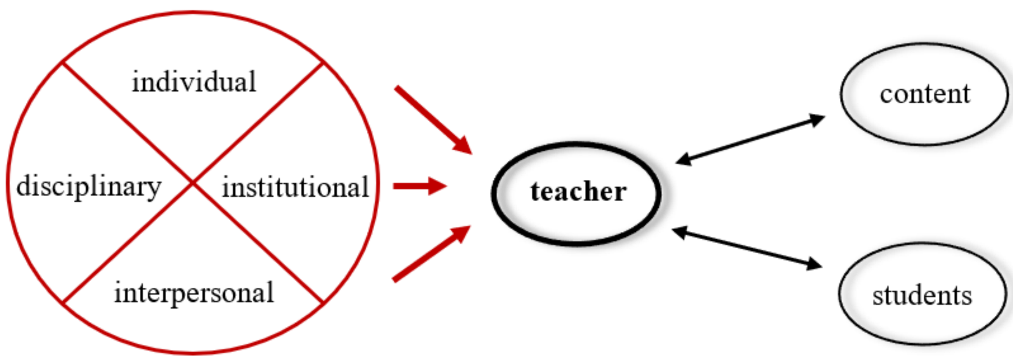

Figure 1. The four professional obligations influence the role of the teacher and the teacher's relationships

Research Questions

This paper addresses the following research questions:

1. What norms do instructional faculty use in their classrooms when teaching introductory-level mathematics via active learning?
2. How do professional obligations play a role in instructors' pedagogical decisions within an active learning approach to teaching mathematics?

Methods

The data presented here are part of a larger qualitative, dissertation study. This study took place at a large, public, research-oriented university that had recently made efforts to shift toward evidence-based teaching practices and create collaborative learning spaces (CLSs) as part of an initiative to improve undergraduate STEM teaching (AAU, 2017). CLSs are classrooms that promote student-centered approaches by incorporating flexible furniture, adaptive layouts, and interactive technologies (e.g., Baum, 2018; Odum et al., 2020).

This paper focuses on three participants, Maggie, Amber, and Charles, who were full-time instructional faculty members in a Department of Mathematics and are considered VITAL faculty. The instructors varied in age, education backgrounds, years of experience teaching, and approaches to active learning. Even though they had various experiences teaching mathematics at different grade levels, they did not have experience teaching via active learning (at any level). They chose active learning based on their recent arrival to this department or encouragement and inspiration from their colleagues.

Together, they taught three introductory courses: College Algebra, Pre-Calculus, and a data-based course intended for non-STEM majors, which focused on interpreting and representing data using a variety of graphs and tools (e.g., Microsoft Excel). Each instructor taught multiple sections of one or more of these three courses, and the sections took place in a variety of classroom spaces, including CLSs, large lecture halls, and smaller, traditional classrooms (see Table 1). They each sought different resources and mentorships in the department and across campus since the experience of teaching via active learning and in CLSs was new for them.

In the larger study, I observed each instructor's teaching six times using the Observation Protocol for Active Learning (OPAL) tool (Frey et al., 2016) and taking field notes. The OPAL tool focused on both student and teacher actions, such as asking and answering questions, working in groups, moving around the classroom, and resources used while lecturing and presenting. Observations informed lesson debriefs and subsequent interviews, all audio recorded. Lesson debriefs were casual discussions following observations that resembled informal interviews (Hatch, 2002). Semi-structured, in-depth interviews built on prior conversations and the observations to understand the teaching perceptions and rationale of instructors. A primary interview took place about halfway through the semester and a secondary interview took place at the end of the semester. The secondary interview also served as a member check for participants to review my interpretations of their lessons and of our prior conversations.

This paper focuses on the analysis of the norms observed during lessons or mentioned by instructors during lesson debriefs and interviews using multiple qualitative coding techniques. In particular, I used Saldaña's (2016) description of *concept coding* to highlight norms and teaching moves, which were guided by relevant research describing practices in undergraduate mathematics classrooms. The norms were then analyzed through the lens of the practical rationality framework (Herbst & Chazan, 2012).

Table 1. Key Information about Instructors and their Classes

Instructor	Course	Classroom	Class Size	Experience
Maggie	Pre-Calculus	CLS	35	Prior experience teaching high school math
	Pre-Calculus	Traditional Classroom	35	
Amber	Data-based Course	CLS	72	Prior experience as graduate teaching assistant
	Data-based Course	Lecture Hall	72	
Charles	College Algebra	CLS	72	Prior experience teaching Community College math
	Pre-Calculus	Traditional Classroom	35	

Findings

After coding the observations and instructors' discussions of their pedagogy, I found that there is a nested structure of norms and teaching moves, where contractual norms describe routines of larger grain size and teaching moves give finer detail about what the instructor implements. In other words, norms are comprised of various teaching moves. This is how, for instance, both Maggie and Amber established a norm of frequently asking their students questions during class, but it looked very different in their classrooms.

In her CLS, Maggie discretely selected table groups ahead of time to respond to her questions; whereas, in her traditional classroom, she let multiple students shout out the answers simultaneously. In her CLS, Amber created an elaborate protocol that used Excel to randomly select a table group and group representative to respond to each question; however, in her lecture hall, she simply asked questions to the whole class and waited for a volunteer to respond. All of these teaching moves correspond to the same norm of asking students questions, but opting for one over another caused the pace of instruction and types of interactions to appear very different.

Out of the 395 total teaching moves coded, 49 moves (about 12.4%) were coded as "rejected", meaning the instructor referred to it in a negative way or claimed to not use it in their instruction. Out of the 49 moves that instructors claimed to reject, 17 corresponded to the norm of lecturing. These rejected teaching moves used the term "lecturing" explicitly or mentioned classroom dynamics related to lecture. Indeed, observation data confirmed that the instructors sometimes (for Maggie and Charles) or always (for Amber) spent less time lecturing than doing activities with students during class. In this way, even though this was their first year trying active learning, they were successful with moving away from lecture-based norms and implementing more interactive teaching moves in their courses.

Discussion

In this section, I discuss how instructors used the norms mentioned above and how the obligations influenced their choice and justifications of these norms.

Discussion of Norms

In the context of teaching undergraduate mathematics, lecturing is typically viewed as the traditional or even expected approach to teaching mathematics at the undergraduate level (Stains et al., 2018); thus, it is the norm. However, the instructors in this study made decisions to alter this approach and breach this norm.

Lecturing was a nuanced norm, as all three instructors rejected it at times and found it to be beneficial other times. For instance, Maggie and Amber both rejected the norm of lecturing when it was used in excess, i.e., "lecturing for the entire class period". They instead implemented "mini-lectures" and "interactive lectures" throughout lessons, situated between collaborative activities. Similar to participants in Mesa et al.'s (2019) study, both Maggie and Amber saw benefits in lecturing only if it was used sparingly and at appropriate times, such as at the end of a lesson to summarize key concepts and restate mathematical definitions. On the other hand, Charles was the only instructor to not outright reject lecturing for an entire class period. He was "trying harder and harder to break that mode" of lecturing, but for most of the semester, he still felt the need to lecture for large amounts of some lessons, mostly due to external factors, such as pressures of content coverage and lack of classroom resources.

As the instructors learned about and experimented more with an active learning approach, they moved away from posing questions to the entire class and instead directed their questions to smaller, specific groups of students in an intentional way, such as Amber's protocol for selecting random tables in the CLS to call on groups of students. The instructors reflected that this not only made questioning norms more efficient by taking up less time but also encouraged equitable participation across all students and helped the instructors relinquish their authority and redistribute it to the groups (Cohen & Lotan, 2014).

Discussion of Obligations

Overall, the instructors attended to all four professional obligations, oftentimes to multiple obligations at once. Imbalances of obligations could often be explained by the instructors' backgrounds. For instance, Maggie taught mathematics for several years at a high school where she felt there were many structures and rules to follow, so she tended to emphasize the institutional obligation and its accompanying constraints. Whereas Charles came to the university after years of teaching in a community college setting and often talked about how he had much more autonomy there. This influenced him to downplay the institutional obligation at the university, since he was not used to such a structured environment.

The following two examples illustrate how Charles and Amber attended to the individual and interpersonal obligations, and how Amber and Maggie justified decisions based on the institutional obligation.

Attending to the individual and interpersonal obligations. Charles viewed lecturing as a way to attend to the individual obligation. He frequently told jokes and personal anecdotes to break up the lesson and not "overload" his students with information. He expressed his desire to lower students' stress levels through "distractions", such as humorous stories about his experiences or math-related puns. In this way, he was very aware of his students' emotions and purposefully crafted his lectures to ease their math anxiety.

Gradually, Charles became more comfortable interacting with student groups during class, rather than lecturing, but participation issues arose in his CLS. This was a large classroom with an unconventional, adaptive layout of furniture, which made it difficult to interact with all students. As other learning spaces researchers have documented, it created a "golden zone" for interactions in the front, center part of the room, and a "shadow zone" (Park & Choi, 2014, p. 757) in the back and along the perimeter, where students were too far from the designated front to interact with Charles while he was giving instructions or writing on the doc cam.

Attending to the interpersonal obligation, Amber also encountered issues with inequitable participation in her lecture hall. She reflected, "So what I found…was that when I just solicited responses last year, like 'somebody volunteer,' I had three students that would always respond." This dilemma led to the protocol for asking questions that she created for her CLS, where table groups were systematically and randomly called on. This satisfied the individual obligation as well, since the equitable participation norms created a low-stress environment where students could discuss questions with peers before answering.

Attending to the institutional obligation. For an example of the institutional obligation, I draw on Amber's and Maggie's experiences. Amber saw an alignment between the institutional obligation and teaching the data-based course via active learning. Since this was a terminal course for students and was designed to focus on problem-solving, it was better suited for active learning (than other introductory courses she had taught), which gave the appearance that Amber ignored some institutional obligations. In fact, these characteristics of Amber's course led to fewer constraints and less content coverage pressure. However, Amber did feel constraints at times as a VITAL faculty member with multiple sections to teach. She acknowledged her obligation to the math department to teach the courses she was assigned, but her assigned class times made it difficult for her to attend campus-wide workshops and seminars to learn about active learning and collaborative spaces.

Maggie frequently referred to tensions between her intended active learning norms and the institutional obligation. Keeping both sections of Pre-Calculus consistent was a constant dilemma, particularly because she was assigned two different types of classrooms. She reflected,

> I think [being in the CLS] was easier to get students to talk to each other about the math. …That collaborative space had the whiteboards, whereas the other more traditional space, there was no individual whiteboards. So it was like, well, if you do a group activity there, how can you get the group to show their work or share out?

Maggie considered the practical aspects of teaching and cited institutional factors and constraints as justifications for her decisions. She stressed how Pre-Calculus had a packed course schedule, which made it difficult to do active learning activities in class. Highly-coordinated, common exams in Pre-Calculus added extra course coverage pressure. Coordinated exams also meant that Maggie had to keep her two sections of Pre-Calculus at the same place in the curriculum, even though the differences in participation and activities meant that the two sections often progressed at different paces. This meant deciding how to utilize the resources in each classroom to best teach the course material.

Rather than mentioning the supports and benefits of coordinated courses and departmental structures (Martinez et al., 2020), the instructors in this study spoke more about the dilemmas and constraints that the institutional obligation placed on them.

Conclusion and Implications

In conclusion, the instructors in this study used a wide variety of classroom norms and teaching moves while teaching via an active learning approach. The practical rationality framework revealed a hierarchy of teaching moves that described each instructor's approach in greater detail, accounting for differences within specific contractual norms. The norms implemented were influenced by a variety of external factors, including student emotions and participation, features of the physical learning spaces, and institutional constraints on the specific courses. The norms were also influenced by the instructors' main teaching goals, their education backgrounds, and their teaching experiences.

The lens of professional obligations brought to light tensions that the instructors experienced while navigating an active learning approach within a mathematics department at a large, research-oriented university. The instructors responded to tensions by recognizing and attending to some obligations while downplaying others; this compartmentalization helped them manage the many factors that influence teaching. This study emphasizes the importance of understanding the teaching approaches and justifications of understudied groups of undergraduate mathematics instructors, namely VITAL faculty. Non-tenure track faculty face obligations that their tenure-track colleagues may not, as well as issues of status. Instructors' packed teaching schedules can prevent them from attending professional development seminars that are crucial for providing support and scaffolds for improving instruction.

The findings presented here suggest the need to study the pedagogy and justifications of VITAL faculty members to better support them as they transition toward evidence-based teaching practices such as active learning. Furthermore, qualitative descriptions of implemented teaching moves were necessary to highlight nuances within contractual norms, which illustrated the types of interactions and levels of collaboration occurring in active learning classrooms. As the number of VITAL faculty members increase while mathematics departments continue to shift toward active learning, it is crucial to align the efforts of those involved to improve undergraduate mathematics education.

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