# FACTORS CONTRIBUTING TO INSTRUCTIONAL SHIFTS AT THE COLLEGE LEVEL

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*Despite copious evidence of the effectiveness of inquiry-oriented and student-centered instructional practices, many college instructors do not implement these instructional strategies. We report on a three-year project aimed at shifting instruction in College Algebra at one institution. This project established a professional learning community (PLC) of instructors around an incremental instructional improvement framework to guarantee instructor buy-in and increase the practicality of the development materials for use in the classroom. Preliminary results indicate that structural factors such as course coordination, dedicated PLC time, a lesson-study-like framework for improving course curricula and materials, and video clubs contributed to changes in both instructors' thinking and practice of inquiry-oriented teaching.*

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Inquiry-oriented mathematics instruction can lead to increased student learning and conceptual understandings (Freeman et al., 2014; Deslauriers et al., 2011; Kogan & Laursen, 2014). Additionally, there is evidence that students who report experiencing more student-centered techniques in their classes are less likely to switch out of a STEM degree (Ellis et al., 2014), and some studies suggesting that the benefits for underrepresented students in STEM are even higher (Kogan & Laursen, 2014). However, didactic lecture remains the most common form of instruction in STEM courses across the United States (Stains et al., 2018). Reasons for this include instructors' lack of personal experience with student-centered instructional practices (e.g., Andrews et al., 2015), fear of losing control of their classroom (e.g., Hayward et al., 2015), and particular beliefs about teaching and learning (e.g., Aragón et al., 2018). Further, mathematics instructors at the college level may have had few opportunities to participate in focused professional development around teaching. As such, it is challenging for many instructors to make lasting instructional changes that focus teaching on student-centered practices and leverage inquiry-based materials. Although instructional change can be difficult to catalyze, professional development through professional learning communities (PLCs) can be one way to support instructors through this process (Hayward et al., 2015; Lee & Lee, 2018; Tam, 2015). Specifically, PLCs create opportunities for instructors to reflect on and refine their practice and to generate new knowledge (Harris & Jones, 2010). This can result in transformational change when the PLCs possess high levels of professional capital, which refers to "the capacity to transform existing resources and constraints into opportunities through collective action" (Lee & Lee, 2018, p. 466), as well as when they focus on student learning (Bolam et al., 2005).

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## Description of Professional Learning Community

The goal of the federally-funded project described in this report was to empower College Algebra instructors at a large, Hispanic-serving southwestern university to improve instruction. The Practicality Ethic framework proposed by Doyle and Ponder (1977) helped us (the investigators) to structure the project, as it was originally designed to describe factors teachers consider when deciding whether or not innovative curricula was practical or deemed realistic for implementation in the context of an actual classroom. These factors are: 1) congruence: how compatible the change is with the instructor's classroom, setting, and instructional goals, 2) cost: if the potential benefits (e.g., student outcomes, student attitudes) that outweigh the effort and other costs of implementation, and 3) instrumentality: if the changes consist of clearly articulated procedures for ease of implementation in the instructor's classroom. Informed by the Practicality Ethic, we prioritized instructors' agency in choosing the content and and form of their curriculum (re)development project. In order to encourage instructors to think carefully in advance of their facilitation of lessons about students' opportunities to actively participate in the class, we leveraged the Continuous Improvement (CI) cycle (Berk & Hiebert, 2009), the incremental lesson improvement strategy informed by lesson study.

### Continuous Improvement Framework

For each of the five "active" semesters of the project, during the time protected for PLC meetings, instructors chose specific focus lessons from the curriculum and implemented the CI cycle: (1) design a task that targets a particular student misconception or deepens understanding of a particular mathematical idea; (2) develop hypotheses about anticipated student responses; (3) collect data and analyze in the form of student work and classroom recordings; and (4) revise the task for use in subsequent iterations of the course. Our choice to use CI to guide course improvement was to seed gradual transformation made with smaller changes over time for sustained instructional improvement (Hiebert & Stigler, 2004), while also leveraging the knowledge, experience and priorities of instructors to guide these changes. We collected data in the form of instructor interviews, video-recorded class observations, recordings of PLC meetings (including each step of the CI cycle and video club meetings), and participant lesson plans.

### Structural Factors Contributing to Instructional Change

We posit that the following structural factors contributed to meaningful instructional change in our context:

1. Course coordination and vertical alignment of curriculum: two years before the start of this project, the department embarked on a concerted effort to coordinate large multi-section courses. Instructors teaching the same course were strongly encouraged to meet regularly, align assessment across sections, and develop a list of student learning outcomes (SLOs) for their course. Course coordinators were similarly encouraged to meet with each other and discuss the progression of SLOs across subsequent courses.
2. Dedicated PLC time: this project provided each College Algebra instructor (all of whom were instructional faculty with 100% teaching loads) with a course release in order to participate in the PLC. Instead of teaching four courses each semester, participating instructors only taught three. Additionally, after the first semester of the project, which was utilized as an establishing and planning semester, all instructors of College Algebra participated in the PLC.

3. Continuous Improvement framework: Using the CI framework allowed us as facilitators to provide a structure for discussions about student thinking and developing active learning materials while still allowing the instructors' own priorities and ideas to guide the instructional improvement process.
4. Video club: embedded into the PLC and as part of the CI cycle, instructors participated in a video club where they observed each other's facilitation of the focus lessons for the semester. This gave instructors the opportunity to open up their practice to each other in a safe and structured way. As advocated by Berk and Hiebert (2009), we encouraged instructors during these video clubs to focus on *instruction* in their observations, not on the personal styles or quirks of the *instructors*.

We report below on preliminary findings that support the importance of each of these factors in catalyzing instructional change.

## Preliminary Results

As a result, we have multiple sources of evidence of instructional change on a number of levels. We summarize the results of three preliminary studies below.

**Study 1**

We investigated the instructors' perceived barriers and drivers for implementing evidence-based instructional practices, drawing on the work of Shadle, et al. (2019). A thematic analysis of the interviews with instructors revealed that most of the barriers to implementing evidence based instructional practices (EBIPs) identified by Shadle et al. (2019) did not resonate with this group of instructors. Specifically, we found that certain departmental policies (e.g., course coordination) mitigated some of the barriers and that the experience of teaching online during the COVID-19 pandemic resulted in the creation of video resources. These resources alleviated the time pressure to "cover" all the required material, making instructors more open to trying out EBIPs. Additionally, we found that the PLC central to this project served as a driver, enabling instructors to implement more EBIPs. For example, the PLC included opportunities for instructors to observe their peers, which provided some accountability and helped instructors to identify and (continue to) implement more innovative strategies in their teaching (Gehrtz et al., 2022).

**Study 2.**

Next, we looked at instructors' attention during the PLC meetings when each instructor showed video-clips from an observation video of another participant teaching one of the lessons collaboratively developed as part of this project (i.e., video club meetings). Informed by the work of Kelley & Johnson (2022), we used the Instructional Triangle (Cohen & Ball, 2001) as an analytic tool to characterize each instructors' foci during the discussion. Preliminary analysis suggests that each instructor had a component of the instructional triangle that they tended to focus on for the initial observation, but then after participating in multiple video-club meetings and seeing what other instructors focused on in their presentations, the discussions tended to shift to focus more on teacher moves. We also noticed a shift from focusing on explanations of the content at the beginning of the semester to showcasing more clips that highlighted teacher actions to engage and support student learning at the end of the semester (Jones et al., 2023).

**Study 3.**

Then, we looked at what was happening in each instructor's class by using the Classroom Observation Protocol for Undergraduate STEM (COPUS; Smith et al., 2013) to analyze class video data, documenting what instructors were doing and what students were doing throughout the class period. We then grouped related codes and created radar plots with the percentage of class time spent with: Students Talking, Students Working, Students Receiving, Instructor Guiding, Instructor Presenting, and Instructor Guiding (Smith et al., 2014). This analysis revealed distinct changes within and across semesters with respect to how class time was spent. Specifically, we saw instructors spend less time lecturing while students were listening and taking notes. We also saw more opportunities in class for students to work individually or in groups and for students to talk in class. Additionally, this analysis allowed us to triangulate what was happening in class to what instructors were describing during interviews about their efforts to implement changes to their teaching by incorporating more evidence-based instructional practices (Gehrtz et al., 2024).

## Discussion

Put together, these three studies show clear evidence of instructional change, at least during the period of the project. Moreover, interviews with instructors after they had been reassigned to other mathematics courses and were no longer participating in the PLC suggest that they wish to implement some of the lessons learned in the PLC with other courses. However, the dedicated collaboration time that was protected by the project is not available to instructional teams in other courses and instructor buy-in for implementing EBIPs varies across the department, making it difficult for the former College Algebra instructors to overcome the systemic barriers for inquiry-oriented learning that the structure of the PLC and the College Algebra course temporarily eradicated.

However, instructors in the PLC are themselves thinking about the sustainability of the instructional improvements. At the end of the project, the College Algebra curriculum will have been completely revamped based on instructors' interpretation of the evidence-based instructional practices. Additionally, College Algebra course coordinators have started to use the video club recordings of classes in the pre-course orientation meeting for new instructors. The current PLC members are also working on an instructor's guide to the course that can preserve their accumulated knowledge and disseminate it to subsequent course team members. These actions speak to the dedication of these instructors to preserve and sustain the work of the project.

## Further Questions

We are currently pursuing a number of other research questions and logistical considerations based on this project:

1. What is the effect (if any) of these instructional shifts on student outcomes?
2. Has participation in this project shifted instructors' beliefs about or use of EBIPs? Is it possible to track these shifts by referencing their interviews, the PLC meeting recordings, or other sources of data that we have collected?
3. How do we preserve the progress made during the project and sustain the work going forward, given the importance of the dedicated PLC time in shifting instructional practices?

Although the evidence of structural factors that influence instructional change may be of use to other investigators and facilitators of professional development for college mathematics faculty, the question of the lasting impact of this project remains open.

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