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Chapter 1

Faculty Engagement for Creating and Sustaining Mathematics Pathways

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Abstract

Redesign initiatives in postsecondary mathematics to provide more students with successful experiences are revitalizing partnerships among two-year and four-year faculty and their institutions and are creating sustainable systemic change. Because achieving research-based educational change occurs foundationally within teaching, faculty engagement is vital to systemic change. This chapter presents processes that sustain faculty engagement: data analysis, identification of problems and solutions, design and implementation of those solutions, evaluation of progress, and understanding of changes accompanying the implementation of mathematics pathways. Also addressed are less obvious but equally critical aspects of faculty engagement, such as early participation in conversations for creating change and communication of the rationale for changes to other stakeholders. Processes common to both two-year faculty and four-year faculty are discussed first, followed by how to foster faculty engagement between institutions.

Introduction

New mathematics pathways and multiple entry-level course options designed to meet the needs of a broader range of degree programs have placed faculty at the front lines of creating lasting systemic change and are revitalizing partnerships between two-year and four-year faculty and institutions.

The implementation of multiple mathematics pathways relevant to different programs of study is now a major strategy in many institutions and has been adopted in over 16 states at the time of this writing. For example, in Texas, all 50 public community colleges are involved in such pathways, as are all 27 public institutions of higher education in Oklahoma. The emergence of mathematics pathways across the country is directly related to the persistent experimentation of individuals and groups of educators who sought to offer mathematics courses that were worthy of their students' goals and time. Those efforts led to broad consensus among mathematical professional organizations that endorse the model of mathematics pathways as worth exploring and supporting. Ongoing efforts to implement and sustain mathematics pathways at scale depend on faculty leadership to establish effective reforms that are systemic and sustainable. In their roles behind the scenes in course development and at the daily front lines of classroom implementation, mathematics faculty have the subject-matter expertise to develop and maintain rigorous and meaningful mathematics courses that serve students' interests. The ongoing effort to implement mathematics pathways around the country will succeed only with strong ownership and engagement of faculty.

In this chapter, the role of faculty in developing and implementing mathematics pathways is examined from the perspectives of both two-year and four-year faculty and their institutions. This chapter presents narrative common to both and offers examples of how

faculty engagement can be fostered by the early inclusion of key stakeholders, collecting data, building engagement, supporting ongoing communication, and implementing professional development.

Initial Steps: Early Faculty Engagement and Data Review

Faculty engagement begins with a working team of mathematics faculty and should be formed early in the process. This team should engage in the initial steps of designing and implementing a mathematics pathways program by exploring alternative strategies and seeking input from faculty at other institutions who have wrestled with similar problems. These discussions inform faculty about the reform approaches, details of implementation, what does and does not work, and important steps that might enable positive changes. Many faculty are appropriately skeptical of new approaches and need to be provided with large-scale data demonstrating the effectiveness of mathematics pathways at other institutions and systems, particularly those with similar characteristics as their own. Faculty may also have a tendency to want to pilot small-scale versions of reforms. However, reviewing data that illustrate that students are not being better served by the status quo, or worse—that great numbers are being harmed—creates the urgency to scale as quickly as possible.

The faculty view of student success is nearly always at the course level. From the lecture hall, lab, or office hours, faculty experience course-specific, semester-long snapshots of their students' academic programs and lives. From this perspective, inspiring performances on challenging projects or an 80-percent pass rate in a course are measures of success. However, faculty are often not able to see the number of students who never made it to their courses

in the first place. They do not know whether their students continued to the next course nor how they fared once there. Faculty may not know whether their courses were ultimately applicable to completing the students' certificates or degrees. By engaging in data review and program redesign—by listening, planning, implementing, and evaluating new mathematics pathways—faculty can gain a broader perspective and participate in transforming key aspects of academic structures that undermine student success. The selection, collection, and review of institutional data to obtain a broader perspective of the role of mathematics courses in the academic system are critical initial steps in program redesign and faculty engagement. Although faculty may have a strong experiential sense about what currently works well in their courses and departments, close review of student success data is necessary to identify and understand previously overlooked problems.

When disaggregated and explored longitudinally, student data reveal which populations succeed, which do not and, where unforeseen, problematic points occur. Not all data need to be collected at once, and faculty may desire to collect other data once a few sets of data have been collected, analyzed, and processed in conversations. As data are reviewed, the faculty team can clarify possible problems by interviewing strategic groups of people. Typical stakeholder groups include faculty from other disciplines who might offer a different perspective, students who were successful in mathematics and have shifted to a non-STEM major, students who have repeated a particular mathematics course, and advisors who work with struggling students.

Early, Comprehensive, and Ongoing Faculty Conversations

Faculty involvement is key to any curriculum transformation effort (Allan & Estler, 2005;

Bailey, Jagers, & Jenkins, 2015; Niehaus & Williams, 2016). After data analysis is complete, mathematics pathways implementation begins with early and comprehensive conversations among mathematics faculty, faculty in partner disciplines, faculty in neighboring two-year colleges and four-year universities, and faculty across the state or nation with experience in similar reform. Being involved in making crucial decisions during early planning about new mathematics pathways allows faculty to participate in developing solutions. Such discussions are richer when they involve a broad range of faculty, including those teaching current gateway courses, developmental prerequisite courses, and courses in partner disciplines that subsequently use content in gateway courses.

Although faculty may be eager to implement changes on their campus immediately, these structural changes take multiple semesters to employ. That time is best used to foster broad faculty engagement to build understanding and ownership. Members of the working team should document their understanding of the problems to address on their campus, the potential challenges in implementing various strategies, and possible resolutions to these implementation challenges. As specific strategies are identified, the team should develop descriptions of how those changes will be implemented, timelines for action, and who needs to be involved or informed at each stage of the change process.

Early in the planning phase, an inventory of specific mathematical competencies required for programs of study in regional or statewide two-year and four-year institutions should be developed. A complete survey of program requirements for mathematics courses provides a strategic starting point to review mathematical prerequisites and competencies that students need to successfully complete two-year and four-year program degree requirements. In both Texas and Oklahoma, an inventory of program

requirements was compiled for all public four-year institutions in each state. This inventory helped mathematics faculty to understand the need to rethink the student learning outcomes of traditional courses and design new courses more relevant to programs of study. Additionally, a survey enables faculty to identify where changes in degree requirements should be considered to ensure that courses taken at one institution will be *applicable* to the students' programs of study when transferred to another institution.

Faculty conversations serve to nurture collaborative planning with others, support instruction, and create aligned assessments for student learning when implementing mathematics pathways. El Paso Community College (EPCC) in Texas successfully implemented mathematics pathways by engaging mathematics faculty in the initial development, review, and offering of statistics pathways courses. At EPCC, involvement in the Guided Pathways program (Jenkins, 2014) allowed the inclusion of all faculty in pathways discussions, boosted implementation of mathematics pathways, and facilitated conversations with faculty from other disciplines. As EPCC's Guided Pathways program evolved, the need to construct groups of common majors (called meta-majors) required faculty to engage in conversations with both Science, Technology, Engineering, and Mathematics (STEM) and non-STEM programs.

In the process of implementing mathematics pathways programs, communication and collaboration between two-year college faculty and four-year college faculty ensures the articulation and applicability of courses to programs of study when students transfer. These partnerships should also involve academic advisors from two-year and four-year institutions who can review and provide feedback on the modified requirements for program-specific mathematics courses.

Re-envisioning Mathematics Prerequisites, Placement, and Competencies

Engaging mathematics faculty early in conversations with other faculty and administrators from other disciplines and institutions provides time for dialogue and discussion around mathematical prerequisites and competencies required in students' broader pursuits. As faculty collaborate with partner institutions, sharing common practices can facilitate needed changes to transfer, prerequisite, and placement policies.

In addition to offering entry-level mathematics courses more appropriate to various degree programs, faculty often encounter related issues that need to be addressed. For example, a typical pass rate (grade of C or better) for developmental and gateway courses is 70 percent. Similarly, the persistence rate (for proceeding to the next course) is also often around 70 percent for such courses, meaning that each course in a required sequence reduces the number of successful students by about half (Tennessee Board of Regents, 2016; Thompson et al., 2007; University System of Georgia, 2013; Wilson & Oehrtman, 2017). Administrators and faculty at many institutions are realizing that the trickle of students emerging from long sequences of courses, especially at the developmental level, is more a result of time and attrition than anything else. Students placed into remedial courses often internalize the message that they are not "college material" and consequently are quick to give up when the courses, or intervening life circumstances, become challenging. Students in College Algebra are often not able to see any meaningful use of the symbolic manipulation they are asked to master and develop a view that succeeding in college is a game that they need to play (Burdman, 2015; Gordon, 2008).

Collaboration among faculty across two-year and four-year institutions and across disciplines can greatly enhance the effectiveness of discussions about relevant and engaging mathematics content. For example, by reviewing longitudinal student success data, faculty nationwide can collaborate to accelerate underprepared students into credit-bearing math courses with remediation provided as additional support that is aimed in a timely and direct way to support success in that course. Likewise, mathematics pathways that are tailored to non-STEM degree programs and incorporate relevant applications and quantitative tools relevant in other fields help students appreciate the relevance of these courses. Such shifts are only possible with significant opportunities for math faculty to review relevant data to make, design, and implement informed decisions.

Degree programs often require a variety of mathematical competencies that are not addressed in a single gateway course or that may not be presented in ways that convey their relevance to students in non-STEM programs of study. Faculty sharing strategically selected lessons from mathematics courses can showcase the competencies students will need before enrolling in a subsequent non-mathematics course. Such collaborations can also help identify core content in each mathematics gateway course that coherently frames and supports significant portions of subsequent courses in students' programs of study. For such topics, faculty should develop:

- (i) a description of the levels of understanding desired for all students in the course;
- (ii) common entry points for students' understanding;
- (iii) a progression of challenges and solutions in which students must engage to develop these understandings;

- (iv) common pitfalls in the learning process and ways to address them;
- (v) a mapping of ways in which these core concepts support thinking and learning throughout the entire course; and
- (vi) applications relevant to the academic degrees supported by the gateway course that could serve as strong context for the learning goals.

Professional Development Focused on Advances in the Learning Sciences

While most faculty have honed their teaching expertise through years of individual practice, reflection, and discussion, few faculty are familiar with new approaches that can be adapted in their courses. As changes are implemented, faculty may become overwhelmed by new curricula pedagogy, assessments, and classroom structures. Support is critical to help faculty adjust to the changes.

A crucial part of a dynamic and growing educational enterprise, faculty development is “a necessity, not a nicety” (McKee & Tew, 2013, p. 3). Faculty development that focuses on advances in teaching and learning via the learning sciences (Bransford, 1999) has already enriched many faculty conversations when implementing mathematics pathways. Professional development to implement mathematics pathways must engage faculty in identifying and understanding student characteristics and core content in mathematics pathways courses. Faculty also need time to learn about teaching and learning processes for these concepts. Important points in these faculty development conversations should be about “knowing how to apply this knowledge” and “applying the discoveries of the learning sciences to teaching in ways that improve and yield meaningful information about student learning” (Moy, 2014, p. 42).

The interactions between students' views of their intelligence and abilities and their persistence and goal orientations are particularly critical for entry-level students (Blackwell, Trzesniewski, & Dweck, 2007; Dweck & Leggett, 1988). Individuals who view intelligence as innate and fixed tend to adopt goals to demonstrate proficiency and persist only in cases of perceived success, while avoiding challenge when they perceive failure. On the other hand, individuals who view intelligence as malleable, and able to grow with use, typically adopt goals to increase their competence and persist, seeking challenges regardless of success. These effects are particularly strong when gender or racial stereotypes of performance are activated in learners (Aronson, 2007), raising particular concerns for the impact that such self-theories may have on performance and persistence of underrepresented populations in academic pursuits. Supporting students' development of a growth mindset requires careful attention to the interplay between mathematical tasks, mathematics as an intellectual pursuit, and the goals, interests, and resources that students bring to the learning environment.

Professional development requires persistence. Faculty development related to implementation of mathematics pathways should not be about attempts to change people but rather about engaging faculty early in focused, ongoing conversations. When data showing increased measures of student success are provided, efforts may be easier to implement, scale, and sustain. As Kegan and Lahey (2001) observed, "Successful collaborative efforts do not occur because leaders change hearts and minds, but rather because they clarify and emphasize how these efforts will promote individuals' preexisting values" (p. 73).

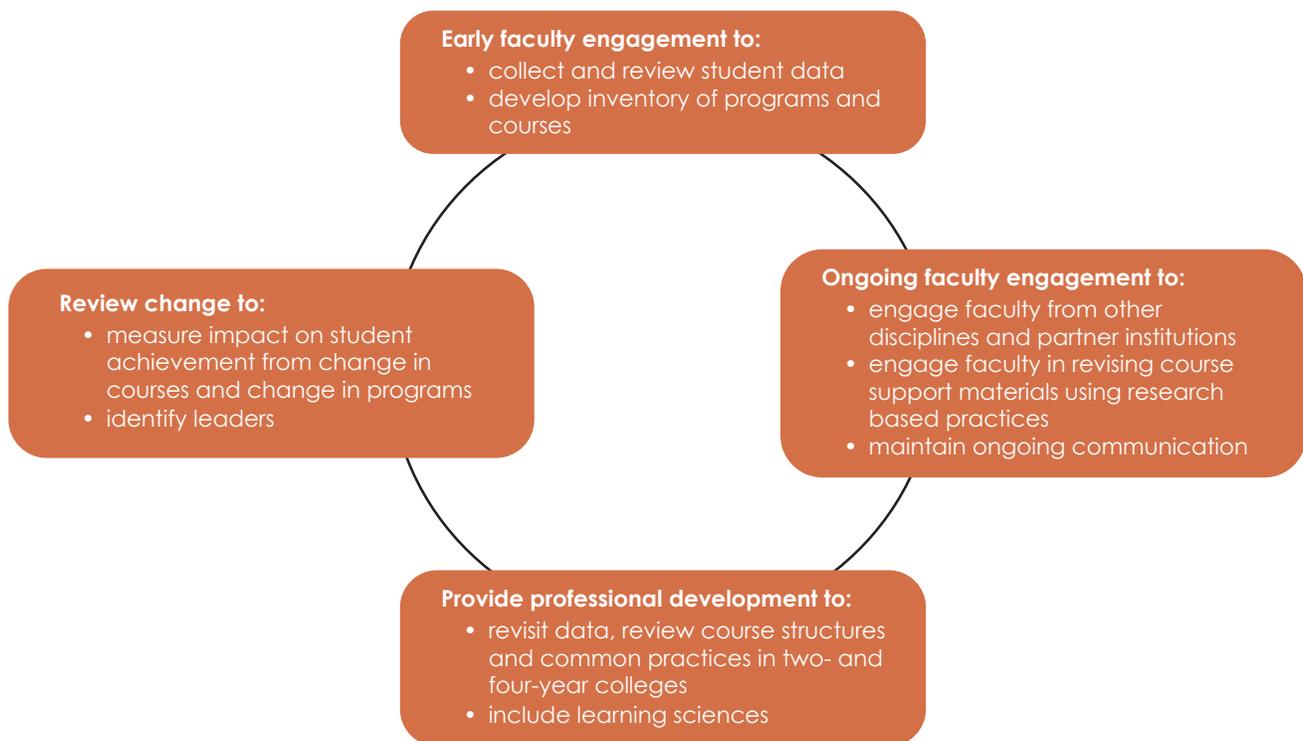


Conclusion

Key recommendations to faculty and institutions considering a curricular redesign are summarized in Figure 1. This cycle of improvement includes:

- 1) **early engagement of faculty** to collect and review data, courses, and programs of study;
- 2) **ongoing conversations** with comprehensive groups of faculty from other disciplines and partner institutions;
- 3) **professional development** to discuss institutional, regional, statewide, and national student data; to identify and clarify mathematical prerequisites and competencies, placement, and common practices in two-year and four-year partners; and to incorporate advances in the learning sciences; and
- 4) **review of the impact that change has on student achievement** and identification of leadership to continue faculty engagement.

Figure 1. Continuous cycle for engaging faculty in program redesign and implementation



Effecting long-term change at the scale of multiple academic institutions, or even an entire state, is an inherently sociocultural process. The priorities and goals of stakeholders from students to faculty, advisors, and administrators must shift. The daily practice of many of these individuals will radically change. Mathematics faculty, as the primary participants in the community engaged around designing and implementing entry-level mathematics course options, must therefore be engaged in increasingly

broad circles of participants. This faculty participation simultaneously grounds the changes in the expertise necessary for success and builds faculty's capacity to initiate and support change. Change as a process will require faculty leaders within the process to bring in other faculty to create sustainable change. As leaders within a culture and process of change (Fullan, 2001), faculty will need added support to take the change to scale and make it sustainable. Each of the key recommendations presented in this chapter focuses on mutually activating these aspects of faculty engagement.

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