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Alternative Models to Deliver Developmental Math: Issues of Use and Student Access

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Abstract

Objective: Changing how community colleges deliver developmental education has become a key policy lever to increase student achievement. Alternative development education models reduce the amount of time a student spends in remediation, provide students with supplemental instruction and support, and contextualize content to align with student academic and career interests. While some states mandate the use of alternative delivery models, other states, such as California, give discretion to colleges over how developmental education should be delivered. We investigated how community colleges from one California district with particularly high remediation rates have responded to external pressures to revamp the traditional delivery model for developmental math. We did so by studying which delivery models they used, where they allocated alternative delivery models in the math sequence, and the extent that they adopted alternative delivery models over time. **Method**: We employed content and descriptive analytic methods to examine descriptions of developmental math courses sections. **Results:** First, colleges employed commonly known alternative models but also utilized unfamiliar ones, such as extending the developmental math sequence. Second, more academically prepared students had greater access to course sections offering alternative approaches in contrast to less academically prepared students. Third, despite the push for alternative approaches, the traditional model prevailed in the delivery of developmental math over time. **Contributions:** We provide hypotheses to explain why community colleges failed to adopt alternative models at scale, and argue that inequitable access to these approaches is a missed opportunity to alter the educational experiences of the least prepared.

Keywords

equity, alternative delivery models, developmental math, developmental education

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Developmental education has been the principal means to prepare postsecondary students who are deemed underprepared for college-level coursework (Arendale, 2002). Despite the fact that more than 60% of community college students are assigned to developmental education, research has shown that only a small percentage of them ever reach college-level courses required for an associate's or bachelor's degree (Bailey, Jeong, & Cho, 2010; Fong, Melguizo, & Prather, 2015). Faced with this evidence, policymakers, administrators, and researchers are calling for change in developmental education policies and practices (Bettinger, Boatman, & Long, 2013; Collins, 2009).[1]

One of the main efforts to reverse low success rates among remediated students involves changing the way community colleges structure and teach—or deliver—developmental education (Rutschow & Schneider, 2011). Traditionally administered as a series of lecture-based, semester-long courses, research suggests that developmental education increases the amount of time a student must spend in school and the possibility that a student will drop out in between semesters, resulting in a situation ripe for non-completion (Bailey, 2009; Melguizo, Hagedorn, & Cypers, 2008).

Community colleges across the United States are developing new or alternative models of delivery to address the perceived flaws of traditionally delivered developmental education by reducing potential exit points and the amount of time spent in developmental education (Bracco, Austin, Bugler, & Finklestein, 2015; Carnegie Foundation for the Advancement of Teaching, n.d.; Jenkins, 2014); contextualizing developmental education instruction in real-life applications (Perin, Bork, Peverly, Mason, & Vaselewski, 2012; Wachen, Jenkins, & Van Noy, 2011); and providing additional academic support and advising to developmental education students (Arendale, 2002; Moore & LeDee, 2006). The overhaul of the traditional delivery model is, in part, due to the enactment of statewide policy reforms requiring community colleges to substantially redesign the structure, instruction, and curriculum of developmental education. For example, Texas Senate Bill 162 requires Texas community colleges to develop instructional models that accelerate a student's progress in developmental education, including those offering non-course-based options, integrated reading and writing, and mainstreaming of upper level developmental education students directly in college-level coursework (The Texas Higher Education Coordinating Board, 2012). Similarly, North Carolina's Developmental Education Initiative had the specific goal of transforming the way that community colleges support students as they move toward college readiness by modularizing developmental education curriculum and blending developmental reading and writing (SuccessNC, 2012). Efforts at redesigning developmental education delivery have also been supported by large philanthropic organizations such as the Bill and Melinda Gates Foundation and the Lumina Foundation for Education, or championed by groups of faculty and administrators, but most of these endeavors have focused primarily on specific models of delivery (Rutschow & Schneider, 2011).[2]

Despite the insistence that the delivery of developmental education must be reformed to better meet the needs of students, current research focuses almost exclusively on reform initiatives encouraged by state legislation or spearheaded by philanthropic organizations whose intent is to expand and test the effectiveness of particular alternative delivery models (e.g., Rutschow & Schneider, 2011; Visher, Weiss, Weissman, Rudd, & Wathington, 2012). This emphasis has limited our knowledge about the extent that all community colleges, particularly in states where delivery reforms have not been mandated, employ alternative models of delivery and determining who ultimately has access to these new approaches. The research questions that frame this study are as follows:

Research Question 1: To what extent are community colleges changing the delivery of developmental education in contexts where mandates do not exist?
Research Question 2: To what extent do students with different remedial needs have access to alternative models of delivery for developmental education?

The answers to these questions are important because they can expose where innovations in the delivery of developmental education are out of reach to students, as well as help to explain disparities in achievement among students of varying degrees of academic preparation.

This study sheds light on the use and the allocation of alternative developmental models to deliver developmental math and centers on community colleges belonging to a large, urban community college district (henceforth, LUCCD) in California. We focus on this group of community colleges for two reasons. First, the LUCCD is located in California, a state that has not passed systemic delivery reforms in developmental education and cedes authority to community colleges over the delivery of developmental education (Getting Past Go, n.d.). Second, LUCCD community colleges annually place, on average, 80% of their students in developmental education (California Community Colleges Chancellor's Office [CCCCO], n.d.), 20 to 30 points higher than estimates of the percent of U.S. community college students assigned to developmental education (Attewell, Lavin, Domina, & Levey, 2006; Bailey et al., 2010; Horn & Nevill, 2006). For these reasons, we argue that studying the use and the allocation of alternative delivery models for developmental math within the LUCCD offers a unique glimpse into the internal efforts of community colleges with high rates of remediation to revamp the delivery of developmental math. We focus on math because evidence shows that students appear to have a harder time progressing through math than reading (Bailey et al., 2010).[3]

In examining descriptions of developmental math course sections published in LUCCD course schedules between 2005 and 2013, we identified which approaches LUCCD used to alter the delivery of developmental math, the degree that developmental math education students had access to these approaches, and the extent that these approaches were taking hold in the LUCCD over time.

Findings from our analysis contribute to developmental education research and knowledge in three significant ways. First, we found that LUCCD colleges not only employed common alternative models to deliver developmental math (e.g., supplemental instruction, acceleration) but also offered ones absent from discussions about alternative delivery models, such as extending the developmental math sequence. This suggests that community colleges, even absent state mandates, are responding to the demands to change how they structure and teach developmental math. However, they are doing so in unique ways, which the literature has overlooked. Second, our analyses showed that students with fewer remedial needs had a disproportionately large amount of access to course sections offering alternative delivery approaches in contrast with students with greater remedial needs. This implies that where community colleges locate alternative models of delivery in the developmental math sequence may be inadvertently exacerbating achievement disparities between students who are more academically prepared for college and and those who are less academically prepared. Finally, we discovered that the national push for alternative delivery models for developmental education had not translated into major changes in the way LUCCD colleges structured and taught developmental math. This hints that community colleges may face significant barriers to changing and scaling how they deliver developmental education.

Traditional and Alternative Models of the Delivery of Developmental Math

Developmental math has been traditionally delivered as a sequence of courses that resemble a high school math progression focused on teaching algebraic content. Researchers find that being placed into a traditional developmental math sequence may predispose students to academic failure in two ways (Grubb, 1999; Grubb & Gabriner, 2013; Melguizo et al., 2008). First, placement into developmental math inherently increases the amount of time and money a student must spend in college to earn a degree or transfer, which may dissuade some from enrolling in or persisting through college (Melguizo et al., 2008).[4] Second, traditional models of delivery, which are typically lecture-based, often employ remedial pedagogies that focus on drills and sub-skills and that are disconnected from other courses and real-world applications; these approaches may not adequately respond to the academic needs and behaviors of remediated students (Grubb, 1999; Grubb & Gabriner, 2013).

In response to legislative mandates, some community colleges have started to employ alternative models to deliver developmental education. Each alternative model or approach uses a different strategy to address the perceived flaws of the traditional delivery model, and falls under four broad categories in Rutschow and Schneider's (2011) taxonomy: (a) helping students shore up skills prior to entering college; (b) providing supplemental instruction, such as tutoring and advising; (c) reducing the amount of time students spend in developmental education; and (d) redesigning curriculum and learning. We exclude the first category of alternative models from our analysis because we focus on approaches implemented after a student has enrolled in college. Below, we define these alternative delivery models and summarize the evidence on their impact on student success.

Providing Supplemental Instruction and Support

Supplementing traditional coursework with additional instruction or support is thought to improve success by providing developmental education students extra academic and non-academic resources (O'Gara, Karp, & Hughes, 2009; Rutschow & Schneider, 2011). As an example, tutoring and math labs are designed to provide individualized instruction to meet students' unique academic needs (Perin, 2004). Likewise, supplemental support provided through student success courses and advising is aimed to help students develop good study skills, manage time effectively, and select academically and career suitable courses (Cho & Karp, 2013).

Evaluative research in this area is exclusively correlational. For instance, Arendale (2002) described how academic-based supplemental instruction (i.e., students reviewed course materials with trained peers) was associated with increased persistence and academic achievement. In other studies, intensive advising was linked with successful completion of remediation (Bahr, 2009) and enrollment in more rigorous courses (Boylan, Bliss, & Bonham, 1997). Participation in student success courses was positively related with improvements in learning strategies (Boylan, 2002) and persistence, completion, and transfer rates (Cho & Karp, 2013; Zeidenberg, Jenkins, & Calcagno, 2007). No studies we reviewed enabled causal inference of these interventions, so further research is needed to more fully understand the impact of this alternative delivery model.

Reducing the Amount of Time in Developmental Education

Alternative models of delivery that reduce the amount of time students spend in remediation directly address the potential negative consequences of long multicourse sequences (Bailey et al., 2010). Students with the most remedial requirements to complete are the least likely to persist (Bailey et al., 2010; Fong et al., 2015), and extending the amount of time in remediation has been found to decrease semester-to-semester persistence (Ngo & Kosiewicz, forthcoming). The existence of "exit points" separating courses in developmental education sequences has also been a point of concern because each one gives students an easy opportunity to drop out in between courses (Hern, 2012; Venezia & Hughes, 2013). Acceleration, compression, and modularization models are three alternative delivery approaches designed to shorten the amount of time spent in developmental education and make the sequence more seamless. Acceleration models typically combine developmental courses to reduce the number of courses a student must complete to enroll in college-level courses (Hern, 2012). Compressed or fast-track courses maintain the same developmental education sequence but shorten the time needed to teach content by requiring students to enroll in two compressed courses the same semester (Hodara, 2013). Modularization models break semester-long developmental education classes down into smaller competency-based units (Twigg, 2005), and center on addressing specific skills in which students are deficient (Rutschow & Schneider, 2011).

Findings from evaluations of these models are mixed, in part because of the way these evaluations were conducted. Correlational studies show that students in the California Acceleration Project were more than twice as likely to complete college-level courses than their peers (Hayward & Willett, 2014; Hern, 2012). Two other studies found that modularized developmental education at Jackson State University in

Tennessee was positively associated with passing rates, improved learning outcomes, and increased retention in and completion of developmental math (Bassett & Frost, 2010; Epper & Baker, 2009). Yet, causal methods studies paint a more complex picture. Using both difference-in-difference and regression discontinuity approaches, Boatman (2012) found that Tennessee students in accelerated courses (at Cleveland State Community College) and modularized developmental math courses (at Jackson State University) completed more units but failed to persist at the same rate as their traditional counterparts. Hodara and Jaggars (2014) used matching methods and found that students in compression programs in the City University of New York were more likely to pass college math and complete their degrees, yet obtained the same number of credits as traditional developmental education students. Based on this range of results, the true effects of acceleration, compression, and modularization models remain unclear.

Redesigning Curriculum and Learning

Alternative models of delivery that redesign curriculum in developmental education inherently change curricular content and how students learn developmental education. This approach is founded on the idea that pedagogical practices and curricula promoting reasoning skills, conceptual understanding, and real-world applications, more so than procedural knowledge, are key to increasing student success (Hiebert & Grouws, 2007; Mesa, 2011). Statway, a program developed by the Carnegie Foundation for the Advancement of Teaching, is perhaps one of the best known types of curricular redesign in developmental math, and is built on the belief that mastery of statistical concepts yields more academic benefits to students pursuing non–Science, Technology, Engineering, and Mathematics (STEM) fields of study (Cullinane & Treisman, 2010; Yamada & Bryk, 2016). Other forms of developmental education redesign we discuss are learning communities, co-requisite courses, and guided pathways (Bailey, 2015; Belfield, Jenkins, & Lahr, 2016; Rutschow & Schneider, 2011). Learning communities require students to enroll in developmental education courses as cohorts and engage in collaborative learning experiences with a core group of professors and peers. This approach is founded on the belief that meaningful interactions between students and faculty can improve communication and content understanding, and thus student success (Tinto, 1997). Co-requisite models allow students to take remedial courses at the same time as college-level courses, giving them the opportunity to earn college-level credit more quickly (Jones, 2015; Smith, 2015). Finally, guided pathway models address the unstructured nature of community college academic programs by encouraging colleges to define learning outcomes and align curricular experiences and support services with students' specific college and career goals (Bailey, Jaggars & Jenkins, 2015).

Although some of these reforms are gaining traction, the evidence on their effectiveness remains limited. The Integrated Basic Education and Skills Training (I-BEST) program in Washington state is a developmental education redesign that has received the most scrutiny. Two separate causal studies found that I-BEST students were more likely to earn credits, obtain a credential, and demonstrate point gains on basic skills tests relative to non-affected students (Jenkins, Zeidenberg, & Kienzl, 2009; Zeidenberg, Cho & Jenkins, 2010). An evaluation of Statway using propensity score matching found robust positive effects on college math credit completion and student persistence (Yamada & Bryk, 2016). Finally, a randomized study of developmental education learning communities found only modest impacts on credit attainment and no evidence of any positive effects on student persistence (Visher et al., 2012). To the best of our knowledge, there have been no causal studies examining the impact of co-requisite courses and guided pathways, although there is some evidence from Tennessee indicating higher pass rates and increased cost effectiveness of co-requisite models (Smith, 2016).

Use of and Access to Alternative Models of Delivery: What's Missing?

While evidence shows that community colleges are employing alternative delivery models in response to state legislative mandates, relatively little empirical research exists on whether these alternative approaches are taking hold in community colleges with high remediation rates but facing low external pressure to change. What is also missing from the literature is a description of the nature of student access to these interventions. Rutschow and colleagues (2011) found that less than 10% of students targeted by the expansive Achieving the Dream initiatives were actually affected by them, which raises concerns that community colleges may be administering reforms in ways that do not provide equal opportunities for *all* developmental education students to succeed. From an Opportunities to Learn perspective (McDonnell, 1995), knowing the extent that students of various levels of academic preparedness have access to developmental math reforms can be useful in understanding why some students succeed in developmental math while others do not.

Setting

The setting of this study is the LUCCD, which serves roughly 220,000 students each year (CCCCO Data Mart, n.d.). The LUCCD is comprised of nine colleges and enrolls a diverse group of students, the majority of whom identify as racial and ethnic minorities. These colleges differ in terms of the types of faculty they employ, as well as the number of degrees they confer to their students. Table 1 compares institutional-level and student demographic characteristics across all nine LUCCD colleges and against the State of California.

Despite these differences, LUCCD colleges have similar developmental math sequences. In eight out of nine colleges, the developmental math sequence starts with arithmetic (four levels below transfer-level math), and is followed by pre-algebra (three levels below), elementary algebra (two levels below), and intermediate algebra (one level below). In one college, a course focused on basic numeracy (titled The World of Numbers) precedes arithmetic. Since the fall semester of 2009, California has required students to pass intermediate algebra to receive an associate's degree. In

Table 1. Statistical Profiles of LUCCD Community Colleges.

	Colleges									
	A	B	C	D	E	F	G	H	J	CA State
College characteristics										
Total enrollment	31,209	17,135	25,767	29,258	14,721	16,676	56,419	31,313	13,256	2,589,518
% FTES	42.8	39.5	44.8	40.5	43.7	41.5	37.9	44.1	35.8	46.6
Number of TT faculty	175	59	156	170	81	80	216	156	55	17,870
Number of adjunct faculty	430	277	290	368	284	282	553	514	204	41,451
Percentage TT faculty	28.9	17.6	35.0	31.6	22.2	22.1	28.1	23.3	21.1	30.1
Associate's degrees awarded	959	729	1,206	1,352	668	661	3,349	1,458	405	148,025
Transfers	134	101	125	190	133	141	234	263	104	28,826
Student demographics (%)										
Female	58.4	62.4	48.9	58.7	59.9	61.5	51.0	56.3	69.4	53.8
Age 24 or less	46.9	60.2	50.2	58.1	63.2	49.7	52.5	63.7	48.4	53.0
Age 25-34	23.9	20.4	24.6	22.3	20.0	25.8	22.0	16.7	22.7	20.9
Age 35-49	17.4	14.2	17.9	13.3	11.9	16.6	18.7	10.2	20.2	15.3
Age 50+	11.8	5.2	7.4	6.3	4.8	7.9	6.7	9.4	8.6	10.6
African American	10.6	5.9	26.6	5.9	14.1	36.4	4.1	6.0	54.2	7.4
Hispanic	45.2	66.0	53.2	42.5	45.5	29.3	59.4	32.5	37.1	32.6
Asian/Pacific Islander	17.8	7.3	6.3	10.2	16.3	8.3	15.0	14.7	2.1	15.5
Native American	0.3	0.4	0.3	0.3	0.5	0.4	0.2	0.4	0.2	0.7
White (non-Hispanic)	18.1	11.2	6.0	29.8	15.8	14.3	7.8	34.7	1.2	32.8
Multi-ethnic	0.8	0.5	0.5	0.8	1.2	1.3	0.2	1.2	0.7	1.4
Unknown	7.2	8.8	7.0	10.5	6.5	10.0	13.3	10.5	4.6	9.7

Source. California Community Colleges Chancellor's Office Data Mart.
Note. Each cell reports averages for the 2005-2013 academic years. Transfers include both in-state and out-of-state transfers. Asian includes Chinese, Japanese, Korean, South Asian, Cambodian, Laotian, Vietnamese, Filipino, Native Hawaiians, Guamanians, Samoans, and other Asian or Pacific Islander subgroups. Multi-ethnic denotes those indicating multiple racial/ethnic backgrounds. CA = California; FTES = full-time equivalent students; LUCCD = large, urban, community college district (in California); TT = Tenure Track.

2012, LUCCD colleges placed 80% of their students into developmental math, even though most report graduating from high school.

Method

Content Analysis

To identify which alternative delivery methods LUCCD colleges used to deliver developmental math, we conducted a content analysis of course schedules published by each college between 2005 and 2013.[5] Unlike other qualitative data sources (e.g., interviews with administrators), course schedules can provide a more objective account of the utilizations of alternative delivery models as they offer brief descriptions of each developmental math course (e.g., prerequisites, unit worth, model of delivery).[6] Course schedules also publish information on the number of sections offered for each developmental math course, which can be used to determine changes in the prevalence of alternative delivery models over time. Because of these characteristics, we argue that course schedules can be considered reliable sources of data for examining the use and the allocation of alternative delivery models for developmental math. In this study, we treated developmental math course sections as our unit of analysis, and reviewed all 8,909 developmental math course sections offered by LUCCD colleges between 2005 and 2013.

To ensure that we captured alternative models used to deliver developmental math course sections in the LUCCD, we adopted deductive and inductive approaches to code data collected on each course section. According to Bradley, Curry, and Devers (2007), a hybrid approach helps researchers to identify concepts already known in extant literature as well as new ones. As a first step, we employed a deductive coding scheme by applying Rutschow and Schneider's (2011) taxonomy of alternative models of delivery to guide our initial analysis (Miles & Huberman, 1994). We applied four general codes to identify alternative models of delivery used to teach LUCCD developmental math course sections: (a) models that provided supplemental instruction and support, (b) models that reduced time in developmental math, (c) models that redesigned curriculum and instruction in developmental math, and (d) the traditional delivery model. In applying our deductive coding scheme, we specifically looked for words or phrases in the description of each developmental math course section to determine whether it corresponded with any of the four general codes. Furthermore, within each general code (with the exception of the traditional delivery model), we also created subcodes that allowed us to identify the specific type of alternative models of delivery being employed (e.g., acceleration, learning community, co-requisite). For example, we classified any developmental math course section that informed students that course material would be taught over 8 weeks, instead of the traditional 16 weeks, as a model that reduced time in developmental math, and more specifically as compression. As another example, we codified any developmental math course section that notified students that they were required to co-enroll in a math lab as a model that provided students supplemental instruction or support, and, more specifically, supplemental instruction. We considered course sections that were described as 16 weeks long, did not offer students supplemental instruction or support, or did not adjust math content to meet specific student needs or interests as the traditional model of delivery.

In instances where we could not clearly match the model of delivery used to teach a developmental math course section to approaches described in Rutschow and Schneider's (2011) taxonomy, we employed an inductive coding strategy. This strategy involved each co-author individually tagging a particular developmental math course section, and then the three of us jointly discussing the structure, the curriculum, and the length of time used to teach that course section. We used these discussions to develop new codes to capture models of delivery that were missing from Rutschow and Schneider.

From the beginning of our coding process, we tagged course descriptions in batches, starting with a random sample of roughly 500 course sections representing the full cross-section of developmental math courses. After coding the first batch, we coded another group of 500 randomly selected developmental course sections to revise our coding scheme, and continued this process until we completed all 8,909 developmental math course sections delivered between 2005 and 2013. This process led us to develop a final coding scheme of alternative delivery models used to deliver developmental math in the LUCCD.

To test whether our final coding scheme adequately categorized the alternative models of delivery found in the LUCCD, we calculated Cohen's (1960) kappa statistic on a randomly selected but representative sample of 212 developmental math course sections, which we each coded on our own. Our calculation produced a coefficient of 0.83, suggesting that each of the coding processes were in close alignment (Landis & Koch, 1977). Where there were discrepancies or problems in our coding, we reviewed them and clarified the coding definitions before applying our amended final scheme to recode all 8,909 developmental math course sections. From this analysis, we developed a revised taxonomy of alternative models to deliver developmental math in the LUCCD (see Table 2).

Data Analysis

From recoded course sections, we created a final dataset that contained a record for each course section that included the semester and the year the course section was taught, the college at which the developmental math course section was taught, the associated developmental math level, type of delivery model (e.g., alternative vs. traditional), type of alternative delivery models (e.g., accelerated, contextualized), and name of the alternative delivery models through which it was administered (if there was one).

Our descriptive analyses examined the extent that students with varying levels of remediation had access to alternative delivery models, and which alternative delivery models LUCCD colleges adopted between 2005 and 2013. To examine student access to alternative delivery models, we calculated the percent of developmental math

Table 2. A Revised Typology of Alternative Models of Delivery for Developmental Math.

Model of delivery	Programs	Definitions	In Rutschow and Schneider (2011) alternative MOD taxonomy
Accelerated Developmental Math: This model of delivery reduces the amount of time spent in developmental math	Compression	Compression shortens traditionally-delivered developmental education courses into several weeks or a half semester	Yes
	Modularized courses	Modularized courses break semester-long developmental education classes down into smaller, competency-based units	Yes
	Mainstreaming	Mainstreaming places developmental education students directly into college-level courses, and typically provides additional academic support in the form of tutoring or a study skills course	Yes
Curricularly Redesigned Developmental Math: This model of delivery changes how students learn developmental math by making content relevant to a student's personal experiences or learning goals	Learning communities	Learning communities enroll students in developmental education in cohorts and engage them in collaborative learning experiences	Yes
	Contextualized learning	Contextualized learning ties developmental education with the student's academic and career interests	Yes
	Co-requisite courses	Co-requisite courses allow students to enroll in remedial and college-level courses in the same subject at the same time	No
	Guided pathways	Guided pathways presents courses in a simple, academically intelligible plan that aligns with a student's academic and career interests	No

(continued)

Table 2. (continued)

Model of delivery	Programs	Definitions	In Rutschow and Schneider (2011) alternative MOD taxonomy
Supplemental Instruction: This model of delivery offers additional academic and non-academic supports to developmental education students	Tutoring and supplemental instruction	Tutoring is general academic assistance typically provided by faculty, staff, students, or through computer-assisted instruction; supplemental instruction is academic assistance directly related to a specific course	Yes
	Intensive advising	Intensive advising involves advisors meeting with students one-on-one to discuss their degree plans, promote their intellectual, social, and personal development, and support their academic and career goals	Yes
	Student success courses	Student success courses teach students basic study and life skills	Yes
Extended Traditional Model: This model of delivery lengthens the amount of time a student must spend in developmental math to meet exit requirements			No
Combined Alternative Delivery Model: This model of delivery combines multiple alternative delivery models into single programs			No

Note. We consider co-requisite courses and guided pathways as new programs that fall under alternative delivery models that align curriculum, instruction, and support with a student's academic and career interests. That said, we ultimately do not consider them new alternative models of delivery, even though they were unrecognized by Rutschow and Schneider in their taxonomy.

course sections offering an alternative delivery model, and disaggregated this statistic by developmental math level. To examine changes in access over time, we tracked variation in the percent of developmental math course sections offering an alternative delivery model across years and math levels.

A Revised Typology for Developmental Math MODs

We found that LUCCD colleges used alternative models of delivery that (a) provided supplemental instruction to developmental math students, (b) reduced the amount of time spent in developmental math, (c) redesigned developmental math curriculum, (d) lengthened the amount of time spent in developmental math, and (e) combined multiple alternative models of delivery. Table 2 summarizes these models of delivery, and also specifies which alternative models of delivery fit within Rutschow and Schneider's (2011) taxonomy.

For the most part, the alternative delivery models we examined largely aligned with Rutschow and Schneider's (2011) taxonomy. For example, we found that some LUCCD community colleges required students to concomitantly enroll in labs or student success courses along with their developmental math courses. Others restricted enrollment in certain course sections to students pursuing specific academic or career fields, or were designed to accelerate a student's progress in the developmental math sequence. For instance, one college offered an elementary algebra course that was restricted to students in the automotive program. Another college accelerated students through their arithmetic and pre-algebra courses by offering a course titled "Algebra Readiness," which was described as "a special two-course, one-semester accelerated sequence of classes to prepare the student to enroll in Math 115 [Elementary Algebra]." While these are a few examples, they give a sense of the breadth of the alternative models of delivery LUCCD colleges have adopted on their own.

Despite close alignment with Rutschow and Schneider's (2011) taxonomy, our analysis demonstrated that LUCCD community colleges employed alternative models of delivery that were absent from their typology. The first missing alternative model of delivery was what we term the *Extended Traditional Model*, which lengthens the amount of time a student spends in developmental math by one semester. Courses employing this delivery model split what are typically one-semester courses (e.g., elementary algebra) into two back-to-back semester-long classes, each one having a unique course number or letter (i.e., Math 15, Math 16). Students have to successfully complete both to move to the next level.

We hypothesize that the logic underlying this approach is the assumption that less academically prepared students need more time to master course material. While this makes intuitive sense, we believe that this approach may lead students to less favorable outcomes because it requires them to *re-enroll* in the second part of the course after completing the first part to obtain course credit. This arrangement inherently increases the number of exit points in the developmental math sequence, which may jeopardize student persistence (Bahr, 2012; Fong et al., 2015). Overall, seven LUCCD colleges utilized the *Extended Traditional Delivery* approach.

The second alternative model of delivery absent from current literature was what we term the *Combined Alternative Delivery Model*, which offers students opportunities to enroll in course sections that combine components of different alternative models of delivery into a single program. This approach contrasts the way research has discussed alternative models of delivery as individual and independently delivered (Bettinger et al., 2013). Table 3 provides a snapshot of these programs, and the types of alternative learning opportunities they offer their enrollees. While the combined approach may reflect educators' acute sense of the needs of developmental math students, any measure of its effectiveness is difficult to interpret because it combines multiple strategies into a single intervention.

Traditional Delivery Dominates, Less Prepared Students Have Limited Access to Alternatives

In addition to categorizing the types of alternative delivery models found in LUCCD, we examined their prevalence in teaching developmental math in the district. Figure 1 shows that 69% of course sections were offered via the traditional model. Of those that offered an alternative delivery model (31%), approximately half of these course sections offered students supplemental instruction (45%), 6% accelerated a student's progress in developmental math, and roughly 1% contextualized math instruction (see Figure 1).[7]

We find that the traditional format was the dominant model of delivery across all developmental math levels (see Figure 2). However, we found considerable variation in the use of alternative delivery models to teach different developmental math levels. Colleges employed alternative models of delivery the most in elementary algebra—two levels below transfer-level math, with nearly two fifths of all course sections using a non-traditional delivery approach. In contrast, colleges used alternative models of delivery the least in the lowest levels of the math sequence—The World of Numbers (<10%) and Arithmetic (22%)—as well as the highest level—Intermediate Algebra (20%). This finding suggests that students at either end of the developmental sequence experienced fewer opportunities to learn developmental math in less traditional and possibly more effective ways.

We hypothesize that the concentration of changes in delivery in the middle developmental math levels might stem from the fact that the majority of students place and subsequently enroll into these two levels (pre-algebra and elementary algebra).[8] Despite the ostensible logic of locating the bulk of innovations in the middle levels of the developmental math sequence, what is concerning is that the scope of innovation was severely limited in the lower levels of the math sequence as students in these levels have the hardest time succeeding in college (Bahr, 2012; Fong et al., 2015).

We also found that colleges were selective in the types of alternative models of delivery they offered to students. Table 4 shows that the majority of course sections offering the *Combined Delivery* model, the *Extended Traditional Delivery* model, and the curricular redesign model were located in the upper two levels of the developmental math sequence. In contrast, of all course sections offering students supplemental

Table 3. Programs that Combine Multiple Alternative Models of Delivery.

		Reducing time		Curricular redesign		Supplemental instruction		
Program	Description	Fast-track/ compression	Modularized	Contextualization	Learning communities	Tutoring/lab	Advising	Student success courses
ASAP	Provides students an opportunity to pass both elementary algebra and intermediate algebra in one semester.	●		●				●
Adelante	Provides student services, linked courses, a stimulating learning environment, and committed faculty.			●	●	●	●	
Auto Tech Learning Community	Designed for students pursuing a career in the automotive industry.			●	●			
FIRST	Designed to help recent high school graduates obtain an associate's degree or transfer after 1 year of enrollment.			●	●	●	●	
Fresh Success	Implements learning communities by pairing developmental courses with counseling classes.				●		●	●
Modeling Algebra	Created to help students succeed in intermediate algebra.	●		●		●		●
Program for Adult College Students	Designed as a five-semester, 60 unit curriculum to help the full-time working adult meet transfer requirements.	●		●			●	
Passageways	Designed to increase the success of male students in community college.				●	●	●	
STATWAY	Intended to accelerate a student's progress in developmental math by combining algebraic and statistics courses together.	●		●				
Teacher Pathway	Devised to train students to become future K-6 teachers; in partnership with California State University.		●	●				
Ujamaa	Designed to promote the academic, personal, and professional growth of African American students.				●		●	●
Urban Teachers Program	Participation leads to a teaching credential; offers part-time employment in after-school programs.			●	●	●		
Visions	Designed to help students reach an associate's degree or transfer through acceleration.	●					●	

Note. Some of the names of these programs have been abbreviated or changed to preserve the anonymity of the district.

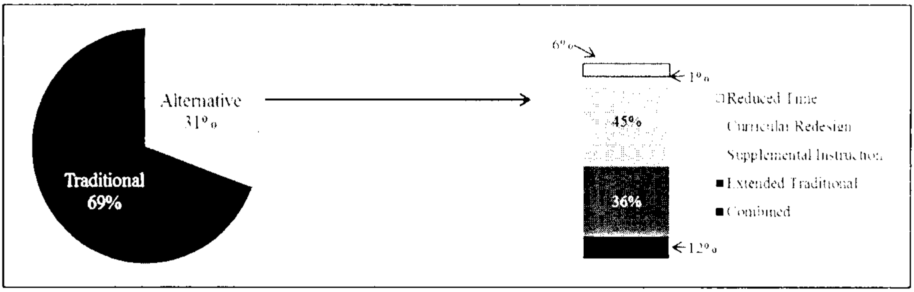

Figure 1. Percent of traditional versus alternative delivery models, distribution of alternative models used.

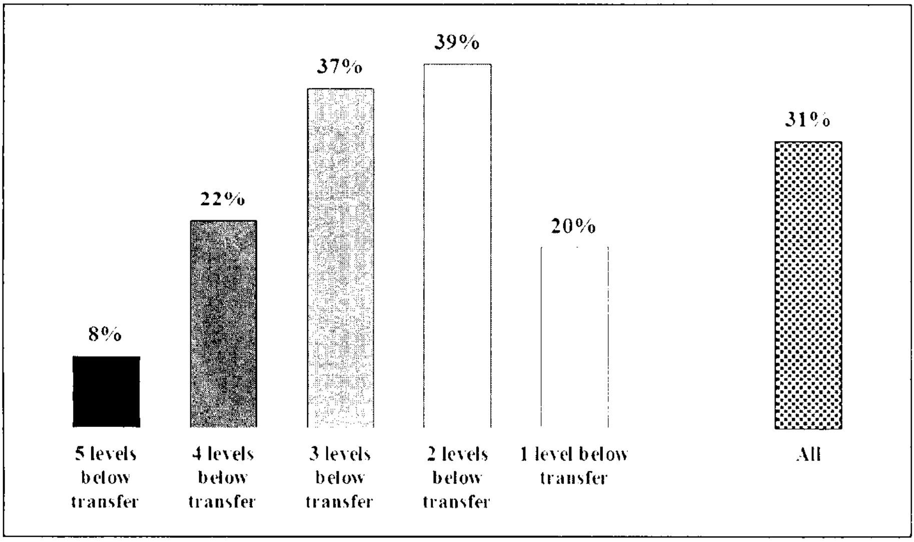

Figure 2. Percent of alternative delivery models, by developmental math level.

instruction, just above half were found in the course sections offering math three levels below transfer level. These results show that not only did the most academically underprepared students lack overall access to alternative models of delivery, but they also lacked access to a variety of these types of models of delivery.

A number of hypotheses might explain why colleges locate specific alternative models of delivery at different levels of the developmental math sequence. One is the belief that students in lower levels of the sequence will benefit more from additional instruction while students in the higher levels may benefit more from additional time to understand the content. Another is that students placed into higher levels of the sequence are more likely to be enrolled as full-time students and able to spend additional semesters of coursework to focus on mastering content. Finally, adjunct faculty are more likely to teach lower levels of the developmental math sequence and may not

Table 4. Distribution of Each Alternative Model of Delivery Across Developmental Math Levels.

	Alternative model of delivery					All alternative MODs
	Reduced time	Curricular redesign	Supplemental instruction	Extended traditional	Combined	
Five levels below transfer	—	—	—	—	—	—
Four levels below transfer	.15	.22	.17	—	.02	.09
Three levels below transfer	.34	.06	.52	—	.10	.27
Two levels below transfer	.34	.67	.24	.69	.58	.46
One level below transfer	.17	.06	.05	.31	.29	.18
% of all Alternative MODs	.06	.01	.45	.36	.12	1.00

have the time or resources to learn how to teach developmental math in ways that radically depart from the conventional method.

Slow Increase in Adoption of Alternative Models of Delivery Over Time

Figure 3 shows that the proportion of course sections offering students alternative models of delivery rose over time, despite briefly decreasing from 2010 to 2011. This increase in usage suggests that LUCCD colleges may have become more responsive to evidence identifying low success rates among remediated students, and, consequently, more open to introducing change to developmental math. The dip beginning in 2010 may reflect budget reductions that affected course offerings district-wide (Public Policy Institute of California, 2013). It also may be linked to the California Community College Chancellor's Office decision to require community colleges to disclose the number of students who were participating in non-course-based instruction (e.g., tutoring sessions, labs), as colleges received additional funding for these services (Academic Senate for California Community Colleges [ASCCC], 2009). LUCCD colleges may have found the new reporting requirement onerous, and as a result abandoned offering this support.

Figure 4 disaggregates adoption trends by alternative delivery model to determine whether some gained or lost traction over time. Overall, we found that supplemental instruction and the *Extended Traditional Model* were the most frequently employed over time. We also observed from 2010 to 2011 that course sections offering supplemental

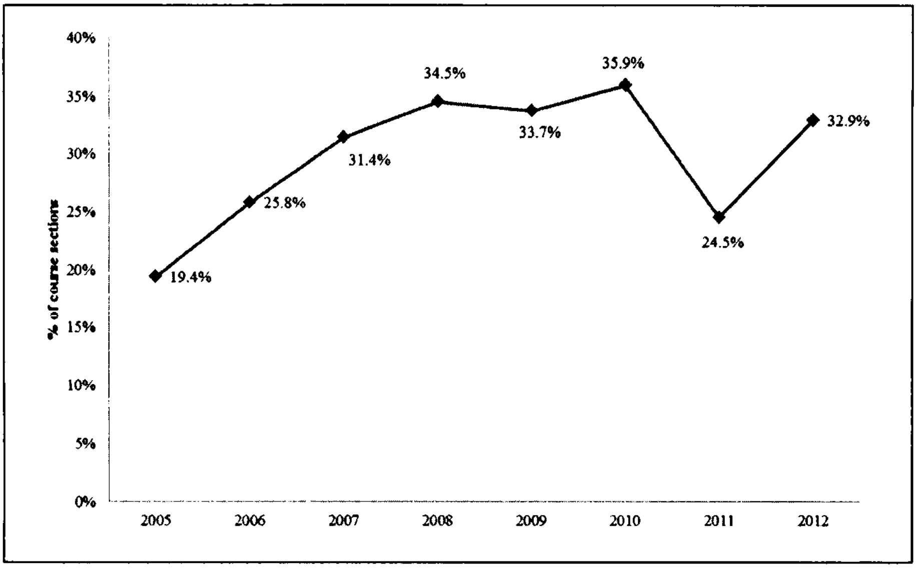

Figure 3. Trends in the overall use of alternative MODs, 2005-2012.

instruction experienced a rather large decrease (54% to 37%) and continued to decrease to 2012 (23%). This decline after 2010 coincides with an uptick in alternative models of delivery which extended the amount of time spent in developmental math (40% to 47%), reduced the amount of time in developmental math (2% to 13%), and combined multiple alternative models of delivery into single programs (4% to 16%).

Increased Use of Acceleration in Lower Levels, Combined Approach in Highest Level

Figure 5 shows that the adoption patterns of alternative delivery models varied by math level.[9] After 2010, acceleration models began to take hold in the LUCCD. Between fall 2010 and fall 2012, the percent of arithmetic (four levels below transfer) course sections offering acceleration increased 10 points; for pre-algebra (three levels below transfer), that increase stood at 8 percentage points over the same time frame. The use of supplemental instruction in arithmetic and pre-algebra also climbed after 2005, but took a dive in 2009.

In contrast to alternative delivery models utilized for math at the lowest levels of the sequence, there has been a constant trend to deliver the *Extended Traditional Model* to students enrolled in the more rigorous developmental math courses. However, the percent of intermediate algebra course sections offering a combination of alternative delivery models increased by 10 points. It is possible that the location of interventions combining strategies in the upper levels of the math sequence is aimed at helping those most likely to persist and succeed in college.

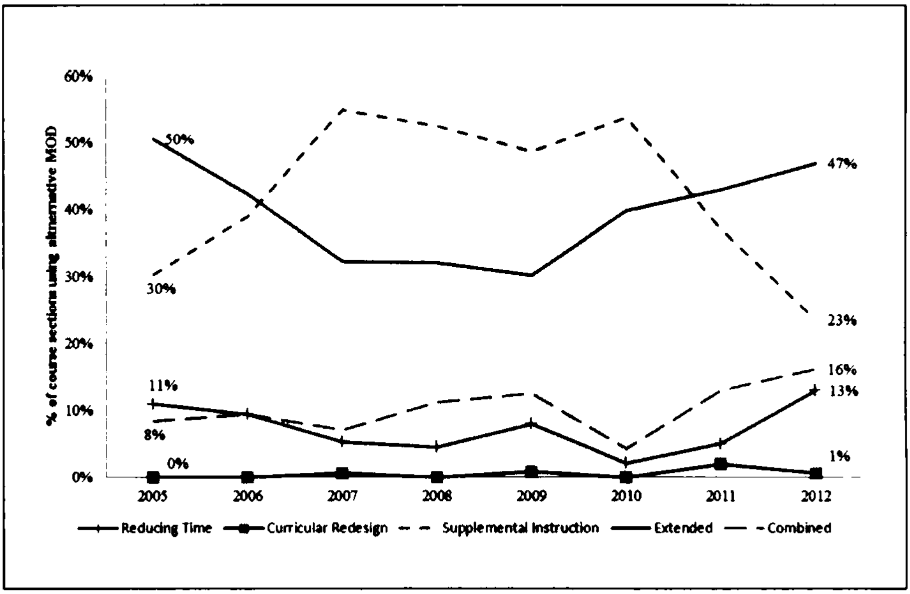

Figure 4. Trends in the use of alternative MODs by delivery type, 2005-2012.

Discussion

Evidence from this study suggests that community colleges may face significant challenges impeding the use and adoption of alternative ways to deliver developmental math. In this study, we found that in the LUCCD, the traditional model continued to dominate among approaches used to teach developmental math, and that nearly half of the deviations identified offered students supplemental instruction, an alternative most closely aligned with the traditional model. We also discovered that developmental math students experienced disproportionate access to these alternative approaches. Compared with students enrolled in the lower levels of the developmental math sequence, students enrolled in levels nearer to transfer-level math may have been advantaged not only because they could access a greater number of course sections offering an alternative approach (with the possible exception of the *Extended Traditional Model*) but also because they could access a wider range of alternative approaches. In examining the use of alternative delivery models over time, while we do find that there has been movement among LUCCD colleges to change how they structure and teach developmental math, this shift has been incremental at best.

Several theories can help to explain why we see these trends. First, implementing alternative approaches to deliver developmental math may require substantial resources (Karp & Fletcher, 2014). For example, a recent study found that the upfront costs of implementing co-requisite remediation was higher compared with that of the traditional delivery model, even though it was a more efficient instructional model overall (Belfield

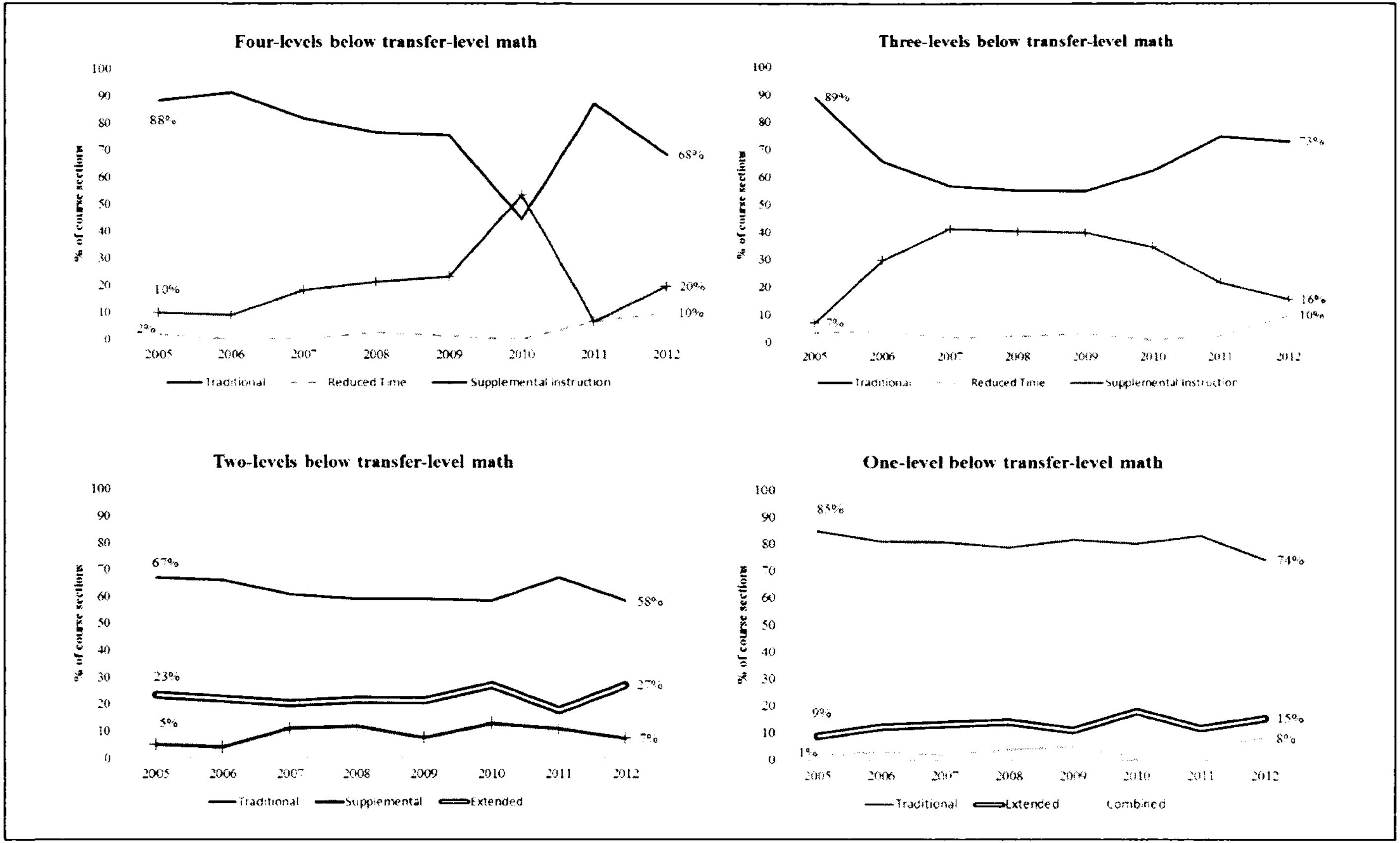

Figure 5. Trends in the use of alternative MODs by delivery type and developmental math, 2005-2012.

et al., 2016). A case where a community college is interested in launching a contextualization program would require that math faculty to invest already limited resources in partnering with industry to create new pedagogy and curriculum.

Second, regulations governing how community colleges deliver curriculum and course content in developmental math may not be flexible enough to allow innovation to occur quickly. In California, faculty interested in re-engineering a course must enter a long and potentially costly process to receive approval from several regulatory bodies located at the institutional, district, and state levels (Harris, 2013). As a result, it may take more than a year before a faculty member receives permission, a cost high enough to dissuade some from considering changing conventional delivery practices. Furthermore, because California requires community colleges to document the number of students attending non-course-based instruction (ASCCC, 2009), it appears that this requirement may have limited the provision of such services. These types of policies and requirements, while aimed at promoting efficiency and quality, may also inadvertently curb the introduction of reforms.

Third, organizational practices may deter innovation from occurring—particularly in the lower levels of developmental math. One concern is the assignment of faculty to developmental education courses. Gerlaugh, Thompson, Boylan, and Davis (2007) estimated that one fifth of developmental education courses nationally were taught by full-time faculty. If faculty working in LUCCD colleges lay claim to upper level developmental, part-time, non-tenured track faculty are left to teach the lowest levels. The concern here is not that adjunct faculty are teaching these courses, but that they may lack opportunities and resources to implement reformed approaches that may benefit developmental education students.

Fourth, community colleges may be uncertain about the academic and career benefits these innovations yield because research on the whole has been inconclusive about their impacts on student success. As Karp and Fletcher (2014) mentioned, enacting reforms requires significant financial and staff resources, and in lean economic times, faculty and administrators must carefully select reforms that are not only effective but also efficient. Without clear and consistent research about the benefits of these alternative approaches on student success, community colleges will likely err on the side of caution, and stick to business as usual. Future research examining alternative models of delivery should be conducted in a way capable of giving practitioners clear guidance on which types of alternative approaches benefit the various student groups affected by developmental education.

Finally, the decision to locate the majority of alternative delivery models in the upper levels of the math sequence may be rooted more in efficiency than in equity. From a cost perspective, the decision to focus on students who are more likely to complete college makes sense, but it comes at an expense of providing equal opportunities that meet the needs of *all* students.

While there are no simple answers to solving the problem of low success rates in developmental education, uncovering the extent that community colleges are using and adopting alternative models of delivery can provide insights into why remediated students—particularly the least prepared for college—have a difficult time progressing and obtaining a college credential. Our research suggests that the push for alternative models of delivery has primarily reached those students at the cusp of college readiness rather than those students who may need it most. Herein is a missed opportunity to change the educational experiences of the least prepared students in college math remediation. If the research on the community college district showcased here is any indication of a wider national trend, then states, foundations, districts, and colleges together will have to intentionally direct efforts toward promoting equity in access to these delivery reforms. This can ensure that all developmental education students—no matter their level of academic preparedness—have educational experiences that can help them achieve their academic and career goals.

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Notes

1. In this article, we use developmental and remedial education interchangeably.
2. Examples of these reform initiatives include the Learning Communities Program at the City University of New York's (CUNY) Kingsborough Community College and the FastStart program at the Community College of Denver.
3. Using data on community colleges participating in the Achieving the Dream Initiative, Bailey, Jeong, and Cho (2010) found that students were more likely to be assigned to developmental mathematics (59%) than developmental reading (33%), and were also more likely to fail to complete the developmental mathematics sequence (66%) than the developmental reading sequence (52%).
4. Compared with transfer students who started directly in college-level courses, transfer students who took at least one developmental education course paid on average US$3,000 more for college and took 40 more credits (Melguizo, Hagedorn, & Cypers, 2008).
5. This investigation is part of a major study examining developmental math in the large, urban, community college district (LUCCD) in California starting in 2005.
6. Given that LUCCD colleges often change course offerings in developmental math after the semester begins, we intentionally sought and reviewed updated course catalogs for each semester we examined.
7. Overall, the traditional model of delivery was the dominant model of delivery in six of the nine colleges. In the other three colleges, Supplemental Instruction or Extended Traditional

were the most prevalent models of delivery. Even a college participating in the rollout of Statway used the traditional model to deliver close to 88% of developmental math course sections, which indicates that even the more "innovative" colleges might still be reticent about revamping the delivery of developmental math completely.

8. Roughly 60% of all students assigned to developmental math enrolled into these two math levels based on 2013 district enrollment data.
9. In Figure 5, we only include the two most common alternative models of delivery utilized within each developmental math level, and plot the percent of traditional course sections as a reference point. We also only present the figures for four, three, two, and one level below college-level math, as close to 99% of course sections offered five levels below transfer level were taught using the traditional model.

References

Academic Senate for California Community Colleges. (2009). *ASCCC basic skills summary report 2006 to 2009*. Available from http://www.cccbsi.org/

Arendale, D. (2002). *History of supplemental instruction (SI): Mainstreaming of developmental education* (Histories of Developmental Education). Retrieved from: http://www.tc.umn.edu/~arend011/SIhistory02.pdf

Attewell, P., Lavin, D., Domina, T., & Levey, T. (2006). New evidence on college remediation. *The Journal of Higher Education*, *77*, 886-924.

Bahr, P. R. (2009). Educational attainment as process: Using hierarchical discrete-time event history analysis to model rate of progress. *Research in Higher Education*, *50*, 691-714. doi:10.1007/s11162-009-9135-x

Bahr, P. R. (2012). Deconstructing remediation in community colleges: Exploring associations between course-taking patterns, course outcomes, and attrition from the remedial math and remedial writing sequences. *Research in Higher Education*, *53*, 661-693. doi:10.1007/s11162-011-9243-2

Bailey, T. R. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges*, *145*, 11-30.

Bailey, T. R. (2015). *What we know about guided pathways* (CCRC research overview). Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/What-We-Know-Guided-Pathways.pdf

Bailey, T. R., Jaggars, S. S., & Jenkins, D. (2015). *Redesigning America's community colleges: A clearer path to student success*. Cambridge, MA: Harvard University Press.

Bailey, T. R., Jeong, D. W., & Cho, S. W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review*, *29*, 255-270. doi:10.1016/j.econedurev.2009.09.002

Bassett, M. J., & Frost, B. (2010). Smart math: Removing roadblocks to college success. *Community College Journal of Research and Practice*, *34*, 869-873.

Belfield, C., Jenkins, D., & Lahr, H. (2016). *Is co-requisite remediation cost-effective? Early findings from Tennessee* (CCRC Research Brief No. 62). Retrieved from http://academiccommons.columbia.edu/catalog/ac:197866

Bettinger, E., Boatman, A., & Long, B. (2013). Student supports: Developmental education and other academic programs. *The Future of Children*, *23*, 93-115.

Boatman, A. (March, 2012). *Examining the causal effects of instruction and delivery in postsecondary remedial and developmental courses: Evidence from the Tennessee Developmental Course Redesign Initiative*. Paper presented at the Association for Education Finance and Policy annual conference, Boston, MA.

Boylan, H. R. (2002). *What works: Research-based best practices in developmental education.* Boone, NC: Continuous Quality Improvement Network, National Center for Developmental Education.

Boylan, H. R., Bliss, L. B., & Bonham, B. S. (1997). Program components and their relationship to student performance. *Journal of Developmental Education*, *20*, 2-9.

Bracco, K. R., Austin, K., Bugler, D., & Finklestein, N. (2015). *Reforming developmental education to better support students' postsecondary success in the Common Core era.* Retrieved from https://www.luminafoundation.org/files/resources/reforming-dev-ed.pdf

Bradley, E. H., Curry, L. A., & Devers, K. J. (2007). Qualitative data analysis for health services research: Developing taxonomy, themes, and theory. *Health Services Research*, *42*, 1758-1772. doi:10.1111/j.1475-6773.2006.00684.x

California Community Colleges Chancellor's Office. (n.d.). Available from http://cccco.edu/

California Community Colleges Chancellor's Office Data Mart. (n.d.). Data Mart [Data file]. *Available* from http://datamart.cccco.edu

Carnegie Foundation for the Advancement of Teaching. (n.d.). *Pathways improvement communities.* Retrieved from http://www.carnegiefoundation.org/in-action/carnegie-math-pathways/

Cho, S. W., & Karp, M. M. (2013). Student success courses in the community college: Early enrollment and educational outcomes. *Community College Review*, *41*, 86-103. doi:10.1177/0091552112472227

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*, 37-46.

Collins, M. (2009). *Setting up success in developmental education: How state policy can help community colleges improve student outcomes.* Boston, MA: Jobs for the Future.

Cullinane, J., & Treisman, P. U. (2010). *Improving developmental mathematics education in community colleges: A prospectus and early status report on the Statway initiative.* New York, NY: National Center for Postsecondary Research.

Epper, R. M., & Baker, E. D. (2009). Technology solutions for developmental math: An overview of current and emerging practices. *Journal of Developmental Education*, *26*(2), 4-23.

Fong, K. E., Melguizo, T., & Prather, G. (2015). Increasing success rates in developmental math: The complementary role of individual and institutional characteristics. *Research in Higher Education*, *56*, 719-749. doi:10.1007/s11162-015-9368-9

Gerlaugh, K., Thompson, L., Boylan, H., & Davis, H. (2007). National study of developmental education II: Baseline data for community colleges. *Research in Developmental Education*, *20*(4), 1-4.

Getting Past Go. (n.d.). Retrieved from https://gettingpastgo.socrata.com/

Grubb, W. N. (1999). *Honored but invisible: An inside look at teaching in community colleges.* New York, NY: Routledge.

Grubb, W. N., & Gabriner, R. (2013). *Basic skills education in community colleges: Inside and outside of classrooms.* New York, NY: Routledge.

Harris, B. W. (2013). *Program and course approval handbook.* Sacramento: California Community College Chancellor's Office. Retrieved from http://extranet.cccco.edu/Portals/1/AA/ProgramCourseApproval/Handbook_5thEd_BOGapproved.pdf

Hayward, C., & Willett, T. (2014). *Acceleration effects of curricular redesign in the California Acceleration Project.* Berkeley: The Research and Planning Group for California Community Colleges. Retrieved from http://collegecampaign.org/wp-content/uploads/2014/06/RP-Evaluation-CAP.pdf

Hern, K. (2012). Acceleration across California: Shorter pathways in developmental English and math. *Change: The Magazine of Higher Learning*, *44*(3), 60-68. doi:10.1080/00091383.2012.672917

Hiebert, J. C., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. K. Lester Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371-404). New York, NY: Information Age.

Hodara, M. (2013). *Improving students' college math readiness: A review of the evidence on postsecondary interventions and reforms* (A CAPSEE working paper). New York, NY: Center for Analysis of Postsecondary Education and Employment.

Hodara, M., & Jaggars, S. S. (2014). An examination of the impact of accelerating community college students' progression through developmental education. *The Journal of Higher Education*, *85*, 246-276. doi:10.1353/jhe.2014.0006

Horn, L., & Nevill, S. (2006). *Profile of undergraduates in U.S. postsecondary education institutions: 2003-04: With a special analysis of community college students* (NCES 2006-184). Washington, DC: National Center for Education Statistics, U.S. Department of Education.

Jenkins, D. (2014). *Redesigning community colleges for student success overview of the guided pathways approach*. New York, NY: Teachers College, Community College Research Center, Columbia University. Retrieved from http://www.ct.edu/files/ssc/DavisJenkins_CCRC_Guided_Pathways_Overview_August_2014.pdf

Jenkins, D., Zeidenberg, M., & Kienzl, G. (2009). *Educational outcomes of I-BEST, Washington State Community and Technical College System's Integrated Basic Education and Skills Training Program: Findings from a multivariate analysis* (CCRC Working Paper No. 16). New York, NY: Teachers College, Community College Research Center, Columbia University.

Jones, S. (2015). The game changers: Strategies to boost college completion and close attainment gaps. *Change: The Magazine of Higher Learning*, *47*(2), 24-29. doi:10.1080/00091383.2015.1018085

Karp, M. M., & Fletcher, J. (2014). *Adopting new technologies for student success: A readiness framework*. New York, NY: Teachers College, Community College Research Center, Columbia University.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*, 159-174. doi:10.2307/2529310

McDonnell, L. M. (1995). Opportunity to learn as a research concept and a policy instrument. *Educational Evaluation and Policy Analysis*, *17*, 305-322. doi:10.3102/01623737017003305

Melguizo, T., Hagedorn, L. S., & Cypers, S. (2008). Remedial/developmental education and the cost of community college transfer: A Los Angeles County sample. *The Review of Higher Education*, *31*, 401-431. doi:10.1353/rhe.0.0008

Mesa, V. (2011). Similarities and differences in classroom interaction between remedial and college mathematics courses in a community college. *Journal on Excellence in College Teaching*, *22*(4), 21-55.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: SAGE.

Moore, R., & LeDee, O. (2006). Supplemental instruction and the performance of developmental education students in an introductory biology course. *Journal of College Reading and Learning*, *36*(2), 9-20. doi:10.1080/10790195.2006.10850184

Ngo, F., & Kosiewicz, H. (forthcoming). How extending time in developmental math impacts student persistence and success: Evidence from a regression discontinuity in community colleges. *The Review of Higher Education*.

O'Gara, L., Karp, M. M., & Hughes, K. L. (2009). Student success courses in the community college: An exploratory study of student perspectives. *Community College Review*, *36*, 195-218. doi:10.1177/0091552108327186

Perin, D. (2004). Remediation beyond developmental education: The use of learning assistance centers to increase academic preparedness in community colleges. *Community College Journal of Research and Practice*, *28*, 559-582. doi:10.1080/10668920490467224

Perin, D., Bork, R. H., Peverly, S. T., Mason, L. H., & Vaselewski, M. (2012). *A contextualized intervention for community college developmental reading and writing students* (CCRC Working Paper No. 38). New York, NY: Teachers College, Community College Research Center, Columbia University. Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/contextualized-intervention-developmental-students.pdf

Public Policy Institute of California. (2013). *The impact of budget cuts on California's community colleges*. Retrieved from http://www.ppic.org/main/publication.asp?i=1048

Rutschow, E. Z., Richburg-Hayes, L., Brock, T., Orr, G., Cerna, O., Cullinan, D., & Martin, K. (2011). *Turning the tide: Five years of Achieving the Dream in community colleges*. New York, NY: Manpower Demonstration Research Corporation. Retrieved from http://www.mdrc.org/publication/turning-tide

Rutschow, E. Z., & Schneider, E. (2011). *Unlocking the gate: What we know about improving developmental education*. New York, NY: Manpower Demonstration Research Corporation.

Smith, A. A. (2015, June 25). When you're not ready. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/news/2015/06/25/floridas-remedial-law-leads-decreasing-pass-rates-math-and-english

Smith, A.A. (2016, April 5). Evidence of remediation success. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/news/2016/04/05/tennessee-sees-significant-improvements-after-first-semester-statewide-co-requisite

SuccessNC. (2012). *Developmental education initiative*. Retrieved from http://www.successnc.org/initiatives/developmental-education-initiative

The Texas Higher Education Coordinating Board. (2012). *Developmental education/TSI*. Retrieved from http://www.thecb.state.tx.us/index.cfm?objectid=C92F1DAA-D49E-03F0-0750060AA756E807

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *The Journal of Higher Education*, *68*, 599-623. doi:10.2307/2959965

Twigg, C. (2005). *Increasing success for underserved students: Redesigning introductory courses*. Saratoga Springs, NY: The National Center for Academic Transformation. Retrieved from http://www.thencat.org/Monographs/IncSuccess.pdf

Venezia, A., & Hughes, K. L. (2013). Acceleration strategies in the new developmental education landscape. *New Directions for Community Colleges*, *164*, 37-45. doi:10.1002/cc.20079

Visher, M. G., Weiss, M. J., Weissman, E., Rudd, T., & Wathington, H. D. (with Teres, J., & Fong, K.). (2012). *The effects of learning communities for students in developmental education: A synthesis of findings from six community colleges*. New York, NY: National Center for Postsecondary Research.

Wachen, J., Jenkins, D., & Van Noy, M. (2011). Integrating basic skills and career-technical instruction: Findings from a field study of Washington state's I-BEST model. *Community College Review*, *39*, 136-159.

Yamada, H., & Bryk, A. S. (2016). Assessing the first 2 years' effectiveness of Statway®: A multilevel model with propensity score matching. *Community College Review*, *44*(3). 179-204. doi: 10.1177/0091552116643162

Zeidenberg, M., Jenkins, D., & Calcagno, J. C. (2007). *Do student success courses actually help community college students succeed?* (Research Brief No. 36). New York, NY: Teachers College, Community College Research Center, Columbia University.

Zeidenberg, M., Cho, S., & Jenkins, D. (2010). *Washington State's Integrated Basic Education and Skills Training Program (I-BEST): New Evidence of Effectiveness.* (CCRC Working Paper No. 20). New York, NY: Teachers College, Community College Research Center, Columbia University.

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