90-Day Cycle: Exploration of Math Intensives as a Strategy to Move More Community College Students Out of Developmental Math Courses

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Section I: Introduction

Community colleges serve a critical role in the education of our nation's workforce; they fulfill the democratic creed of accepting all students who arrive on their campuses, regardless of educational background, qualification or credential. Students who enroll in community college are initially assessed in the academic areas of mathematics and English Language Arts (and in some cases English Language proficiency), typically with a standardized placement test.[i] Many students who go through this placement process are identified as in need of developmental courses, non-credit bearing courses that are below college-level and do not count toward a degree, certificate or transfer. Higher numbers of students have developmental needs in math than English Language Arts. Estimates of the number of students that place into a developmental math course range from 60 to 90 percent of entering community college students, with significant portions of students referred to courses as many as four levels below a credit-bearing course. Failure rates for these students are staggering, with less than 10percent of those that place into the lowest level actually finishing the developmental math sequence and continuing on to credit bearing math courses (Bailey, Jeong & Choo, 2008). Many spend long periods of time repeating courses or they simply leave college. Either way, they are not able to progress towards their education or career goals.

Community colleges have responded to these high failure rates with a variety of interventions aimed at improving the developmental math sequence (i.e. supplementary instruction, tutoring, learning communities, use of technology, etc.). In this document we set out to examine a domain of intervention activity—boot camps. Boot camps are aimed at decreasing the number of students that would initially place into the developmental sequence by providing students with short, intensive math experiences prior to placement. We chose boot camps as a high priority to investigate because their short intensive design aimed at a critical juncture when many students get lost creates a potential to move high numbers of students along (or out) of the developmental continuum in a replicable and cost effective manner. In our attempt to scan the field for innovative programs, we encountered many interventions with similar goals that went by names other than boot camps—such as summer bridge programs and accelerated math courses. Thus, we broadened our domain of interest to include a larger range of interventions, all with short-term intensive math experiences aimed (at least in part) at shortening the time students spend in developmental math. We call this class of activity math intensive programs.

The goal of our scan is to explore the potential of these interventions as high-leverage activities; that is, if done correctly, the activity might have significant positive effects for large numbers of students. To understand the potential of math intensive programs to significantly improve the extraordinary high failure rates of students currently placing into developmental math, we need to understand the key elements of the interventions and their potential to scale. When interventions take form in the field, many variants with different specific services and theories of action may emerge, even while sharing a common label. Moreover, when these locally defined interventions emerge, the full details of their actual operation may be underspecified, leading interested others to replicate the form but not necessarily the substance of the innovation. Thus we seek to "get under the hood" of these boot camps and other intensive math interventions. In particular, we aim to scrutinize this domain in order to identify program specifics, synthesize evidence regarding their efficacy and costs and elicit deeper understanding of the cause-effect logic of their design.

We explored the intensive math interventions using a 90-day cycle process we borrowed from the Institute for Healthcare Improvement (IHI). The IHI 90-day cycle scans activity in the field as a "quick way to research innovative ideas and assess their potential for advancing quality improvement" (IHI documentation, 2009). We were interested in the utility of a similar 90-day cycle process for investigating promising educational innovations that have not yet been adequately explored in the educational literature, without tying up significant resources or encountering unnecessary delays. In particular, we sought to learn how to design a 90-day cycle methodology that captures intervention activity in a way that allows for an initial assessment of their potential to produce improvement at scale.

Overall, the programs we describe have employed a variety of innovative strategies to improve student outcomes in developmental math. Although these intensive programs are targeted at students with developmental math needs, they often support more than just math. They help students learn about college support systems, teach study skills and serve as opportunities for students to build relationships with peers, mentors and faculty. One of the most intriguing elements common to many of these programs was their use as an onramp; carefully designing transitions between high school and college. The attention paid to the problem of transition across many programs and contexts suggests further exploration into how these *transitions* can be effectively executed.

As a group, the interventions are characterized more by variation than similarity. Even within interventions that went by the same name, we encountered differences both in how they were structured and in the elements of their design. In other words, our scan produced evidence that these programs are more a set of *local solutions* than a *class of intervention* that is currently well enough understood to be leveraged at scale. Assessing the potential of any one of these localized programs to scale to other contexts will require instrumentation of key elements, implementation in multiple contexts, and common measures of effectiveness.

The remainder of this report is organized into five sections. We begin in Section II by describing our methodology, which includes our definition of math intensive programs and our framework for how we approached our data collection efforts. In Section III we detail 14 math intensive programs and identify similarities and variations within three category types. We then examine costs and efficacy of these programs in Section IV, followed by a closer look at three colleges with multiple strategies for supporting developmental math students with intensive programs in Section V. Section VI concludes.

Section II: Methodology

The IHI 90-day cycle consists of three phases: (1) a scan of the field, (2) a focus on particular front-line theories to refine understandings about what works, and (3) dissemination of the findings to appropriate parties. At IHI, small teams work on each 90-day cycle, completing each phase in roughly 30 days. In our first adaptation of the 90-day cycle, we focused our more modest resources on the scan phase, attempting to produce a useful description of a wide array of intensive math programs using only one researcher and 90 discontinuous days.[ii]

We employed a snowball methodology to explore math intensive programs (Coleman, 1959; Spillane, 2000). We spoke to people familiar with community colleges and/or developmental math programs. Each individual pointed us to areas of interest: community colleges doing innovative math work, specific programs, individuals, websites, conferences and articles. We read papers, combed conference proceedings and engaged in many phone and email conversations with various faculty members, math department heads, college administrators, community college researchers and other experts. We discovered a wide range of programs, of which we discuss a subset in this report. In the beginning of our study, we thought we were only focused on boot camp programs. We explain our initial assumptions and definitions about boot camp programs, how that definition expanded, the selection of the programs we detail in this report, and the framework that drove the descriptions of the math intensive programs.

Background and Definitions

Historically, boot camp programs go back to the 1960s and 1970s and support a wide range of learners (not just recent high school graduates). For example, the Cal Poly Pomona boot camp was organized for returning soldiers. Boot camps began by helping students prepare for college. They supported students in developing motivational goals, focused intensive time on a subject matter, and were based on a cohort model which involved students working together as a unit, building relationships and a shared experience that would help carry them through their college career. In the 1970s there was a large community building boot camps, some of whom were using the (then) military connotation with regard to building unit cohesion (Treisman, 2009).

Boot camp programs also link to the tradition of summer bridge programs and learning centers. Developmental summer bridge programs are four to six-week intensive programs for students who just completed high school. They include instruction in math, reading and/or writing, a “college knowledge” component, and offer multiple types of academic support (Barnett & Pretlow, 2009).

We began our work with the assumption that boot camps were a clearly defined and distinctly understood concept in the field. We set out to identify boot camp programs that included the following elements:

1. Non-STEM[iii] focused students who do not score high enough on a placement test to place into college level math (or for the students who have not yet taken the placement test, but are at risk to not place into college level math).
2. Two to eight week time frame (less than a semester).
3. Intensive (could be all day for two weeks, several hours each day, etc.).
4. Extended time commitment.
5. At the transition between high school and college. In some cases, these programs happen during high school; in other cases, these programs support returning students who have been out of high school for years.
6. Located on campus.

Refining the Definition and Selecting Programs

As we spoke with more experts, we were pointed to a wide variety of programs that have similar goals. We quickly learned that many of these programs are about more than simply reviewing and/or teaching mathematics. We also discovered that boot camps are not widely enacted, nor is the term commonly used for the kind of program we were researching. In many cases, colleges had programs with similar goals that were referred to as summer bridges or intensives. Summer bridge programs tend to focus on a smaller number of students and recruit a more targeted population (typically high risk high school graduates), but they often have math intensive components that respond to the critical need for math support.

As the lines between boot camps, summer bridges and multi-course programs blurred, we broadened the domain of activity we were interested in to include any program that, through an intense, relatively short intervention, focused on mathematics and aimed to move students higher up the developmental math sequence than they originally placed, if not out of developmental math altogether. We revised the timeframe to include any programs one semester or less.

Many programs have other goals, as well as foci beyond math, but these two elements—math focused and intensive—serve as the core of our definition. The programs vary in structure, incentives and target audience. They all focus, to some degree, on math instruction, and many have integrated services (counseling, tutoring, etc.) that wrap around the math instruction. Other models, such as boot camps for middle school students, dual enrollment programs and creative methods to support and enhance developmental math courses, are not included in our analysis but nonetheless serve students with similar academic challenges and demographic backgrounds, and often address the same problems effectively. We have changed the name of our programs from boot camps to intensive programs whose goal is to accelerate students' progress through the developmental math sequence or to by-pass it entirely.

We selected programs for our sample that satisfied our definition and shared some promise of success. In many cases, evidence of "success" is empirically thin, which we discuss in more detail section IV. In some cases we removed certain programs from our sample before we broadened our definition. For this reason, and because of our (intentionally) short time frame (we identified programs in a 30 day period in June-July, 2009 when many people are on vacation, etc.), we acknowledge that the programs we examine in our report represent a sample of a larger domain of activity.

Even though these programs often shared the same name (i.e. summer bridge) or were identified as having the same goals, their design features vary for a variety of reasons: the diversity in student population, differences in institutional resources, differences in levels of support, problem identification, improvement strategy, and local context. Some colleges offer a range of programs to address the diversity of student needs (e.g., Community College of Denver, El Paso Community College, and Pasadena City College) while other colleges focus programmatic resources on one strategy (e.g., Foothill College). The programs we consider fall into three categories:

1. Boot Camp Programs: Short (1-3) week summer program with a primary or exclusive focus on math skills.
2. Summer Bridge Programs: Longer (5-10) week summer program with intensive math and support for other skills.
3. Accelerated Programs: Intensive semester course that covers more than one developmental math course.

Framework for Program Investigation

This report details 14 programs from 10 colleges across seven states. These programs all share the six elements of our definition. We conducted 45-90 minute phone interviews with representatives from each program[iv] (faculty, department chairs, program coordinators, etc.). We introduced our 90-day cycle focus, shared our definition of math intensive (boot camp at the time), and determined if they had a program that fit our scope.

The interview protocol used to explore these programs was driven by four main sources. First, we used our definition as a starting place to identify programs that included all our elements, outlining a beginning understanding of each program.

Second, in order to explore the potential of these interventions to be used beyond their current context, we designed probes intended to surface descriptions that would enable us to evaluate the program's ability to scale. These probes included questions about design/theory of action, component work processes, local context, efficacy and costs. These areas were framed by the Carnegie Foundation's core evaluative questions, which organized our thinking about the potential of an intervention to leverage significant improvement at scale (see Appendix B).

Third, we considered a range of elements for each program in order to understand the complexity of instructional support these programs offer. To make sense of the complexities of developmental math, we use several existing frameworks for developmental education (both in general as well as math specific) and community college success. For more information on the frameworks, see Appendix C and D.

From these existing frameworks we established an initial list of program elements to investigate, including *instructional leadership*, *curriculum and materials*, *appropriate assignment of students* (in this case, recruitment), *social support of achievement*, *community building* (cohort), *qualities of faculty and other support staff*, *instructional quality* (which we term more broadly as pedagogy & instructional formats, and teaching), and *student engagement.*

Finally, we generated a list of five overarching program goals. We based our goal definition on our initial scan of community college programs for developmental math students. We used our program goals to probe for a deeper understanding of how each program enacted their work. All programs achieved one or several of these goals.

- Goal 1: Learning the math necessary to score well on the placement test and place into college level math courses (or at least place higher up the developmental math sequence).
- Goal 2: Developing math understanding needed for subsequent success.
- Goal 3: Forming dispositions to succeed in college (study skills).
- Goal 4: Forming relationships to success in college (peers, faculty, tutors).
- Goal 5: Informing students with specific knowledge that they need/access to information to progress toward their goals (financial aid, college services, etc.).

Taken together, these five sources framed the interview protocol used to conduct the scan of the intensive math interventions.

In the next section we describe the characteristics and variations of the intensive programs, identifying various key instructional elements of each program. We also discuss similarities, differences and key patterns across elements that are important to the design of math intensive programs.

Section III: Descriptions of Programs that Show Promise[v]

In this section we describe the programs in their own terms. We attempt to capture both the variation in what they are trying to accomplish and how they are going about it. To do this, we divided the intensive programs into three categories: Boot Camps, Summer Bridges and Accelerated Programs. We describe each program type using a wide range of characteristics. In Table 1 (of each category, so Tables 1.1, 2.1, and 3.1) we include the basic descriptors for each program: number of students, duration and frequency of classes. In Table 2 we include faculty resources, student incentives for participation, whether students get course credit, costs to the institution and to the student, and funding. In Table 3 we identify student population, program recruitment, and the test used to determine course placement in math at that college. In Table 4 we specify instructional formats and curriculum, and in Table 5 we identify social supports for achievement (social, psychological, etc.). These characteristics allow us to describe the common elements and variations in how each strand of program is designed. We then characterize what the programs were trying to accomplish with these elements using our five goals as a frame.

Program Specifics

Boot Camp Programs

Boot Camp Examples (For specifics, see Tables 1.1-1.5)

- PREP (El Paso Community College)
- CLICK (Houston Community College Southeast)
- Math Intensive (LaGuardia Community College)
- Fast Track (Montgomery Community College)
- Math Jam (Pasadena City College)

Common Elements of Boot Camps. Boot camp programs are short, target a wide range of students, accommodate large numbers, and support improved math performance on the math placement test. The students who would most benefit from these courses are more than likely students who need to review math concepts rather than learn developmental math content.

All boot camp programs occur in the summer for a period of one to three weeks.[vi] Students who attend boot camps have made a connection with the college prior to classes starting, which leaves out the segment of the population who arrive at campus just before classes begin (a relatively large part of the developmental education population). The majority of the programs (Math Jam, CLICK and LaGuardia Intensive) require students to be in school all day for one or several weeks, which creates an obstacle for students who work or who are not committed to giving up part of their summer to be in a non-credit bearing course.

The short duration of these programs affords a shorter opportunity to learn math, build relationships with peers and faculty, and utilize extended resources. One faculty member noted this difference as she compared her college's shorter and longer programs, "[The shorter program is] a lot of fun, very energizing… but no bonding experience [like in the longer program]; just fun with math for two weeks… If we could design it so that you can stay with that faculty into the next class, that would work better."

All of the programs offer incentives for the students to participate, ranging from material rewards (free iPods, free textbooks) to more intrinsic rewards (a chance to retake the test and place out of developmental math).

Variation within Boot Camps. The boot camp programs differ in how they recruit students for participation. CLICK recruits at the local high schools and serves high school students, while the other programs use less organized recruiting (word of mouth), and pull from a wider population of students (including older and returning students).

While some boot camp programs focus exclusively on teaching/reviewing math, some do more. Many programs support the students' transition into college by giving new students a taste of college, helping them identify a career path, and connecting students with college support resources. In these cases, math faculty teach the courses and other staff (e.g., counselors) play a support role.

The instructional staff also varies in boot camp programs. In some cases, math faculty are solely responsible for teaching the program. In other cases, the colleges depend on tutors to be available to students, primarily in the computer lab or to support with homework.

The core math curriculum is presented in different ways across the programs studied. In two cases the math component is largely dependent on a computer program, while faculty are responsible for instruction in the other three programs. In two of the colleges, math faculty developed the curricular materials they use in the boot camp programs while the other programs use a textbook.

Table 1. Boot Camp Program Details

Table 1.1 Basic Program Descriptors			
Program	**Students served per year**	**Duration**	**Credits**
PREP	2800	Varies, avg. 15 hours	None
CLICK	50	1 week M-F 9-3	None
LaGuardia Math Intensive	1300	2 weeks M-F 5 hrs/day class 1 hr/day computer lab	None
Fast Track	180	2 weeks, M-F, 2 hours (am & pm offered)	None
Math Jam	150	2 weeks M-F 9-3	None

*Continuing Education ($120 + book)

Table 1.2 Faculty Resources, Incentives, and Funding					
Program	**Faculty (Resource commitments)**	**Incentives**	**Cost**	**Cost to Student**	**Funding**
PREP	Full time manager, 7 specialists, 1 lab specialist, peer tutors	Opportunity to retake placement test and place into a higher math course		None	Started as a Title V grant. Institution support
CLICK	Dept. chair, math instructor, counselor, recruiter	iPod and chance to win computer for completers		None	Chancellor's Innovation Grant Cost approx $14,200
LaGuardia Math Intensive	10-20 faculty with 60 hours each (enough to cover 20-22 sections)	Free course, free software, free books.	$300,000	Book (free tuition)	Institution supported
Fast Track	Five math faculty with part time responsibility. 1/2 credit hour for each course; about 10-12 per year so it totals to about 1.5 full time position.	Complete two developmental math courses in two weeks.		Tuition*	Students pay $120 + cost of book ($30.65-43); no financial aid.
Math Jam	5 instructors, 10 peer tutors, director of TLC, counselor	Free program & textbook for fall Fall support: Tutoring, counseling, conferencing		None	Institution and grant supported

Table 1.3 Student Population, Recruitment, and Placement			
Program	**Target Population**	**Recruitment**	**Placement**
PREP	All incoming new students		Accuplacer
CLICK	Recent HS graduates	Recruits at local high schools. Has a recruiter on staff.	Compass Test
LaGuardia Math Intensive	Recent HS graduates (“Generation 1.5”: some HS in their country, some in US, have huge math needs)		Compass Test
Fast Track	Recent HS graduates and adult students returning to school after a long absence		Accuplacer
Math Jam	Underprepared, first generation HS graduates	Fliers, word of mouth	Accuplacer

Table 1.4: Instructional Formats and Curriculum			
Program	**Content Taught**	**Practices & Pedagogy**	**Curriculum**
PREP	Instruction about test. Work on individualized, computer based plan. Case management[vii]	Diagnostic evaluation in A+dvancer Assessments Computer tutorial exercises in Plato (on-line)	Plato
CLICK	Math (My Math Test, Pearson) Study and Life Skills: What Employers Want Recent College Graduates to Know	Math component: Computer based program, individualized. Math teacher in lab for support.)	My Math Test
LaGuardia Math Intensive	Introduction to Algebra (MAT095) or Elementary Algebra (MAT096)	Six hours a week with instructor (5 hours each day in class + one hour each day in computer lab). The lab sheets are used by the instructors as teaching tool. 1-2 hours per week are used for on-line system for quizzes and tutorial. Also have homework on line and online departmental exams. Focus on problems solving; intensives are skills based.	*EducoSoft* software and textbook (College has collaborated with company for >20 years; customize to college/student needs)
Fast Track	Basic Fast Track: Pre-Algebra + Elementary Algebra; Advanced Fast Track: Elementary & Intermediate Algebra	Traditional lecture in beginning of class with time to work on problems. Extra help available before/after class + math learning lab	Department designed curriculum
Math Jam	3 courses offered: Pre-Algebra, Beginning Algebra, Intermediate Algebra. Includes study skills, college orientation, counseling and tutoring	Constructivist Math is Fun: Hands on, games, real world problems; projects, competitions. Tutor and instructor taught. Guest speakers.	Department designed math curriculum.

Table 1.5 Social Support for Achievement	
Program	**Social Support for Achievement**
PREP	Case management to identify academic goals, degree plan, intervention plan, information on financial aid, counseling, daycare, etc.
CLICK	Provides a head start on college. Explore career options, learn what employers want you to know, become better prepared for the college placement exam, learn about financial aid and scholarships, interact with faculty and peer mentors, meet peers that can share the do's and don'ts of college.
LaGuardia Math Intensive	Walk-in tutoring support from the math learning center tutors.
Fast Track	2 hours of individual counseling. Accommodations made for placement into appropriate course following semester. Course runs June, August, and January.
Math Jam	Study skills. Where to find resources on campus. Where to get help, financial aid, counseling, tutors. Student signs summer contract, and upon completion signs fall contract which includes supports (meet with counselor, faculty and tutors, use TLC lab). Develop network of support between teachers, mentors, and students.

Summer Bridge Programs

Examples of Summer Bridge Programs. (For specifics, see Tables 2.1-2.5)

- College Connection (Community College of Denver)
- Project Dream (El Paso Community College)
- Math Boot Camp-3 models[viii] (Houston Community College Southwest)
- Summer Bridge (Moraine Valley Community College)
- Summer Bridge (Pasadena City College)

Common Elements of Summer Bridge Programs. Summer bridge programs also happen in the summer, but they run for longer periods of time (between 5-10 weeks). They are all math intensive and they all focus support on transition to college and explicit instruction of study skills. Unlike the boot camp programs, these programs tend to recruit from a more targeted population—typically recent high school graduates (but in one case those with a GED) in high-risk populations—and students are typically identified and contacted while still in high school.

Due to the long and intensive program support, these programs tend to touch far fewer students than the boot camp programs. In some cases, these programs may not necessarily reach the target population: only a student who can afford not to work can attend summer school, and/or who is disciplined to give up his summer to attend courses that do not count toward a diploma. In addition, many of the high need developmental students do not find out about this program or do not sign up for college until the end of the summer, when the programs are well under way or over. Some colleges have solved this problem by testing students when they are still in high school. Building relationships with the local high schools is a pattern in some of these institutions and one recommended in the research (Karp & Hughes, 2008).

All of the programs have faculty that extend beyond the math faculty. In the high school course (Houston), tutors support the instructional goals. In the other four programs, a variety of people (e.g., program coordinators, counselors, mentors, case managers) support the program goals.

The longer period of time affords a cohort bonding experience. The four college transition programs (Denver, El Paso, Moraine and Pasadena) identify this as a critical component to the success of both the course and the future success of the students. The extended duration also allows new students to bond with faculty and become aware of the university resources (intentionally built into coursework at Denver, El Paso and Pasadena).

These summer bridge programs offer a higher likelihood for students to learn math than boot camp programs. In addition, the four college transition programs focus on college transition skills, cohort building, and building relationships with faculty. As one faculty member from Pasadena points out, it “takes time to unlearn unproductive high school behavior. Six weeks doesn’t do it, one semester doesn’t do it. So it takes about a year.” For this reason, the support services introduced in the summer bridge program at Pasadena continue throughout the students’ first year of college.

Variations within Summer Bridge Programs. Two of the programs offer an incentive, which are both currently grant-supported. The high school program is subsidized by the high school, and two other programs (Pasadena and El Paso) require the students to pay tuition, for which students get course credit.

The academic focus is different in summer bridge programs. Two of the programs have math as the only academic content, while the other three programs offer math, reading and writing coursework. Moraine and Houston offer different levels of math; the other three programs offer one math course. These programs include more faculty-designed curricular materials than the boot camp programs. Project Dream, College Connection and Pasadena SB all use textbooks infused with faculty developed math materials. Moraine Valley has a customized edition of a traditional textbook. Four of the programs use a computer program as part of their in-class work and/or homework practice.

There is a wide range of faculty and support staff in the summer bridge programs. Two of the programs depend heavily on tutors. The other programs are staffed by various people, depending in their model. In Denver, math and English faculty work with a part-time case manager to support the students. In El Paso and Pasadena, in addition to the math and/or ELA faculty, a counselor works with the students.

The support for achievement varies program to program. The four college prep programs support learning beyond mathematics to include coursework in study skills, life skills and college information/resource skills. On the other end of the support spectrum, the high school program primarily supports math learning with a study skills component.

Table 2. Summer Bridge Program Details

Table 2.1 Basic Program Descriptors			
Program	**Students Served Per Year**	**Duration**	**Credit**
College Connection	15	8 weeks M-Th 4 hrs/day, 9-1 Fri- 2 hours	Yes
Project Dream	140	5 weeks M-F 4 hrs/day	No
Houston SW Boot Camp	25	10 weeks M-Th 2.5 hrs/day + 1.5-2 hrs in lab w/tutor	No
Moraine SB	43	8-1 M.T.Th	1 credit for COL 101
Pasadena SB	60	6 weeks M-F 9-3	Yes

Table 2.2 Faculty Resources, Incentives, and Funding					
Program	**Faculty (Resource Commitments)**	**Incentives**	**Cost to Institution**	**Cost to Student**	**Funding**
College Connection	One PT math and one PT English faculty/program coordinator, part-time case manager	Free tuition and books			Grant
Project Dream	16 faculty, 8 classes (one math faculty, one ELA faculty, and one mentor per class) Counselor	Stipend		None	Institution & grant funded
Houston SW Boot Camp	Math instructor, tutor	Required by high school		None	HS program and internal grant funding
Moraine SB	FT Director, 6 faculty (3 math, 3 COL 101 number dependent on number of sections offered), tutor	Lunch, travel vouchers, free tuition, calculators, backpacks. Opportunity to retake math placement exam and place into a higher math course	$40,000	None	Grant
Pasadena SB	2 math instructors, one tutor, counselor, TLC			Tuition	Institution & grant funded

Table 2.3 Student Population, Recruitment, and Placement			
Program	**Student Population**	**Recruitment**	**Placement**
College Connection	Specialized program for GED and high school students who are planning to enroll in fall college classes and who place into multiple levels of developmental math, reading or English.		Accuplacer—mandatory testing and placement.
Project Dream	Most students are Hispanic (reflects the population)	Recruit HS graduates with at least one developmental need.	College gives Accuplacer to HS students.
Houston SW Boot Camp	11th grade HS students who did not pass TAKS to move on to 12th grade	Recruit at the high schools.	TAKS exam
Moraine SB	Target students with ACT scores between 16-19.	Test HS students (Compass). Send home letters with trajectory information.	Compass Test
Pasadena SB	Target incoming students who are most at risk; Latino, mostly first generation, enter with a low Academic Performance IndexAPIs[ix].		Accuplacer

Table 2.4 Instructional Formats and Curriculum

Program	Content	Practices & pedagogy	Curriculum
College Connection	Math (2 hours) integrated reading/English (2 hours), college experience course (one credit), technology; multi-level classroom	College developmental education faculty understand what knowledge and competencies students must master and how they will be measured; instructors are sensitive to the instructional and social characteristics of the students; professional development for faculty is a component of the program.	Follows developmental math curriculum, with MyMath lab computer program and instructor developed materials
Project Dream	Math (2 hrs), reading (1 hr), writing (1 hr). Covers whole developmental series from basic skills to Algebra.	Hybrid approach: Computer work and small group work.	Faculty developed math materials (student and faculty handbook) based on McGraw Hill and ALEKS.
Houston SW Boot Camp	Math 306 (Pre-Algebra) and Math 308 (Algebra I)	Small group, faculty and tutor support. Work on My Math Lab after class with tutor. Discipline, hard work, holds them to college standards of behavior, attendance, work completion, and work ethic.	Bettiger Addison Wesley Textbook and My Math Lab computer program
Moraine SB	Math: Offer three levels: Basic Math (Math 090), Beginning Algebra (Math 095), Intermediate Algebra (Math 098) Study Skills College 101	Traditional, face-to-fact instruction. Department syllabi and test. College Skills: Tailored for math; tutoring component. College 101 course (overview course to transition to college. Required of all new students. Assess study strategies, set goals, values, decision-making skills, appreciation for diversity. Complete education plan; work with advisor.)	Customized Pearson editions of textbooks. Some texts are changing this fall and spring.
Pasadena SB	Math Content: Pre-Algebra On Course (College and Life Skills)	Traditional lecture.	Some materials developed by faculty; real life based project in each chapter. Math Excel: On-line program for homework.

Table 2.5 Social Supports for Achievement	
Program	**Social Supports for Achievement**
College Connection	Emphasis on critical thinking skills. Study groups. Study skills. College atmosphere. Interventions to support student affect: group activities/cohort approach; integration into college life. Logistic/systemic support: financial aid, admissions, and registration paperwork.
Project Dream	Learn about college resources, develop college-going attitude and success strategies, receive support to enroll in college in the fall, use Titon and Ashton scholarship to build cohort, sense of belonging. Faculty believe integration, acclimation, acceptance, and belonging goes a long way; sense of belonging is a key component of student engagement. Bond with peer group. Meet other faculty, use tutoring center at least once, become familiar with campus and services available, counselor.
Houston SW Boot Camp	School bus drops them off and picks them up.
Moraine SB	Study skills and tutoring. Cohort approach. Build sense of community. Focus on transitioning to college through the COL 101 course.
Pasadena SB	Counselor. Ropes course at start: cohort building. Class tutor an hour before class starts to work on homework. Computer lab. Students who pass pre-algebra stay with same instructor into the fall and spring courses.

Accelerated Program Examples. (For specifics, see Tables 3.1-3.5)

- Cool at School (Daytona State College)
- FastStart (Community College of Denver)
- Math My Way (Foothill College)
- Math Path (Pasadena City College)

As opposed to the summer programs aimed at students who want to finish or skip some developmental math credits before they enroll in the fall, these accelerated programs are math courses that exist during fall and spring term. They differ, however, from regular developmental education courses in that they provide students with the opportunity to complete more than one developmental course in a single term. For most of these colleges, these courses reflect a redefinition of developmental math instruction, and while they do not fit into our original definition of boot camp (a course that spanned less than a semester), the intensity of their design and the speed-up goal caused us to redefine our focus.

Common Elements of Accelerated Programs. As we have seen in some of the other programs, all of these accelerated programs do more than teach mathematics. In the case of Foothill and Daytona, students are required to sign up for a study skills course that runs in tandem with the developmental math course. These students not only have heavy support for math learning (they are required to achieve 87% or better in order to move to the next module), but they also are explicitly taught study skills. Math My Way is required for all developmental math students, regardless of placement, and they have the opportunity to move through all ten modules and test out of developmental math in one quarter (although very few actually do). In the other three programs, students are provided with additional supports in the form of tutoring labs. Fast Start also builds in case management, academic support, career exploration and financial aid counseling.

All of these courses are very well supported by a range of college resources. Either the faculty work together on a daily basis (Math My Way and Math Path), or the programs have extensive webs of support from other college staff (e.g., tutors, Academic Support Center, case manager, student services, etc.). Because these accelerated programs happen during the regular term, staffing them is not difficult.

In all of the accelerated programs the teachers use a combination of traditional textbook materials and their own designed materials. Working together as a learning community, building a cohort, and active learning are other strategies used in these programs.

Variations of Accelerated Programs. One main difference between these programs is the instructional tools used in the coursework. In two cases computer-based software is used as part of classroom instruction. Some programs have study skills built into the design (required class to complement math course) while other courses have social supports for achievement built into the programs in other ways (computer lab with tutor support; extended services students can access during and after class).

Pasadena and Denver's programs serve a very targeted population: those students interested in spending extra time on math to finish more quickly. The intensity of these programs can translate into little, if any, other coursework undertaken at the same time. On the other hand, to finish two courses in a single term cuts down on the lapsed time students have to spend getting into college level coursework, although technically they may spend as many hours in math courses. Fast Start is an exception to this; full-time students typically take an additional six credits.

Table 3. Accelerated Program Details

Table 3.1 Basic Program Descriptors			
Program	**Numbers**	**Duration**	**Credit**
Cool at School	13,000	8 weeks, 4 days/week, 1.5 hrs/day	Yes
FastStart	150 per semester	3 hours, 2 days a week for semester	Yes
Math My Way	150-165	Quarter 5 days/week, 2 hours per day	Yes^
Math Path	30-35 students per class; 4-6 sections per semester	16 wk semester M-F: 2 hour class; .5-1 hr support class MTThF	Yes

^Developmental credits do not count toward graduation, but do count toward financial aid.

Table 3.2 Faculty Resources, Incentives, and Funding					
Program	**Staff**	**Incentives**	**Cost to Institution**	**Cost to Student**	**Funding**
Cool at School	1 faculty per course, class size of 30 Peer tutors, tutors who are graduate students in engineering from a neighboring school. Faculty serve as tutors in Academic Support Center.	Complete 2 math courses in 1 sem		Tuition	Students pay tuition
FastStart	1 faculty per course; .4 release position to coordinate program; case manager; collaboration with math and English dept chairs, deans, divisions of student services (testing center, recruitment, career services).	Complete 2 math courses in 1 sem		Tuition	Students pay tuition.
Math My Way	Five classrooms, 5 math faculty. Study skills support (adaptive learning division faculty)	Required course		Tuition	Students pay tuition.
Math Path	One full time math faculty (equivalent) for Algebra; 2/3 of a full time load for other courses (unique teachers; meet together daily to collaborate.)	Complete 2 math courses in 1 sem		Tuition	Students pay tuition.

Table 3.3 Student Population, Recruitment, and Placement			
Program	**Student Population**	**Recruitment**	**Placement**
Cool at School	Developmental education students	Students who place in take these courses.	Accuplacer
FastStart	Students who can handle intensive requirements of acceleration with regard to work and family obligations.	Advisors and testing center personnel refer, word of mouth, posters.	Accuplacer, mandatory testing and placement
Math My Way	Required for all students who place into developmental math courses.	None.	Accuplacer
Math Path	Counseled for entry; high stakes in that only take this course for a semester so if student doesn't pass, they get no credits for the entire semester. Only take this and a PE credit. Need to work 20 hours week max and have the emotional maturity to persist.		Accuplacer

Table 3.4 Instructional Formats and Curriculum			
Program	**Content**	**Practices & pedagogy**	**Curriculum**
Cool at School	Basic Math Pre-Algebra Beginning Algebra Intermediate Algebra College Algebra	20 min lecture: Minimize passive part of learning. Mandatory assignments in class: group work. Textbook has day-by-day format with daily worksheets that are due at the end of class or the beginning of the next class.	Textbook custom made for their course by McGraw Hill. Numerics (computer program for Basic Math/Prealgebra). Mandatory lab for Prealgebra (Numerics) or pencil-paper labs for Beginning Algebra.
FastStart	Dev math 1 and 2 Dev math 2 and 3 Dev math 3 & college Algebra	Work as a learning community where students are encouraged to ask questions and think critically. Develop habits, attitudes and skills of successful learners. Interactive teaching.	Accelerated courses use teacher created materials and a mastery approach (supported by Pearson's My Math Lab). Students co-enroll in first year student experience course.
Math My Way	Textbook, review worksheets, ALEKS software	Self-paced with high amounts of structure. Mini-lectures, small group work, students working independently and reorganized based on improvement. Mastery learning.	Textbook custom made for their course by McGraw Hill. ALEKS Study skills curriculum designed by department
Math Path	Pre Algebra/Elementary Algebra Elementary + Intermediate Algebra Trig/Pre Calculus First two semesters of single variable calculus Multivariable calculus/linear algebra	Course opening: respond to questions, homework assessment, explain and demonstrate new material, group work Students help each other. Depth over breath. Support class: Study skills that respond to student needs	Addison Wesley Pearson textbook: Introductory and Intermediate Algebra by Lial Hornsby McGuinnis Paul D. Nolting Math Study Skills Workbook Other teacher created materials

Table 3.5 Social Support for Achievement	
Program	**Social Support for Achievement**
Cool at School	Academic Support Center with faculty and peer tutors.
FastStart	Case management, academic support, career exploration, tutoring in college learning lab, financial aid counseling.
Math My Way	Study skills twice a week.
Math Path	Teaching and Learning Center resources. Learning community.

What are these Programs Trying to Accomplish?

In addition to employing different elements the boot camp, summer bridge and acceleration programs also varied in their intended goals. After a quick initial scan of programs at various colleges, we identified a set of five program goals. We then used these goals to identify patterns in each program we studied. Some programs address one of these goals, while most attend to several.

- Goal 1: Learning the math necessary to score well on the placement test and place into college level math courses (or at least place higher up the developmental math chain).
- Goal 2: Developing math understanding needed for subsequent success.
- Goal 3: Forming dispositions to succeed in college (study skills).
- Goal 4: Forming relationships to success in college (peers, faculty, tutors).
- Goal 5: Informing students with specific knowledge they need/access to information to progress toward their goals (financial aid, college services, etc.).

We identified which goals each program had, and subsequently followed up with program personnel to verify our goal identification.[x]

Table 4. Program Goals.

Math Intensive Program	**Goal 1**	**Goal 2**	**Goal 3**	**Goal 4**	**Goal 5**
Boot Camp Programs					
PREP: El Paso Community College	X		X		X
CLICK: Houston Community College Southeast	X				X
First Year Institute: LaGuardia Community College	X	X			
Fast Track: Montgomery College	X	X			
Math Jam: Pasadena City College		X	X	X	X
Summer Bridge Programs					
College Connection: Community College of Denver	X	X	X	X	X
Project Dream: El Paso Community College	X	X	X	X	X
Math Boot Camp for High School Students: Houston Community College Southwest	X		X		
Summer Bridge: Moraine Valley Community College	X		X	X	X
Summer Bridge: Pasadena City College		X	X	X	X
Accelerated Programs					
Cool at School: Daytona State College		X	X		
FastStart: Community College of Denver	X	X	X	X	X
Math My Way: Foothill College		X	X	X	X
Math Path: Pasadena City College		X	X	X	X

In general, boot camps focused more on reviewing math (Goal 1) than on an in-depth study of mathematics (Goal 2). The short duration of the boot camp programs offers less of a chance to build relationships (Goal 4, only a goal in one program), but in several cases boot camp programs offer students support in learning specific knowledge to progress toward their goals (Goal 5). Two boot camp programs begin to form dispositions in students to succeed in college (Goal 3), but the short duration hinders a deep investment in this goal while this is a main goal in all five of the summer bridge programs. Even though these boot camps have similarities that range from when they happen to students they serve, only two of the boot camps share exactly the same goals—LaGuardia and FastTrack—and these programs are the only ones of our scan that only focus on mathematics review and learning.

Like boot camp programs, summer bridge programs all focus on a review of math (Goal 1). Because they tend to serve as a transition program for high school graduates, they offer other supports that include building relationships with peers and faculty (Goal 4) and learning about other college resources available to them (Goal 5).

The accelerated programs tend to do less review of mathematics (Goal 1) and focus more on teaching new mathematical concepts to students (Goal 2). In addition, the longer time students spend together allows for stronger relationship building than the other two program types (Goal 4), and also allows them to learn about the other college resources to help them succeed (Goal 5). Learning "college" behavior is also a goal in two of the three programs.

As with boot camps, the summer bridge and accelerated programs share some similar goals, but never exactly the same goals. While structurally the program types have many similarities, and there are many similarities across program types, goals of the programs are not always the same. Within the same program type we see different goals, and even a different emphasis on particular goals. Three of the programs have all five goals (one accelerated and two summer bridges), while two accelerated programs have Goals 2-5. With these few exceptions, and the two math only boot camps, none of the programs have exactly the same goals. The structures and strategies used to achieve these goals varied as well, as we reported in the beginning of this section.

Section IV. Efficacy and Costs of these Programs: What Do We Know?

Costs, Institutional Support and Funding

Because boot camps are not credit bearing, and usually students do not pay tuition, boot camp programs cost the university money. For that reason, most of these programs began as grant funded programs and still rely on some grant funding to keep them going. In addition, three of the programs offer material incentives, which can be costly. Summer bridge programs are even more resource intensive for colleges. They require more resources in that they last longer and typically have more faculty/staff involved. However, some of the programs offer course credit, which allows students to pay with financial aid dollars. In all of the accelerated programs, students pay tuition, and get credit. This allows students to use financial aid to pay for courses.

College personnel identified financial support as critical to the effectiveness and longevity of a math intensive program. Funding patterns varied in the programs we studied. Some community colleges directly support the work, allocating funds for developmental math programs. In these cases, math intensives are in the math department or part of a developmental education support program. In other cases, programs began with grant funding.

Five programs (Denver, El Paso, Houston, Moraine Valley and Pasadena) began as grant projects, where faculty built the programs, designed curriculum, bought incentives for students, and/or built infrastructure to support the program. Two of these programs are still externally funded. A couple of them have managed to build institutional support to continue the programs. In the case of the college that was able to transfer a grant-funded math intensive to college funding, a couple of supportive administrators and showing positive results helped garner support. In three cases, the college supports developmental education programs by allocating a certain amount of monies to be spent as desired by each department. In the Houston Community College system this money came in the form of a Chancellor’s Grant, and two campuses designed innovative developmental math programs from those monies.[xi] At LaGuardia, the college gives the math department a certain amount of money that they decide how to spend; their math intensive is an aspect of that spending. In several instances, colleges have built the programs to give students credit (although not credit toward a degree, but in most cases credit that will count for financial aid) and therefore charge tuition.

Two recent programs utilize a return-on-investment model for colleges to estimate the cost of running developmental education programs based on incremental costs and revenue from increased retention. With data from six states, Rob Johnson found costs for developmental programs were offset by the income generated from successful students who went on to progress through the system (Johnson, 2009. FastStart@CCD calculates that the breakeven point for program costs is reached in the semester after intervention, with additional revenue accruing with additional semesters, based on higher rates of retention (Corash & Baker, 2009).

More data needs to be collected around costs of each program. We have some information (overall cost information for two programs; incentives; materials), but ideally we would have the institutions’ share cost estimates for each program and/or complete Johnstone’s or Corash and Baker’s template for calculating ROI. [See Tables 1.2, 2.2, and 3.2 for available cost data on select programs.] In addition, we have calculated a very crude student/faculty ratio for each program to gain a sense of “cost” with regard to human resources (see Table 5). In all cases this is a rough measure, and does not take into account all of the other necessary resources to run each program. However, it offers a sense of scale across the programs.

Table 5. Approximated student/faculty ratio.[xii]

Program	# students per one full time faculty position
PREP	175
CLICK	71.4
LaGuardia	86.7
FastTrack	120
Math Jam	88.2
College Connection	25
Project Dream	29.2
Houston	83.3
Pasadena SB	85.7
Cool at School	100
FastStart	93.8
Math My Way	137.5
Math Path	52.2

Using this calculation, the boot camp programs and the accelerated programs tend to use less faculty resources than the summer bridge programs. Future analysis would examine the benefits of summer bridge relative to such differences.

What Do We Know About the Efficacy of the Programs?

While there is some evidence of the success of each of the programs we discuss in this report, that evidence is at times sparse and anecdotal. Each college collects some information about efficacy, dependent on particular goals and institutional capacity. Ideally, a successful intervention program would increase student retention in math courses, course success rates, persistence to a degree, progression to college level work, and overall units attempted and earned. Most colleges do not collect these data, and in many cases data systems are not yet built to easily track these numbers. In fact, examining transcript data by hand is still a common practice in some colleges seeking to determine the success of their programs.

We now outline the types of data that the colleges track for the programs we examined. In some cases the data are reported for students from the intensive program; in other cases the data are comparisons between program students and a group of non-program (but similar) students. In all cases these data were what we were given by the colleges in our short data collection window (about 45 days in the summer of 2009).

Other data may exist but was not quickly or easily accessible. A couple of colleges shared data from external reviews, indicating that in many cases these data are not systematically collected and analyzed as a matter of course in the colleges, but are when additional funding, resources, or external scrutiny come into play.

We set out to organize the available data around our five goals. Extant outcomes primarily address Goals 1 and 2 (the math focused goals). Only one program assessed Goal 3 (forming college dispositions). Collecting and analyzing data around Goals 3, 4 (forming relationships), and 5 (specific "college" knowledge) would be a meaningful next step in terms of understanding overall success of math intensive programs. Many institutions also reported course completion rates and overall persistence and performance in community college as other measures of efficacy. While it is possible that aspects of the programs had an impact on persistence rates, grades, graduation rates, etc., the data we have is not specific enough to point in any such direction. We add specific data points in Appendix E and summarize below.

Data To Support Goal 1

Learning the math necessary to score well on the placement test and place into college level math courses (or at least place higher up the developmental math chain)

The data colleges reported for Goal 1 were percentages of students who completed an intensive program and increased at least one developmental math level. [xiii] None of the colleges reported data with regard to how these numbers stack up to a comparison group. In the six programs who reported data for students, between 38-67% of students completed the program and increased at least one level.

Data to Support Goal 2

Developing math understanding needed for subsequent success

Institutions reported data on college level math course completion, percentages of students who passed the next course (with comparison group numbers), and grades in the next course. The most impressive report was Foothill's, who compared program completers to non-program participants and found a 30% increase in success rate.

Data to Support Goal 3

Forming dispositions to succeed in college (study skills)

Almost no one provided evidence of this goal, but Daytona State reported on greatly improved attendance, which serves an indicator of dispositions to succeed in college.

Beyond improved performance, getting students to register and continue to take math classes is still a common challenge. In one study, three to four students out of ten who are referred to remediation actually complete the entire sequence to which they are referred, and more students exit their sequence because they did not enroll rather than because they failed a course (Bailey, Jeong, Cho, 2008, Appendix E). For this reason, we identify data that hints at how students who complete intensive programs faired in subsequent courses, how they perform in other courses, and if they to persist to a degree.

Data on Math Course Completion

Some colleges collect data on the percent of students who pass the developmental math courses. In most cases they collect percentages of students but do not provide comparison groups. Some colleges reported as high as 89 percent passage rates. However, in many cases there is no comparative data to show how program completion compares with similar populations that did not complete the program. Three colleges reported comparison groups, and found the programs to have a pass rate between 10-20 percent higher.

Data on Performance and Persistence

Colleges collect a range of data that shows evidence of college performance, in general, and persistence to a degree. Performance data include GPA and success and retention in college courses. These sites all had comparison group data included. Denver's FastStart students had higher GPAs than comparison groups in their first semester after program completion. Persistence data include number of students who go on to enroll in college after program completion, success in basic skills sequences, persistence to a degree percentages, graduation rates, and college credits earned. Many of these sites include comparison groups. Most striking are the high numbers in El Paso (87 percent) and Denver (78 percent) who go on to enroll in college after program completion. One challenge colleges face in collecting graduation data is the difficulty in tracking students who leave the college. Graduation rates may be higher than reported, but most colleges do not collect graduation data on students who transfer to other colleges and universities.

Other Measures

Some colleges measured other important data that doesn't fit cleanly into one of our categories above but is important to mention. Pasadena shared data on behavior measures from students in their Math Jam program. Almost all students reported they feel better about math and have less anxiety after program completion. At several other colleges, faculty reported student surveys; these anecdotal results indicate positive responses to the programs, even in cases where students did not pass the course but still enjoyed and recommended the experience. In addition, Daytona State reported that program completers finished their college math sequence in a shorter duration than a comparison group.

Overall, the evidence we collected came in two main forms: descriptive data with no comparison group or descriptive data with plausible comparison group (either baseline or a different cohort of students). In Table 6 we give an overview of the levels of evidence we were able to gather in our 90-day cycle based on the reported goals each program had and showed evidence for (Goals 1-3), math course completion, and evidence for performance and persistence. In many cases there was no available evidence; this could be because the colleges do not collect the data or because they did not have it readily available to share in the timeframe in which we conducted our review.

Table 6. Levels of Evidence[xiv]

Math Intensive Program	Goal 1: Learn math to place higher	Goal 2: Learn math for subsequent success	Goal 3: Dispositions to succeed in college	Math Course Completion	Performance and Persistence
Boot Camp Programs					
PREP: El Paso Community College	1		*		
CLICK: Houston Community College SE	*			1	
First Year Institute: LaGuardia Community College	1	*		1	
Fast Track: Montgomery College	1	2 (+)			
Math Jam: Pasadena City College		*	*	2 (+)	2 (+)
Summer Bridge Programs					
College Connection: Community College of Denver	1	*	*	1	1
Project Dream: El Paso Community College	1	*	*	1	1
Math Boot Camp for High School Students: Houston Community College Southwest	*		*	1	
Summer Bridge: Moraine Valley Community College	*		*	2 (+)	
Summer Bridge: Pasadena City College		*	*	2 (+)	2 (+)
Accelerated Programs					
Cool at School: Daytona State College		*	1	1	
FastStart: Community College of Denver	*	2 (+)	*	2 (+)	2 (+)
Math My Way: Foothill College		2 (+)	*		
Math Path: Pasadena City College		*	*	2 (+)	2 (+)

The levels of evidence are coded as follows. 1= reported a measure of the goal for students involved in the programs   2= reported data that compared the performance of students in the program with a plausible comparison group. For 2's the + or – in parentheses indicates whether students in the intensive program had higher or lower performance relative to the comparison group. * = identified the outcome as a goal of their program but had no data readily available to report.

Many different students attend community college, and a majority of them end up in developmental math courses. According to Achieving the Dream data[xv] 59 percent of students were referred to developmental math: 24 percent to one level below entry-level college, 16 percent to two levels below, and 19 percent to three or more levels below. (See Appendix G for a graph of how Achieving the Dream students fall into developmental math courses by race/ethnicity.) For this reason, colleges must support the wide range of student needs presented in this diverse student population. Some are right out of high school; others have been out of school for many years. Most community college students also work, and many have family and other obligations. Many speak English as a second language. Community colleges face the challenge of serving non-traditional populations, the principle being that they accept all students. Thus, one challenge of data collection becomes using data to understand what programs are working for which students. In addition, better data needs to be collected in order to understand how to place students. More research needs to be done to identify exactly what population is being served best by different elements of the boot camp programs. In addition, a refined way to identify student needs could improve placement. As the debate continues over appropriate placement and cut scores (Collins, 2008), developing better placement mechanisms may be useful. One teacher remarked that a mechanism to figure out which students fit best into each type of program would be useful, particularly in situations like enrolling students in on-line, self-paced courses versus more traditional lecture sections.

In the next section, we look at how one community college designed a program for all incoming students that identifies student needs, via one-on-one case management, and develops customized support for proper course placement. Additionally, the college designed a second program to serve needs of a specific population.

Section V: A Closer Look at One College with Multiple Strategies

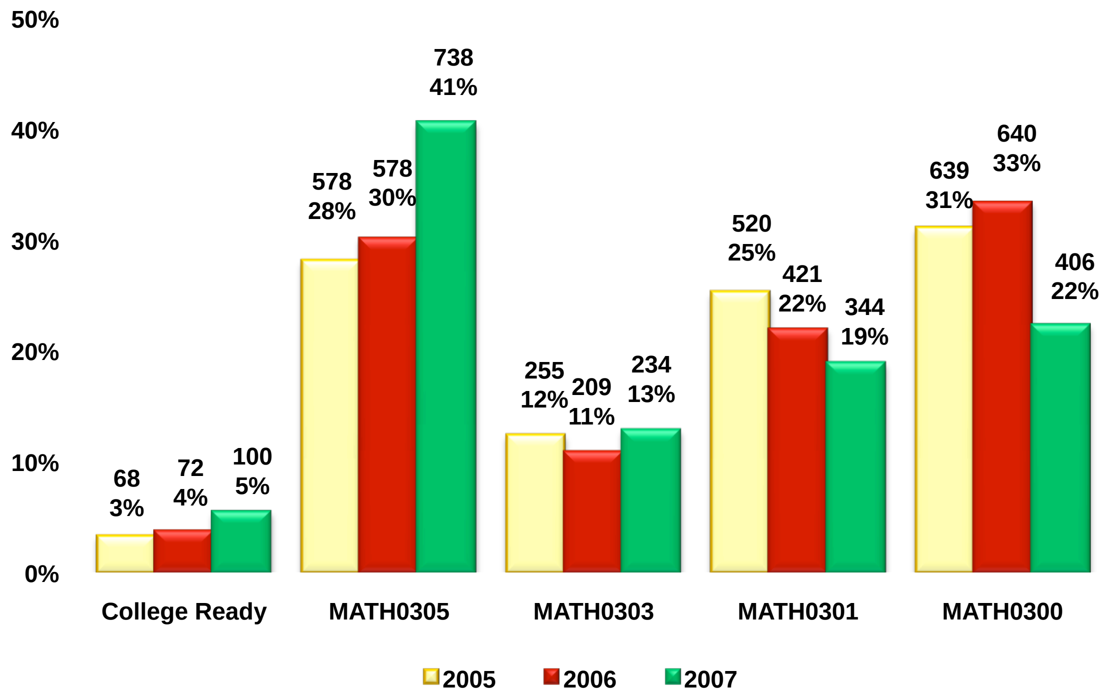
In addition to understanding the specifics of *what* these programs were doing, we also attempted to understand *why* these programs employed the structures they did and how they came to be. Undergirding the various program elements are perceived relationships between program elements and the students, resources, problems and constraints of the context where they are implemented. While our protocol for this scan did not surface all of these perceived relationships, we did get a sense of the logics behind some of the design elements in colleges where multiple programs were implemented, each aimed at a different population of students. We offer as an example below an account of one college that solved the diversity of student needs problem by designing an array of programs to support developmental math students.

The Case of El Paso Community College

The town of El Paso, Texas, is 80 percent Hispanic with a median household income $16,000 below the median household income in the United States. Of people 25 years old and older, 32 percent do not have a high school diploma, 23 percent are high school graduates and 18 percent have an associate's or bachelor's degree. El Paso Community College's (EPCC) students are 85 percent Hispanic and 59 percent female. Most students are first generation college students and most speak Spanish as their first language. In the fall of 2006, 21 percent of the students (both full time and part time) were 21 years old or younger. Enrollment rates have risen in the last five years (8.6 percent) while graduation rates have also increased dramatically (69 percent since 2003).

In 2007 only 5percent of first-time college students at EPCC placed into college level math.[xvi] The remainder placed into developmental math and cluster around one or three levels below college level math (see Table 7).

Table 7. Three-Year Comparison of Math Placement by Level, post PREP



Note: The EPCC developmental education sequence in mathematics is 0300, 0301, 0303, and 0305. Students who place above 0305 are determined "college ready" and can take a college level math course for college credit.

The number of students in the lowest two levels has decreased between 2005-2007, while the number placing two levels below college math has stayed the same. The director of student success believes this decline is attributable, at least in part, to specific services EPCC has put in place to better serve their students. Eight years ago El Paso Community College identified the need to have a variety of services available to their students. They wrote for and were rewarded a Title V grant with which to build a new developmental education program. Many of EPCC's students did not understand the importance or implications of a placement test, nor did they know how to prepare to take one. The PREP program grew out of this work, and now supports 2800 students, roughly 70 percent of EPCC's incoming student population, including returning (older) students (see Table 8). El Paso Community College's goal is to scale up PREP to support all incoming students.

Table 8. El Paso PREP Data.

Total Number of students served:	2787
Students who attended Placement Test Overview (Pretest)	818
Students who attended New Student Orientation (Retest)	692
Health Occupation Programs	277
Average number of hours students worked with Plato tutorials	15
Average number of modules students mastered in Plato tutorials	10

PREP is a case management approach to student support and placement. The goal of this program is not to teach new skills, but "to achieve proper placement through refresher." According to Irma Camacho, Director of Student Success, roughly 70 percent of their incoming students are dissatisfied with their initial placement. Each student meets individually with a specialist who works with the student to build an individualized preparation plan. These plans take into consideration how long students have been out of high school, what skills they feel they are good at, what skills they *are* good at (based on the diagnostic test), and self-diagnoses of their skills.

Students attend a 90-minute session in which they are introduced to the Accuplacer test, given test-taking strategies, and taught the importance of their performance on this test. After students take the Accuplacer, if they are dissatisfied with their score, they meet with a case manager and take a diagnostic test (A+ Advancer). The student is then given an individualized course of study, on the Plato course materials, where they practice, online, the areas of weakness (as determined by the diagnostic test). They use the computer program in a lab where they have access to tutors and can spend as much time as they need. They then retake the test for the chance at a new placement. In addition, each student sits down with a counselor for one-on-one case management. This support includes goal setting and course selection, as well as support in navigating the system (e.g., financial aid, registration, etc.)[xvii].

Comacho adds, "Students who have gone through the program place higher than students who have not. Our goal is to get them into the best placement: give them a refresher if they need it. We have a wonderful developmental education program, and we don't want to keep students who belong in [developmental education] from being in there." Many students that complete their intervention program place out of one, two or three developmental education courses. Course placement results based on Accuplacer Retest are below in Table 9.

Table 9. Intervention Program Success Rates

	Math	Reading	Writing
2003-2004	60%	68%	80%
2004-2005	54%	70%	69%
2005-2006	52%	69%	70%
2006-2007	54%	66%	75%
2007-2008	66%	68%	80%

Note: These numbers represent the percentages of students who placed out of one, two, or three developmental education courses (based on their Accuplacer retest results) after they completed the intervention program.

In addition to PREP, EPCC also has a summer bridge program called Project Dream which supports developmental students in a different way. This program offers recent high school graduates, who have at least one developmental need, an intensive, five-week immersion course in math, reading, writing and study skills. Taking a contextualized approach, and drawing from the work of researchers like Perin, Tinto, and Astin, the program faculty collaborated to create very intentional course and material designs. For example, the English and math faculty worked together to develop reading materials in math. The math component of the program involves small group work as well as computer work using faculty-developed materials based on McGraw Hill and ALEKS. The program is designed so that students feel like they belong. "Integration, acclimation, acceptance, belonging—that goes a long way," states Camacho. According to Comacho, during the course students not only learn subject matter content, but they also bond with their peer group, meet faculty, use the tutoring center at least once, and become familiar with the campus and support services available (e.g., a counselor).

Similar to their PREP program, EPCC shows positive effects of Project Dream. They collected data on four cohorts across three years (2006-2008). The number of students in the program more than doubled from 2006 to 2008 (from 64 to 133) and between 87-97 percent of the completers went on to enroll in the fall term. Between 36-54 percent of the completers increased at least once course level in math as a result of their involvement in the summer bridge program. Next we examine the design features of both programs.

PREP Design Features

- *Case management* to support first generation students who are unfamiliar with college processes.
- *Test education* to support first generation students who are unfamiliar with the importance of the placement test and the format of the test.

- *Individualized plan for support in class selection.*
- *Individualized math plan to review specific needs.*
- *Intensive time on math via computer program* to support flexible scheduling and the variation of time needed across a range of needs and to support student engagement in the task of math review.
- *Opportunity to retake placement test.*

Project Dream Design Features

- *Focused, intensive time spent learning.*
- *Focused, intensive time spent learning reading and writing skills.*
- *Faculty designed curriculum materials, contextualized approach to teaching, small group work, computer program.*
- *Cohort model.*
- *Lessons in use of tutoring center, financial aid, counselors, etc.*

While in some cases serving similar populations, these two programs are designed with different outcomes in mind. They are resourced differently, have different goals, and with the exception of time spent learning/reviewing math, have different design features. PREP is intended as a filtering program that supports students in their initial entry into college and arms them with important knowledge to take the critical first steps (understand, review and perform to one's potential on the placement test, get individual counseling to generate a plan of study). Project Dream goes deeper into the transition support, offering students math instruction (rather than just review) while providing an opportunity for students to build relationships, college skills, and college knowledge which will, ideally, support them as they persist to a degree.

It is unlikely that any one intervention can be used to address all of the challenges developmental math students face. Ideally colleges design programs deemed most critical for leveraging change in the particular context. In a few cases, colleges are able to design several programs to target different needs and accomplish different goals, like in the case of El Paso Community College, Community College of Denver, and Pasadena City College. Other colleges had to make strategic choices defining the program they think best serves the needs of their students with the resources available.

Section VI. Common Themes

We set out to explore a set of interventions that, at a broad level, shared a common conception of how to improve outcomes of students requiring developmental math instruction. Specifically, they aimed to shorten or remove the need for developmental math coursework altogether. In describing the structural features of these programs we found variation in program goals, and variation in of the array of elements aimed at achieving these goals. Overall, each program shows some indications of success, but the evidence varied in rigor, number of students positively impacted, and depth and range of impact. In essence, the programs we describe represent more a set of local solutions than a class of intervention whose key elements are currently well enough understood to be adapted to new contexts.

Undergirding these programs, we can infer a set of common working hypotheses—that this set of interventions seeks to address—about the specific nature of the problem(s) of developmental math and strategies believed to be best suited to address these problems. Improving student success in developmental math is ultimately a complex activity, requiring changes at the instructional, institutional and field levels of the community college system. Interventions necessarily focus on parts of this overall system, designing practices believed to affect change. The intensive developmental math programs' significant activity falls into four domains: (1) using intensive math instruction to shorten the developmental math sequence (2) strengthening students' connections to faculty and peers, (3) providing students with 'college knowledge' and guidance for success, (4) attending to the transition of students into college. In this section we summarize the intensive math programs' activity in these four domains.

Intensive Math Instruction to Shorten the Developmental Math Sequence

The boot camp, summer bridge and accelerated math programs all attempt to provide intensive math instruction to ramp-up the math knowledge of developmental math students and help them succeed in college. In some cases this intensive math instruction is aimed at reminding students of the math that they already knew, and in other cases it is used to fill gaps in their math understanding. In some cases, the math instruction and/or review is aimed specifically at placement tests in an effort to help students score higher and place further along (or completely out of) the developmental math continuum. In other cases, the programs teach conceptual knowledge necessary for subsequent success in math courses. In all cases, these programs are based on the assumption that *intensive math instruction* can be used to achieve gains in math learning that are higher than what would be accomplished in a non-intensive model. Many faculty members we spoke with believe that the pure time put towards learning math will have positive results. As William Coe from Montgomery College noted, "You would expect that if they do 20 hours of math, they will do better." Putting time towards studying math would logically result in more math learning. And many of the teachers echoed Mahmoud Shagroni's belief in student ability, "If they do the work, it's impossible for them not to do well in math, no matter who he is!"

The programs deliver the intensive instruction using a diverse array of instructional materials, formats and strategies. In ten cases, traditional textbooks or curricular materials based on textbooks were the primary course material. Colleges used books from the following publishers: Pearson (5), EduSoft (1), McGraw Hill (1), Plato (1), unknown (2). In eight cases the textbook linked with a software program and/or used software unrelated to the textbook [ALEKS (2); EduSoft (1); Math Excel (1); My Math Lab (3); Plato (1)]. In many cases, the faculty has done some material design or redesign, ranging from a reorganization of an existing text (3) to a complete drafting of the materials used (2). Several colleges made an effort to make the learning materials more relevant to the students. For example, the Pasadena summer bridge has a real life based project in each book chapter. In other cases, the classroom arrangements and lesson execution attempted to increase student engagement (Math Jam: Math is Fun!). In many cases the faculty continues to revise the content to meet the needs of their students.

Some customization is probably appropriate, based on different populations. For example, Montgomery Community College in Maryland adopted Fast Track from their neighboring county, Prince George's County. William Coe, a math faculty and Fast Track professor, redesigned the curriculum to fit the needs of Montgomery students. His population is 30 percent international and generally has slightly higher math skills. A higher socio-economic demographic might account for some of this difference.

Pedagogy varied from program to program, as did instructional formats. Some programs are 100 percent computer based while others do not use computer software at all. Many programs have students working in small groups and interacting frequently. This often matched the instructor's teaching philosophy as well as supported the relationship-building element of the program. In some cases students work individually, and two programs have individualized programs so that these students work at their own pace. In some programs, math is taught exclusively by math faculty, while in other programs tutors support the instruction and/or the homework/practice element of the course. Some programs were directed at mastery while others were constructivist. In a few programs the individual teacher was critical to program implementation; in most programs this was not the case. We did not collect enough evidence in or initial scan to determine how much pedagogy and instruction matter for program success.

The wide variation in how programs use materials and instructional formats makes evaluation of their efficacy difficult. Further research to look for evidence of efficacy of specific instructional materials and strategies will be useful to determine which formats, practices and materials are most powerful for supporting student learning in math intensive programs.

Strengthening Student Connections to Peers and College

A pattern that emerges in most of these programs is they explicitly provide students the opportunity to build relationships with other students (both their peers and more experienced students who serve as tutors and mentors) as well as faculty and other adults who can support them in their path to graduation. In some cases students will go on field trips or camping trips aimed at expediting this bond. Like developing real-world and engaging curricular materials, this was another powerful strategy for increasing student engagement. Imagine Success identifies characteristics of college programs that engage students: personal connections, high expectations and aspirations, plan and pathway to success, effective track to college readiness, engaged learning, integrated network of financial, social and academic support (Center for Community College Student Engagement, 2008). Many researchers argue that engaging developmental students is critical (Astin, 1998; Kuh, Kinzie, Schuh, Whitt, & Associates, 2005; Pascarella & Terenzini, 2005; Tinto, 2003). This is particularly true for students who are low-income, first-generation college students for whom their time in class is more than likely their only time on campus engaging with faulty and peers (Engle & Tinto, 2008).

All of the programs, with the exception of PREP, include an on-campus, class meeting time. For many students who work full time and/or have family obligations, this class time is frequently the only opportunity they get to interact and connect with their peers and faculty. Anecdotal evidence indicates that these relationships support students in persistence to finish the course and in some cases to continue to the next math course.

Many of the intensive math programs we consider use a cohort model in their design, intentionally supporting students to build relationships with peers that will last beyond the program boundaries. The intensive element of the programs—where students meet every day for a period of weeks and/or for extended periods of time on the days they meet—supports this relationship building, both with faculty as well as peer and tutors. By having the programs on campus, the schools also support students with a first opportunity to connect with the campus and also to see themselves as college students. In the case of Pasadena Math Jam, where students continue with the same professor, this opportunity to build relationships is further strengthened.

Strengthening Guidance for Student Success

Some experts believe that helping students address non-academic deficiencies is just as important as supporting their academic development (Boylan, 2002; Pascarella & Terenzini, 1991; Zeidenberg, Jenkins, & Calcagno, 2007). Four colleges had support centers that expand the academic support for developmental students (Daytona, Denver, El Paso, Pasadena). For example, the Teaching Learning Center (TLC) at Pasadena City College is a large room with computers and big desks for students to work. There is a lab assistant on duty, and several offices for the director, counselor, and several faculty members establish the perimeter of the center. Peer tutors are also available in the TLC. The lab is open all year for students to come get tutoring help, work on homework with other peers, and have a quiet place to study. The faculty has built a family-like environment where students have multiple resources to tap into in order to get support throughout their college experience. Several other colleges have learning labs with computers staffed with peer tutors and/or faculty. Developmental education students tend not to use these resources, which is why some of the intensive programs build in time and activities that explicitly require students to use these resources in order for them to be comfortable using these resources on their own in the future.

In addition to academic support, many of these programs introduce other kinds of support for developmental students including:

- Financial aid counseling
- Career counseling
- College and life goal setting
- College counseling
- Test taking skills
- Study skills
- Life skills
- College skills (how to be a college student)
- Guaranteed seat in the next course in the progression

The additional supports are quite prevalent in most of the programs although the degree to which they are supported and implemented varies based on duration of the program, resources available, and individual capacity.

Increasing Student Engagement

Many researchers argue that engaging developmental students is critical (Astin, 1998; Kuh, Kinzie, Schuh, Whitt, & Associates, 2005; Pascarella & Terenzini, 2005; Tinto, 2003). This is particularly true for students who are low-income, first-generation college students for whom their time in class is more than likely their only time on campus engaging with faculty and peers (Engle & Tinto, 2008). Imagine Success identifies characteristics of college programs that engage students: personal connections, high expectations and aspirations, plan and pathway to success, effective track to college readiness, engaged learning, integrated network of financial, social and academic support (Center for Community College Student Engagement, 2008). Math intensive design must be intentional in how the programs engage students, both in the classroom instruction as well as in college on a broader level. We saw anecdotal evidence of this in many of the programs, as faculty worked to make curricular materials meaningful to students, built various wrap around supports, and designed cohort models to connect students with peers, mentors and faculty.

Building On-ramps to Effectively Transition Students into College

The population of students who enter developmental math courses share the challenge of low math performance, but for a variety of reasons. Some students have not had math in many years, either because they have been out of school for a long time or because they took their final required math course early in high school. Many students work and have family obligations. They often are not strong students, and do not see themselves as “college” material. This may be due to lack of success in high school or because they have no role models for what a college student looks like. The students who struggle in developmental math also tend to struggle in other academic areas (as seen in placement test results) as well as with basic study skills, maturity, motivation and defining clear career goals (as described by community college personnel). For this reason, programs often focus on more than learning math skills. In many cases, learning the math is secondary, or a venue in which to accomplish other goals. In most cases, the program is an important opportunity for the college to bridge the student from an uncertain and struggling past to a successful college student.

Since many students are lost at this critical juncture of transition into community college life, efforts to strengthen the transition for student success generally, and mathematics skills in particular, represent a promising solution process within a larger program improvement effort. This transition period is a critical juncture in many students' lives, and the intensive programs are one solution to this challenge. El Paso's PREP program supports students' entrance into college by teaching students about the format of the placement test and the importance of the test. Several other programs we consider ease the transition for students by helping them set career goals and/or programs of study through case management or counseling support.

Role of Institutional Leadership and Faculty Ownership

Leadership is an important element to understand as we explore ways these programs can be brought to scale. In all cases, there are passionate and creative individuals who have worked long hours to make sure that their math intensive program exists and serves as many students as well as possible. In some cases, a dynamic leader has built a team, established a network of supports, and instituted a wide array of practices for developmental education students, in the absence of institutional support and adequate funding. Leadership is critical, and clearly more effective leaders will be better at utilizing resources to build successful programs. But having just one leader does not appear to be necessary. In many cases leadership is distributed across multiple individuals or teams. Important knowledge and skills include knowing how the system works, building teams of faculty, bridging departments to gain external support, and finding space—both in the buildings and in the schedule—to conduct programs so they work well for the target population. (In many cases, space and schedule limitations interfered with allowing for adequate sections, desirable times for working students, etc.). In some cases, leaders found creative solutions and faculty who are invested.

As a group, these interventions problematize elements of the instructional system and student support systems in community colleges. They challenge notions of how long it should take for students to learn the math they need and the institution's responsibility for providing students with the college knowledge, guidance and relationships students need. They also challenge notions about how much the institution is responsible for supporting students with the transition into college. In many cases colleges took this challenge seriously, finding resources to support students in more than just math learning. Many colleges pull staff from across different divisions of the institution (counselors, financial aid officers, tutors) to support developmental education students. While some programs depend on adjunct faculty who are not well supported in their own professional development, many have found ways to collaborate on a regular basis to build stronger programs and better instruction). In most cases we found evidence of a culture of faculty collaboration who were designing relevant curriculum, working as a team to support student needs, reflecting and improving on one's own practice. If we were to take this investigation further, documenting the specifics of the practices the programs use to achieve these ends would be a productive starting point.

Section VI: Conclusions

High numbers of the students who enter the community college system get identified as in need of developmental math coursework, and the majority of those students never persist to a degree. Supporting students who struggle in mathematics is a challenge for the community college system, and many creative solutions have been put in place to attend to this need. In this report we explored a set of interventions that shared a family resemblance in their approach to solving this critical challenge. We detailed the elements of their approach, summarized what is known about their efficacy and costs, and inferred the particular problems on which they appear to be focused.

Through this exploration we gained insight into the nature of the challenge of developmental mathematics as construed by this set of interventions. The programs employed strategies to speed up the development of math understanding through the intensification of instruction. This stands in stark contrast to the multicourse sequence that is the norm in developmental math. The student support system was also problemetized, as individuals designed new ways to connect students with the institutional resources and promote the formation of stronger relationships. One element we found to be particularly intriguing was the use of these programs as an onramp, to effectively transition students into college. This attention to the initial engagement of students within an academic program and the institution may be an important element to incorporate in the design of other programs.

Most of the programs we examined have anecdotal evidence of success. In a couple of cases we have some long term evidence that students who participate in these programs do better than students who do not (e.g., higher rates of completion of the next level math course). However, long-term data does not exist to empirically show that these programs definitively work, nor do we know exactly which program changes might work best for different kinds of students and organizational contexts.

The issue of program targeting is one meriting further examination. Test scores and college faculty indicate that most students need more than a refresher. "There is no clear agreement on how many students may be able to accelerate through targeted remediation, although math chairs at Community College of Denver and Ivy Tech Community College, Kokomo, estimate that between 10-35 percent of students would fall into the category of benefitting from targeted remediation rather than the more traditional format" (Epper & Baker, 2009, p. 8). Delineating characteristics of particular student need are critical to address and would increase success rates when they are a good match to particular program characteristics. For example, students whose first language is not English and who are the first member of their family to attend college more than likely need different support services than programs that serve students who learned the math and just need a refresher course. A refined way to identify student needs could greatly improve placement. As the debate continues over appropriate placement and cut scores (Collins, 2008), developing better placement mechanisms would be useful. More research needs to be done to identify exactly what population is being served best by different elements of the math intensive programs.

The specifics of program design varied widely. They varied in their use of materials, instructional formats, instructional staff, time allocation, and instructional foci. In many cases this variation appeared to result from the conception of the specific nature of the problem and available resources within the local context. In some cases limitations of faculty and other key resources dictated the program design.

Utility of the 90-Day Scan

Overall, in our first instantiation of the 90-day cycle scan we were successful in quickly producing *program descriptions* of a domain of intervention; variations in how similarly named programs differed in their structural characteristics. We were somewhat less successful in documenting the designer knowledge behind the particular structures employed. *Specification* of both the structural characteristics and the assumed causal mechanisms as they interact with resources/constraints and a theory of change is important for the considerations of scale, particularly the adaptability, reliability and learnability of the intervention in a new context. Developing protocols that surface and capture this knowledge will improve future scans of the field. We also got a relatively quick sense of the state of the knowledge regarding their efficacy and costs that can serve as the basis of further instrumentation and investigation.

Recommendations

We recommend further investigation of the math intensive intervention in order to better understand which design elements are most powerful, with the goal of developing a scalable intervention solution. We propose the following next steps:

1. Identify 3-6 programs (at least one from each strand) and provide them with support to build an infrastructure to collect and analyze long-term, systematic data. At least one college with several program options should be included. Data collected would include:
    - Number of students who score higher on the placement test, (and therefore take fewer –or no—developmental math courses).
    - Information on if students then place into a college level math course, or at least move up the chain, do they enroll in a math course.

- Information on whether students successfully complete the next math course, and subsequent math courses including college level math courses.
- Success in each class, as measured by grades.
- Student engagement levels.
- Persistence to a degree.
- Cost benefit analysis of each program.

2. Build a collaborative to examine programmatic data in an effort to build a deeper understanding of key design features. Empirically examine the variability in outcomes for whom and under what contextual conditions. Identify which design features matter most (e.g., cohort model, math skills with additional study skills and college skills, pedagogical models) and which features are less important. Consideration should be paid to understanding the balance of features that are easy to scale (curricular materials) as compared to those that may be harder to scale (professional development).
3. Use this analysis to determine which model (boot camp, summer bridge or accelerated) and which design features are most likely to scale. At the same time examine colleges that have multiple options and determine possible need for this approach.
4. Further examine the challenge of correct placement of students.

This 90-day cycle has revealed much enthusiasm and interest on the part of college faculty and administration with regard to reducing the need for developmental math and supporting struggling students. We believe that building a collaboration will be possible as many colleges are eager to improve their support to developmental students and learn from the field. Additionally, many are eager to and in need of support to build the infrastructure to support better data collection and analysis.

Appendix A. Placement Test Information

The programs we studied use one of two standardized placement tests to place students into math courses: The Accuplacer or the Compass Exam. Below is the breakdown by college, followed by information on each test.

College Placement Test Use

College	**Accuplacer**	**Compass**
Anne Arundel Community College. Maryland	X	
Community College of Denver	X	
Daytona State College	X	
El Paso Community College	X	
Foothill College	X	
Houston Community College Southwest		X
Houston Community College Southeast		X
LaGuardia Community College		X
Montgomery College	X	
Moraine Valley Community College		X
Pasadena City College	X	

Accuplacer: College Board. A computer-adaptive placement testing system designed to facilitate the evaluation and placement of college students in three basic skills areas: reading, writing and mathematics. “It is especially noteworthy that the placement tests that are used to identify students for remediation are usually calibrated to select students who have severe deficiencies, typically those who lack the skills required in eighth grade,” (Levin & Calcagno, 2008, p. 181).

The Accuplacer has three math tests: Arithmetic Test, Elementary Algebra Test, and College Level Math Test.

Arithmetic Test

This test measures your ability to perform basic arithmetic operations and to solve problems that involve fundamental arithmetic concepts. There are 17 questions on the Arithmetic tests divided into three types.

• Operations with whole numbers and fractions: topics included in this category are addition, subtraction, multiplication, division, recognizing equivalent fractions and mixed numbers, and estimating.

• Operations with decimals and percents: topics include addition, subtraction, multiplication, and division with decimals. Percent problems, recognition of decimals, fraction and percent equivalencies, and problems involving estimation are also given.

• Applications and problem solving: topics include rate, percent and measurement problems, simple geometry problems and distribution of a quantity into its fractional parts.

Elementary Algebra Test

A total of 12 questions are administered in this test.

- The first type involves operations with integers and rational numbers and includes computation with integers and negative rationals, the use of absolute values, and ordering.
- A second type involves operations with algebraic expressions using evaluation of simple formulas and expressions, and adding and subtracting monomials and polynomials. Questions involve multiplying and dividing monomials and polynomials, the evaluation of positive rational roots and exponents, simplifying algebraic fractions, and factoring.
- The third type of question involves the solution of equations, inequalities, word problems. Solving linear equations and inequalities, the solution of quadratic equations by factoring, solving verbal problems presented in an algebraic context, including geometric reasoning and graphing, and the translation of written phrases into algebraic expressions.

College Level Math Test

There are 20 questions on the College-Level Mathematics.

The College-Level Mathematics test assesses from intermediate algebra through precalculus.

- Algebraic operations includes simplifying rational algebraic expressions, factoring, expanding polynomials, and manipulating roots and exponents.
- Solutions of equations and inequalities includes the solution of linear and quadratic equations and inequalities, equation systems and other algebraic equations.
- Coordinate geometry includes plane geometry, the coordinate plane, straight lines, conics, sets of points in the plane, and graphs of algebraic functions.
- Applications and other algebra topics ask about complex numbers, series and sequences, determinants, permutations and combinations, fractions, and word problems.
- The last category, functions and trigonometry, presents questions about polynomials, algebraic, exponential, logarithmic and trigonometric functions.

Compass (ACT) A nationally normed, computer-adaptive college placement test. (Based on your answer to question #1, you get a unique question #2, etc.) Test spans broad range of questions and can last between 20 minutes and two hours.

From their website:

The **Math Placement Test** is a multiple-choice test that evaluates students' ability levels in terms of basic skills such as performing a sequence of basic operations, application skills such as applying sequences of basic operations to novel settings or in complex ways, and analysis skills such as demonstrating conceptual understanding of principles and relationships for mathematical operations. The Math Placement Test offers up to five subject areas: Pre-Algebra, Algebra, College Algebra, Geometry, Trigonometry. Do colleges have different rules as to which sub-tests students actually take? [Colleges select the subject areas for their test. A student proceeds through the test until failure, so if a school has all five math subject areas, the math placement test can range anywhere between 15 minutes to two hours, depending on the student's content knowledge.]

To ensure variety in the content and complexity of items within each domain, COMPASS includes mathematics items of three general levels of cognitive complexity: basic skills, application and analysis. A basic skills item can be solved by performing a sequence of basic operations. An application item involves applying sequences of basic operations to novel settings or in complex ways. An analysis item requires students to demonstrate a conceptual understanding of the principles and relationships relevant to particular mathematical operations. Items in each of the content domains sample extensively from these three cognitive levels.

Students may use calculators that comply with ACT specifications when taking the COMPASS math tests.

Appendix B Carnegie's Seven Core Evaluative Questions[1]

1. Is the boot camp solution a high leverage activity (i.e., is there reason to believe that large effects might accrue for large numbers of students by getting this right)?
2. Are boot camps scientifically grounded (i.e. what principles undergird its theory of action and what is the warrant for these)? Why do we think boot camps have a chance of working, and what counter arguments and evidence might be raised?
3. How are boot camp innovations intended/designed to work? What are its component work processes? How well specified is the innovation in terms of supporting materials, instructional time, activity protocols, roles and routines? The focus here is on specifying the details for executing the innovation at scale.
4. What, if anything, do we know about the adaptability of boot camps to variations in personnel capabilities and local contexts?
5. What do we know about efficacy and costs (and, again, how well do we know these things)?
6. Can the boot camps pass reliability and learnability tests? That is, is it likely that professional learning and other support systems can be developed to assure that the boot camps can be supported with efficacy at some scale?
7. The customer test: Would take-up by individuals and/or institutions be likely in a beta phase and beyond?

[1] These were the evaluative questions as of June of 2009. They have since been revised.

Appendix C. Frameworks that Influenced Our Work.

We used the following frameworks to help us identify key components of the work processes of math intensive programs.

1. MDRC:
    a. Recruitment
    b. Accelerated and contextualized learning
    c. College knowledge
    d. Academic support
    e. Cohort model

2. Epper & Baker
    a. Intensity
    b. Reduction/redesign of curriculum
    c. Project based learning
    d. Contextual learning
    e. Acceleration
    f. Learning communities

3. Best practices for retaining low-income, first-generation students: (Muraskin, 1997)
    a. A structured freshman year experience
    b. An emphasis on academic support
    c. An active and intrusive approach to advising
    d. A plan to promote instruction
    e. A strong presence on campus

4. Pathways to College Access and Success

CCRC Brief 27, February 2006

Katherine L. Hughes, Melinda Mechur Karp, Beranda J. Fermin, and Thomas R. Bailey

Four key program features:

1. Student recruitment and selection
2. Curriculum
3. Support services
4. Data collection and use

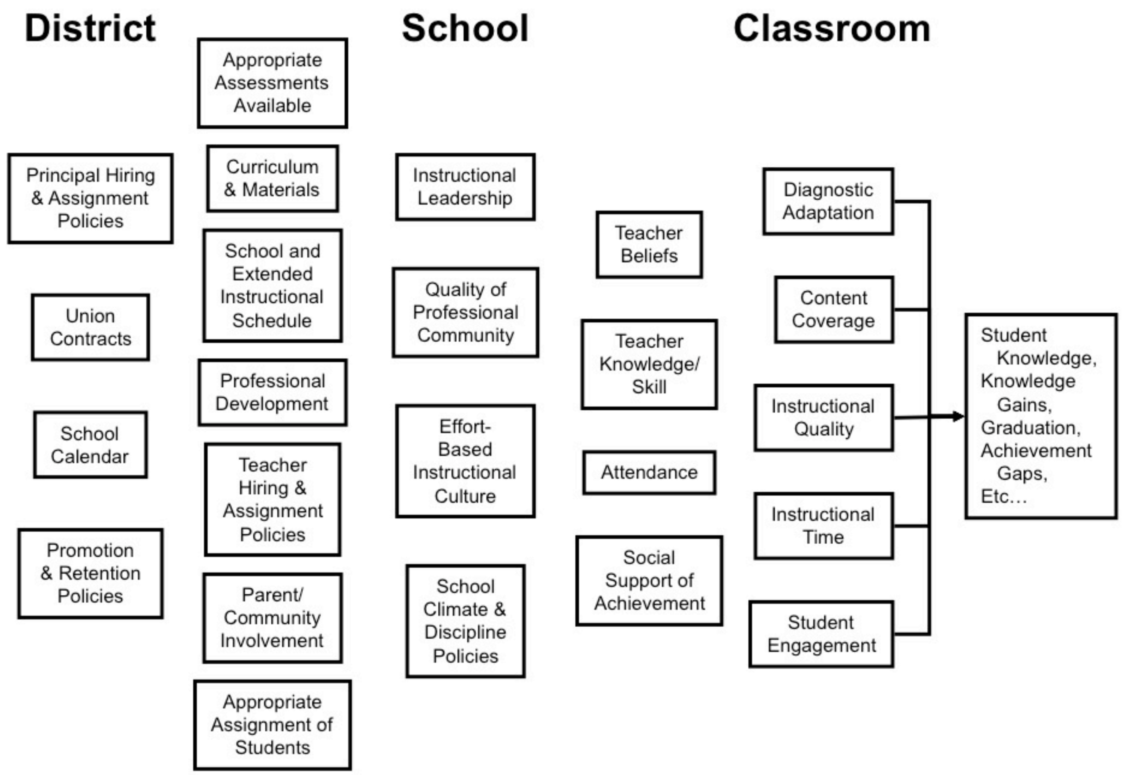
Recommendations:

1. Student access
2. Institutional collaboration (between HS and colleges)
3. Data collection for program evaluation

Appendix D. Framework for Understanding and Improving K-12 Education Systems

(Resnick, Besterfield-Sacre, Mahelik, Sherer, & Halverson, 2007).

In addition to the frameworks in Appendix C, we use Resnick et al's framework for instructional improvement in an education system (Resnick, Besterfield-Sacre, Mehalik, Sherer, & Halverson, 2007) to identify key elements of system reform (e.g., curriculum and materials, instructional leadership).



Appendix E. Additional Data Collected about Math Intensive Programs

Goal 1: Learning the math necessary to score well on the placement test and place into college level math courses (or at least place higher up the developmental math chain)
Percent of students who completed an intensive program and increased at least one level.

- 25% advance one level; 42% advance two or more levels (College Connection, Denver)
- 38% passed MAT095: course and Compass; 40% passed MAT096 course and Compass (LaGuardia Math Intensive)
- 45.8% went up one level; 20.8% went up 2 levels (Fast Track, Montgomery County)
- 54% (1-3 levels, math, 2008) (Project Dream, El Paso)
- 56% moved up to next math level course (2006 Math Jam, Pasadena)
- 66% (1-3 levels, math, 2007-08) (PREP, El Paso)

Number of students who pass placement test to get out of developmental math courses

- 76% program completers passed Compass (LaGuardia MAT095)
- 79% program completers passed Compass (LaGuardia MAT096)

Data to Support Goal 2
Developing math understanding needed for subsequent success
College level math completion

- Program completers complete college level math courses at higher rates (Fast Track, Montgomery County)
- 34.2% passed all developmental ed/college ready math courses vs. 23.8% of comparison group (MAT 030-060 FastStart, Denver)
- 71.7% passed all developmental ed/college ready math courses vs. 49.6% of comparison group (MAT 060-090 FastStart, Denver)

% of students who pass next course (comparison)

- 55-60% pass rate for beginning Algebra (next course) vs. 85-90% pass rate for program completers (Foothill)

Grade in next course

- Minimum grade B+ in Math 101 the following quarter (Foothill)
- Students do better in recommended courses the semester following Fast Track completion (Montgomery County)

Data on Math Course Completion

% of students who pass the intensive math course

- Completion rates increased for both Pre-Algebra and Introductory Algebra (courses offered in intensive) (Daytona State)
    - 75% completed Pre-Algebra
    - 59% completed Introductory Algebra
    - 56% completed Intermediate Algebra
    - 62% completed College Algebra
- 50% passed course (LaGuardia MAT095)
- 51% passed course (LaGuardia MAT096)
- 80% of students complete College Connection program (Denver)
- 85% completed program (Project Dream, 2008, Pasadena)
- 89% complete program (Math Jam, Pasadena)
- 100% of students (2008) passed both courses, passed the TAKS, and graduated from high school the following spring. (Houston HS Boot Camp)

Rates of course completion (comparison group)

- 60-65% pass rate (students who pass math course) vs. 50% pass rate for course taken in regular term (Moraine Summer Bridge)
- Pass rates are 20% higher than in traditional courses (Pasadena, Math Path)
- 86.7% passed 1+levels of developmental math vs. 78.3% of comparison group (FastStart MAT 060-090, Denver)
- 88.6% passed 1+levels of developmental math vs. 65.7% of comparison group (FastStart MAT 030-060, Denver)

Developmental math credits

- FastStart MAT 030-060 students averaged 6.09 developmental math credits vs. 5.39 for comparison group (Denver)
- FastStart MAT 060-090 students averaged 6.21 developmental math credits vs. 5.53 for comparison group (Denver)

College Math Gatekeeper Course

- 16.5% of FastStart MAT 030-060 students passed college math gatekeeper course vs. 9.9% of comparison group (Denver)
- 35% of FastStart MAT 060-090 students passed college math gatekeeper course vs. 23.5% of comparison group (Denver)

Overall, Summer Bridge and Math Jam students at Pasadena did better than comparison students in course completion for the following courses:

- Beginning Algebra and Freshman Composition (35%/19%/10%)
- Intermediate Algebra (27%/13%/7%)
- Intermediate Algebra and Freshman Composition (24%/12%/6%)
- 66.7% persist after two levels as compared with 35.7% comparison group. (Denver, spring 2006).

Data on Performance and Persistence

GPA

- Fast Start students had statistically higher first semester GPA after program than matched comparison group (2007)
- FastStart MAT 030-060 students had a 2.72 average GPA after 24 months vs. 2.29 in the comparison group.
- FastStart MAT 060-090 students had a 2.68 average GPA after 24 months vs. 2.28 in the comparison group.

Success and Retention in All Courses

- Summer bridge students have a higher success rate in all courses (78.5%) as compared with all Pasadena Community College students (65.9%) and all basic skills students (59.4%).
- Summer bridge students have a lower retention rate in all courses (78.8%) as compared with all Pasadena Community College students (82.7%) and all basic skills students (81.4%).

Number of students who proceed to enroll in college

- 78% of completers enroll in college (College Connection, Denver)
- 87% enroll in fall term (Project Dream, El Paso)

Basic Skills Sequence

- Pre-Algebra Start Level Students: At the end of 11 terms (four terms per year), 13% of Math Jam students had completed the basic skills sequence (and could transfer into college level math), 28% of summer bridge students completed, and 8% of the comparison group completed.
- Beginning Algebra Start Level Students: At the end of 11 terms (four terms per year), 20% of Math Jam students had completed the basic skills sequence (and could transfer into college level math), 48% of Math Path students completed, and 27% of the comparison group completed.

Persistence to a Degree

- 17.7% of FastStart MAT 030-060 students are still enrolled after 24 months vs. 13.4% of comparison group (Denver)
- 28.3% of FastStart MAT 060-090 students are still enrolled after 24 months vs. 14.8% of comparison group (Denver)

Graduation

- No FastStart MAT 030-060 students graduated with a certificate after 24 months vs. 1.7% of comparison group.
- No FastStart MAT 060-090 students graduated with a certificate after 24 months vs. 1.7% of comparison group.
- 1.3% of FastStart MAT 030-060 students graduated with a two-year degree after 24 months while no students in the comparison group did.

- 1.7% of FastStart MAT 060-090 students graduated with a two-year degree after 24 months while no students in the comparison group did.

College credits earned

- FastStart MAT 030-060 students earned an average of 8.9 college credits 24 months after entry vs. 9.5 in comparison group (lose data on students who transfer)
- FastStart MAT 060-090 students earned an average of 14.5 college credits 24 months after entry vs. 12.6 in comparison group (lose data on students who transfer)

Other data: Behavioral measures and math sequence duration

Behavioral measures (they feel better, less math anxiety)

- 97% students felt better prepared for their fall math course (Math Jam, Pasadena)
- 94% reported feeling less anxious about math (Math Jam, Pasadena)
- Students rave about program to next group of students, even if they are not passing (Math Path, Pasadena)

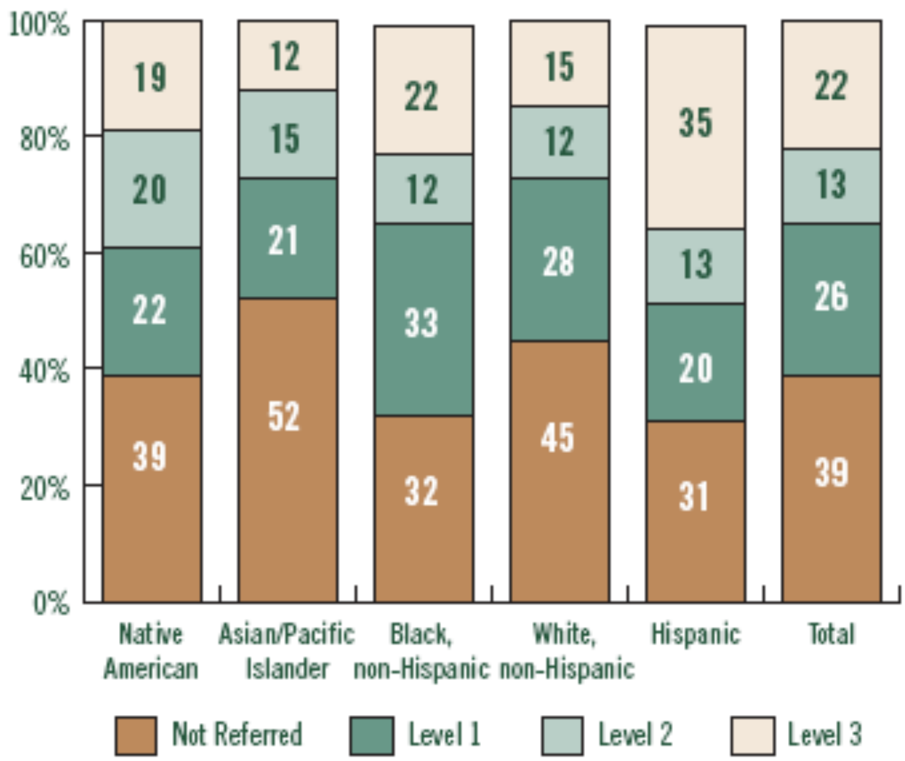
Duration of math sequence

- Decrease in # of semesters it takes for students to complete math sequence (Daytona State)

Appendix F. Distribution of developmental math students, by race/ethnicity.

[From *datanotes*: Keeping informed about Achieving the Dream Data, Feb 2006]

Figure 3. Distribution of students in the 2002 Achieving the Dream cohort by developmental math referral level and race/ethnicity*



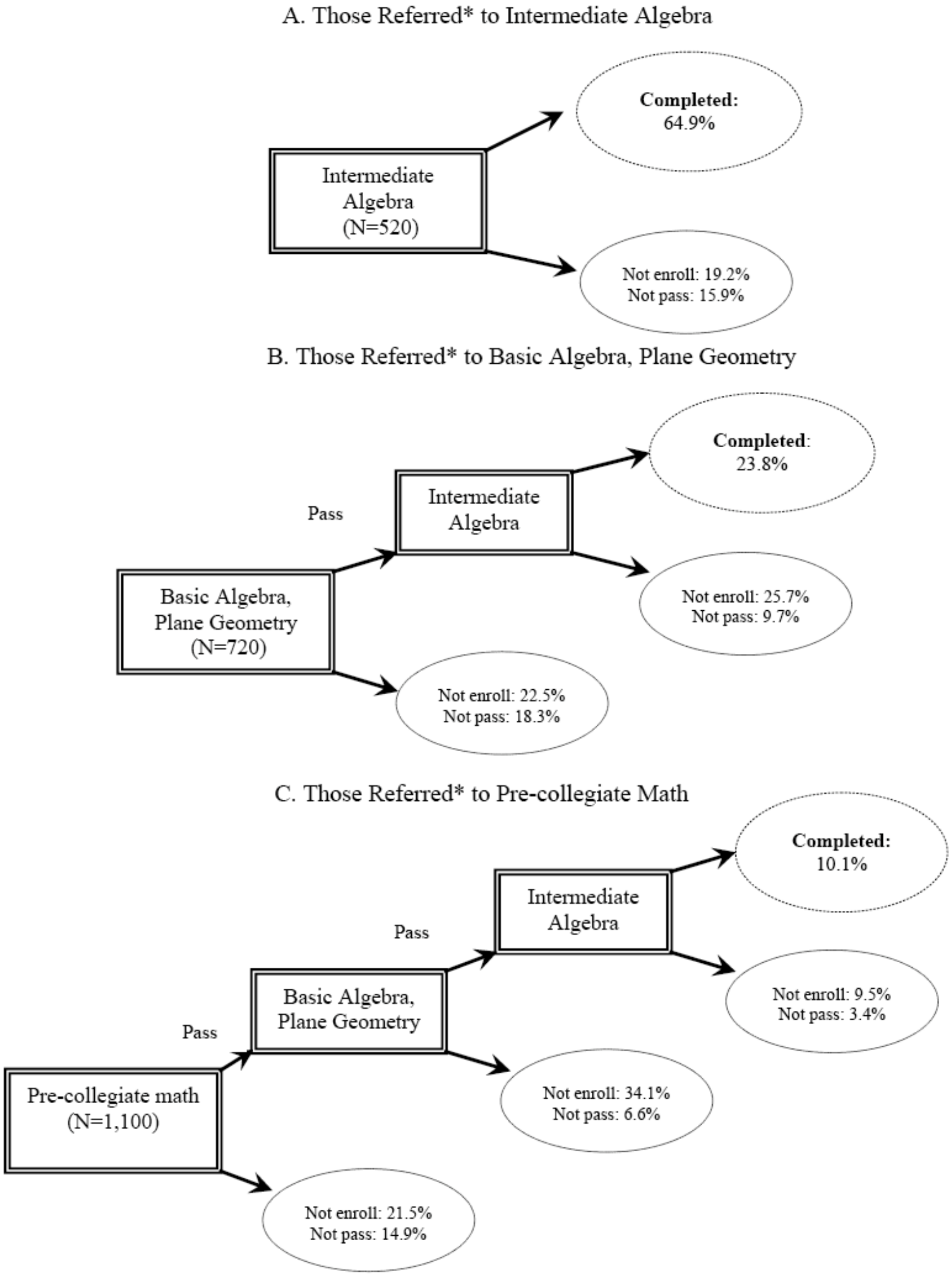
**for institutions reporting data on math referral levels*

Note: Due to rounding, totals may not equal 100 percent.

Appendix G. Referral, reenrollment, and completion in developmental education sequences in community colleges.

From Bailey, T., Jeong, D. W., & Cho, S. W. (2008).

Figure 7:
In-Order Completion of Developmental Math Courses among NELS Students Estimated to be Referred to Various Levels



* For the NELS analysis we estimate these referrals.

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[i] Colleges use one of two placement tests to place students: The Accuplacer and The Compass Exam. See Appendix A for more information on each exam.

[ii] There was one researcher who did the primary research and the first draft writing of the report. This was done in eight consecutive weeks. Subsequent time and energy was put into figuring out the organization and content of the report from additional people. For consistency, we use the pronoun "we" throughout the paper.

[iii] STEM stands for Science, Technology, Engineering and Mathematics. STEM students major in one of these disciplines, while non-STEM students choose different majors, at least initially. There is evidence that some students, upon successful completion of some of the boot camp programs we discuss in Section III, change their majors to mathematics or other STEM-related fields.

[iv] In some cases we spoke with more than one individual; in the case of Daytona State we used conference presentation and email follow ups to collect program data.

[v] At this stage, we set a wide lens for "promise." Programs we explore in this paper have been identified as such by key leaders in the field. They may or may not have empirical evidence to warrant this. Additionally, we acknowledge that this is a subsection of "successful" programs that exist nationally.

[vi] Fast Track also occurs in January, as Montgomery Community College offers this program before each semester begins—June, August and January.

[vii] The case management includes: one-on-one advising. The specialists work with students individually to review the placement test scores, diagnostic testing test results, to develop an intervention plan, and to make referrals to other services. The first session is lengthy, but after that follow-up may be a phone call or a quick check in. The specialists are often the first significant point of contact for students, so this helps to clear up many questions. Group sessions come in the form of the first Pre-testing Overview session with usually 25 students. Here the specialists review the placement test process, developmental course sequence, and sample test questions (available on many Accuplacer test sites). After students participate in this general session they have the option of continuing with the rest of the program services including meeting individually with the specialist, taking a diagnostic test, and working on computer based modules. There is some personal tutoring, but this is usually minimal.

[viii] Houston SW has three different boot camps. Each serves a targeted high school population and there is some variation in curricular materials used and classroom practices. See Appendix D for more detail.

[ix] API is a California measure of performance. "The API is a single number, ranging from a low of 200 to a high of 1000 that reflects a school's, an LEA's, or a subgroup's performance level, based on the results of statewide testing. Its purpose is to measure the academic performance and growth of schools. The API is calculated by converting a student's performance on statewide assessments across multiple content areas into points on the API scale." For more information see http://www.cde.ca.gov/ta/ac/ap/ or http://www.cde.ca.gov/ta/ac/ap/documents/infoguide08.pdf

[x] We asked program personnel to "weigh" each goal, identifying 1 if there was a hint of this goal in their program and 5 if this was a strong goal of their program. Unfortunately we did not get a response from all institutions, so we left the table with Xs to identify

which goals each program had, understanding that some were more of a focus than others within programs and across institutions.

[xi] One such program is the Dual Enrollment at Houston SE. While this did not fit into our boot camp definition, this program has seen great results for student learning as well as helped build key relationships with the local K-12 system.

[xii] This is a very rough estimate as to the ratio of students to faculty. Faculty members are given value of 1. Tutors are given value of .5. Other support staff are estimated at their time value (for example, if a counselor was used for a program, we calculated a part-time number depending on how much of that person's time was used). We also assumed that each faculty member teaches five courses for a full load (so each course was the equivalent of .2 of a full time faculty member). This may vary program to program and institution to institution, which could dramatically change these values.

[xiii] Note there is a potential regression to the mean effect in these data, if the test results are used to initially select into the program. Just by chance alone, some will improve as a result of measurement artifacts.

[xiv] A "1" denotes descriptive data reported with no comparison, and a "2" denotes a comparison group. In some cases colleges have data for a particular goal that is both descriptive with and without a comparison group; in these cases we simply marked a "2." In all cases the comparative data reported show a positive overall effect, although some are certainly more convincing than others.

[xv] Achieving the Dream data is not nationally representative since these colleges tend to be urban and therefore have an over representation of Hispanic and African-American students.

[xvi] This is based on a sample of students (5802) that the college tracked who were first-time college goers, graduated from high schools that were members of the Achieving the Dream College Readiness Consortium, took all three placement tests before their first day of class, and were not former dual credit students. This sample consists of just over 20 percent of the ELCC student population.

[xvii] Available data include a snapshot of how students participated in PREP. El Paso Community College is in the process of collecting longitudinal data on these students. They have found that setting up this data tracking system takes time.