FINAL REPORT ON THE DEVELOPMENTAL MATHEMATICS AND LANGUAGE PROJECT

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Final Report on the Developmental Mathematics and Language Project Part I

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The Developmental Mathematics and Language Project

The Mathematics and Language Project focused broadly on non-English-background students and, more specifically, on a rapidly growing population of community college students known as *Generation 1.5* (young people who have grown up in this country and been educated in American schools). While some attention has recently been given to English language learners (ELLs) at the community college level (e.g., Bunch, 2008), there is no information available about the demands made by mathematics instruction on the varying levels of English language proficiencies found in non-English-background community college students.

The long term goal of the Language and Mathematics Project is to inform the design and implementation of developmental mathematics courses that can appropriately meet the needs of this particularly vulnerable group of community college students. In order to do so, the project was designed to inform an initiative by the Carnegie Foundation focusing on developmental mathematics at community colleges about the role of language limitations in the study of mathematics and about the ways in which the receptive and productive competencies of ELLs at different levels of English development interact with (a) instructional delivery systems (e.g., lectures); (b) text materials of different types; (c) classroom activities of different types; and (d) assessment systems.

Focus of the work

During the six month planning period, therefore, we carried out the following two tasks:

Task 1: Review of the Literature

Task 1 involved our updating an existing review of the literature on language proficiency in the study of mathematics (Gifford & Valdés, 2003) in order to inform our collective understanding of the role of language limitations in moving spontaneously from natural language to the mathematical writing system, mathematical discourse, or symbolic language used in mathematics. The original review of the literature was current up to the year 2000 but did not include more recent work on language in the study of mathematics, and on newly-promoted pedagogical approaches for working with limited English proficient students in mathematics classrooms. A fully updated review was produced as a deliverable at the end of the project period and is included as Part I of this report.

Task 2: Exploratory study of the experiences of linguistic minority students in mathematics courses in community colleges

Task 2 involved an exploratory study of the experiences of language minority students in math departments in three community colleges. Given limitations of time and resources, we initially selected three institutions that were well known to members of the team and that offered opportunities for the examination of the role of language in the study of developmental mathematics. A description of this work is included as Part II of this report.

Part I

Generation 1.5 Students and the Linguistic Demands of Community College Mathematics Classes: A Review of the Literature

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Summer 2009

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Introduction

As President Barack Obama highlighted when announcing a new initiative focusing on creating more college graduates in the United States, community colleges comprise the largest portion of the country's higher education system, enrolling more than six million students (White House Press Office, 2009). More students of color and students from low-income backgrounds attend community colleges than attend four-year colleges and universities (National Center for Education Statistics, 2008a). However, once enrolled, only small percentages of community college students obtain a certificate or degree (National Center for Education Statistics, 2008a). Many struggle in remedial classes, particularly remedial mathematics classes (Bahr, 2008; Bueschel, 2004).

In this literature review, we first provide an overview of the community college context, including a description of who attends community colleges, how academically prepared community college students are, what happens to community college students once they enroll, and what the characteristics of teaching and learning in community colleges are. Following this overview, we focus on a distinct subset of the community college population: individuals who are non-native English speakers but who have attended U.S. schools for many years. This group has been dubbed generation 1.5 students by numerous researchers (cf. Bueschel, 2004; Bunch, 2008; Harklau, 2003; ICAS ESL Task Force, 2006). After describing characteristics of generation 1.5 students, we then turn our focus to the challenges generation 1.5 students face in their community college mathematics classes. We analyze the existing literature on the linguistic demands of mathematics that all students encounter and describe the particular linguistic challenges mathematics presents to students receiving instruction in a second language. We highlight the specific linguistic demands of mathematics at the community college level, particularly the linguistic demands of algebra. We conclude by reviewing literature that describes curricular innovations in community college mathematics classes. It is our hope that by describing the special linguistic challenges that generation 1.5 students encounter in community college math classes, in the future educators may design more effective curriculum and intervention programs specifically targeting the needs of generation 1.5 students in these classes, enabling this subset of the population to develop greater mathematical skills and experience more success in postsecondary education.

Community College Context

Who Attends Community Colleges?

More than six million Americans attend community colleges; California's community colleges alone enroll more than 1.4 million students (National Center for Education Statistics, 2008a). Furthermore, community college enrollments are increasing rapidly, up 17 percent from 1996 to 2006 (National Center for Education Statistics, 2008a). Community colleges serve a more diverse pool of students than other segments of higher education, enrolling more low-income students than four-year colleges and universities (National Center for Education Statistics, 2008a). In addition, more than 40 percent of community college students have parents who did not attend college, compared to approximately one-fourth of students at four-year colleges and universities (National Center for Education Statistics, 2008a).

Community colleges also enroll more minority students than other segments of the higher education system. In 2003-04, 15 percent of community college students were African-American and 14 percent were Hispanic. In comparison, in public four-year colleges and universities, 10 percent of students were African-American and 8 percent were Latino (National Center for Education Statistics, 2008b). More than half of all Latino students enrolled in higher education are enrolled in community colleges (Saenz, 2002). Community colleges provide a more affordable higher education option, allow for part-time enrollment and flexible scheduling, permitting students to maintain full-time jobs. In addition, community colleges are typically located near residential areas, allowing students to continue to live with their families. Finally, community colleges generally have open enrollment processes, enabling all students, regardless of their academic backgrounds, to attend.

Students have a wide variety of reasons for attending community colleges, not all of which include degree attainment. According to the most recent national data available, approximately one-third of community college students list future transfer to a four-year university as one of their principal reasons for attending community college, while 43 percent list obtaining an associate's degree and 17 percent list obtaining a certificate. Forty-six percent of students report enrolling for personal interest and 42 percent report enrolling in order to obtain job skills (National Center for Education Statistics, 2008a).

How academically prepared are community college students?

Many students entering community colleges have significant academic needs and get placed in non-credit-bearing developmental education classes in mathematics, reading/writing, or English as a Second Language.[3] Detailed data on the academic readiness of entering community college students at a national level are difficult to come by for several reasons. First, no uniform assessment and placement system exists across community college campuses. For example, within California alone, community colleges use 16 different placement tests in mathematics and English (Brown & Niemi, 2007). There is also wide variability among community colleges in the cutoff scores for these placement tests, the amount of student discretion involved in final course selection, the amount of information about high school course completion used in the placement process, and the linkages between the standards emphasized in high school courses and those assessed by the placement exams (Brown & Niemi, 2007; Marwick, 2004; Shelton & Brown, 2008). Given this variability in the assessment and placement process, a student who might be placed in a developmental math class at one community college could easily be placed in a credit-bearing math class at a different community college if the college used a different placement test or a different cutoff score. This fact complicates interpretation of the data about the percentages of students enrolled in developmental courses at community colleges. Nonetheless, these percentages represent one of the only means of assessing the academic readiness of community college students, so they still merit consideration.

[3] Non-credit bearing courses designed to meet the needs of students not ready for college-level coursework go by many different names in the research literature, including developmental, remedial, and basic skills classes. The various terms are used interchangeably here.

Estimates of the percentage of entering community college students who require some type of remedial coursework range from 33 percent to 95 percent, depending on the group of students being considered and on the definition of remedial coursework (Bueschel, 2004). For example, one study using a sample of more than 85,000 California community college students found that 81 percent of students were initially referred to a remedial math course (Bahr, 2008). On the other hand, a national study with a sample of more than 250,000 community college students found that 59 percent of students were referred to developmental mathematics courses, while 33 percent of students were referred to developmental reading courses (Bailey, Jeong, & Cho, 2008). Regardless of the exact figure, it is clear that a large portion of students enter community colleges with substantial academic needs. Furthermore, African-American and Latino community college students are more likely to be placed in developmental courses than their peers (Rosin & Wilson, 2008).

Percentages of community college students requiring English as a Second Language classes are even more difficult to establish, as no national data is gathered and concentrations of non-native English speakers vary widely by state and community. Some community colleges have only minimal numbers of ESL classes, while others serve thousands of students. Santa Monica Community College in California houses the largest ESL program in the world, and ESL is now the largest department at Miami Dade Community College (Crandall & Sheppard, 2004).

What happens to community college students once they enroll?

Because a sizeable portion of community college students do not intend to attain a degree, traditional methods for calculating graduation rates and degree attainment do not apply, complicating data reporting. Instead, researchers must confine their samples to community college students who initially intended to complete a degree and compute the rate of degree attainment among that group. Even then, gathering accurate data on community college outcomes presents numerous challenges. Nonetheless, the data that do exist suggest that more than half of students who enroll in community colleges never complete a postsecondary degree (Kane & Rouse, 1999, cited in Fry, 2002; National

Center of Education Statistics, 2009). Among only those community college students who intended to transfer to a four-year university, after three years, 39 percent had left school without completing a degree (National Center of Education Statistics, 2008a). In California, researchers found that after six years, only 24 percent of community college students had completed any type of degree or transferred to a four-year university (Moore, Shulock, & Ceja, 2007).

Latino and African-American community college students have degree attainment, persistence and transfer rates that are lower than those of their peers (California Postsecondary Education Commission, 2007; Moore, Shulock, Ceja, & Lang, 2007; National Center for Education Statistics, 2009). Of students who began their postsecondary education at a community college, after six years only 34 percent of Latino students and 38 percent of African Americans had achieved any type of degree, compared to more than 40 percent of white and Asian students (National Center for Education Statistics, 2009). While Latino students represented one-third of the community college population in California, they represented only one-quarter of the students who successfully transferred to a four-year university (California Postsecondary Education Commission, 2007). African-American community college students in California transferred at just half the rate of their proportion of the community college population (California Postsecondary Education Commission, 2007).

Students who are assigned to developmental courses are particularly unlikely to attain a degree or transfer to a four-year university. In his study of more than 85,000 California community college students, Bahr (2008) found, "Eighty-four percent of the students who did not complete a credential and did not transfer were remedial math students who did not remediate successfully" (p. 446). Unfortunately, many of those referred to developmental coursework not only do not attain an associate's or bachelor's degree, many also do not complete even their first developmental class. In Bahr's (2008) study, three-fourths of students assigned to remedial math courses did not successfully complete their remedial coursework within six years. Similarly, in their large national study of 250,000 community college students, Bailey et al. (2008) found, "Only 31 percent of students referred to math remediation and 44 percent referred to reading remediation completed their sequences [of developmental coursework] within three years" (p. 11). Furthermore, approximately half of the community college students referred to developmental coursework failed to complete their first course in the developmental sequence (Bailey et al., 2008). African-American and Latino community college students are less likely to pass their developmental courses than their peers (Rosin & Wilson, 2008).

What characterizes teaching and learning at community colleges?

The most in-depth study of teaching and learning in community colleges remains Norton Grubb's (1999) book *Honored But Invisible: An Inside Look at Teaching Community Colleges*. Grubb and his colleagues visited 257 classrooms in 32 community colleges in 11 different states, typically observing each instructor for three to six hours and then conducting an in-depth interview lasting at least one hour. From this rich dataset, Grubb crafted an analysis of the modal classroom in community colleges. He also analyzed instructors' work lives, instructional practices in developmental classrooms, and institutional forces affecting teaching and learning in community colleges, among other topics.

As Grubbs and his colleagues point out, community college instructors are hired for their subject matter expertise and generally have master's degrees or doctorates in their fields. Very few have had any formal teacher training, and most community colleges provide no pedagogical support to instructors. Unlike four-year universities, most community colleges have no school of education and no repository of pedagogical expertise on which to draw. Thus, instructors develop highly individualistic approaches to teaching. The lack of support provided to community college instructors is compounded by the isolation in which instructors work, with few institutional mechanisms for collaboration and interaction with their peers. "Except in a small number of exemplary institutions most instructors speak of their lives and work as individual, isolated, lonely. A teacher's job is a series of classes, with the door metaphorically if not literally closed," Grubb writes (p. 49).

The isolation of teaching in community colleges is magnified for the large portion of community college instructors who have part-time teaching appointments. In the fall of 2007, 69 percent of the faculty at public two-year postsecondary institutions were employed parttime (National Center for Education Statistics, 2009). Grubb found that many part-time community college instructors become "freeway flyers," patching together teaching loads at several community colleges in their region to create the equivalent of full-time jobs. Due to their limited time on any one campus, part-time instructors have few opportunities to interact and collaborate with their colleagues.

Against this background of limited instructional support and interaction with colleagues, what happens in community college classrooms? Grubb emphasized the variety of teaching practices he and his team encountered:

> We saw everything from a conventional lecture with eighty students to an intense discussion about Muslim history in a seminar of four students, from conventional classrooms with seats arranged in neat rows to vocational workshops in dairy barns and automotive shops, from remedial classes struggling with basic punctuation to the most sophisticated discussions of microeconomics, calculus, and the physics of heat transfer (Grubb, 1999, p. 61).

Nonetheless, one format predominated: a combination of lecture and discussion, in which instructors presented information to students, interspersed with or followed by opportunities for questions and dialogue. Student engagement in these lecture/discussion classes varied, depending on the balance of lecture and discussion, instructors' skills as presenters, and the types of questions instructors posed to students, among other factors.

Grubb and his colleagues found that the lecture/discussion format predominated in developmental classes as well to varying degrees of effectiveness: "We found both the best and the worst teaching [in developmental classes] – the most inspired student- and meaning-centered approaches and the most deadly drill-and-kill classes" (p. 174). Grubb describes a selection of highly engaging developmental mathematics classes, some of which were connected to vocational programs in which students were enrolled.

However, he found that overall "some of the most lifeless teaching can be found in remedial math classes, where students continue to repeat the same errors that have carried them through elementary and secondary schooling" (p. 194).

Generation 1.5 Students in Community Colleges

Who are generation 1.5 students?

A substantial, growing segment of the community college population that demands greater attention from research is generation 1.5 students. Rumbaut & Ima (1988) coined the term "generation 1.5," which has since been adopted by other researchers and policymakers to refer to non-native English speakers who have completed substantial amounts of schooling in the United States (cf. Bueschel, 2004; Bunch, 2008; Harklau, 2003; ICAS ESL Task Force, 2006). Many researchers (cf. Portes, 1996; Suarez-Orozco & Suarez-Orozco, 2001) analyze immigration patterns in terms of immigrant generations, with those born outside the receiving county considered first-generation immigrants and the children of first-generation immigrants born within the receiving country considered second-generation immigrants. It is within this typology of immigrant generations that the label generation 1.5 was devised.

Generation 1.5 students can be conceptualized as a distinct subset of immigrant students, English learners and Latino students. Before explaining the overlap between these different groups and generation 1.5 students, the relevant terminology should be defined. For this discussion, we will use the term immigrant students to refer to individuals born outside the United States. English learner (EL) is a label used primarily within the K-12 educational system to describe individuals who are still in the process of developing English fluency. Finally, as many researchers have noted, the term "Latino" is extremely problematic and is not a term commonly used by those it supposedly describes (Farr, 2006; Oboler, 1995). Instead, individuals included in the category "Latino" tend to describe themselves in terms of nationality – as Mexican, Dominican, Puerto Rican, etc. Nonetheless, this term has salience in many contexts, including educational contexts, in which Latin American immigrant students of different nationalities may be grouped together due to their shared primary language of Spanish. Additionally, the Spanish-language media is increasingly using the term "Latino" as a way of addressing its audience from a wide variety of national backgrounds.[4]

As Figure 1 illustrates, generation 1.5 students overlap with these other groups of students in particular ways. Like all English learners, like most first-generation immigrant students, and like some Latino students, generation 1.5 students are non-native English speakers. In addition, like most Latino students, like many English learners, and like some first-generation immigrant students, generation 1.5 students have completed substantial amounts of schooling in the U.S.[5]

As Bunch (2008) notes, detailed data about the number and characteristics of generation 1.5 students in community colleges is very sparse. Community college systems generally do not collect data about the languages spoken by students, nor do they collect data about the country of birth of students or their parents (in other words, they do not track the number of language minority students nor the number of immigrant students enrolled in community college classes). However, data about the racial/ethnic distribution of community college students is available. From this limited information, combined with information about trends in the demographics of the K-12 student population and the general US population, it is possible to make inferences about trends in the generation 1.5 population at community colleges. As a recent Urban Institute report stated, "The number and share of immigrants in [K-12] schools have tripled since 1970" (Ruiz-de-Velasco, Fix, & Clewell, 2000, p. 8). Schools have also experienced a corresponding increase in the number of English learners, with thirteen states seeing the number of English learners double in the last decade (National Clearinghouse on English Language Acquisition, 2006). In California, English learners represent approximately one-quarter of the K-12 student population (California Department of Education, 2009a). The

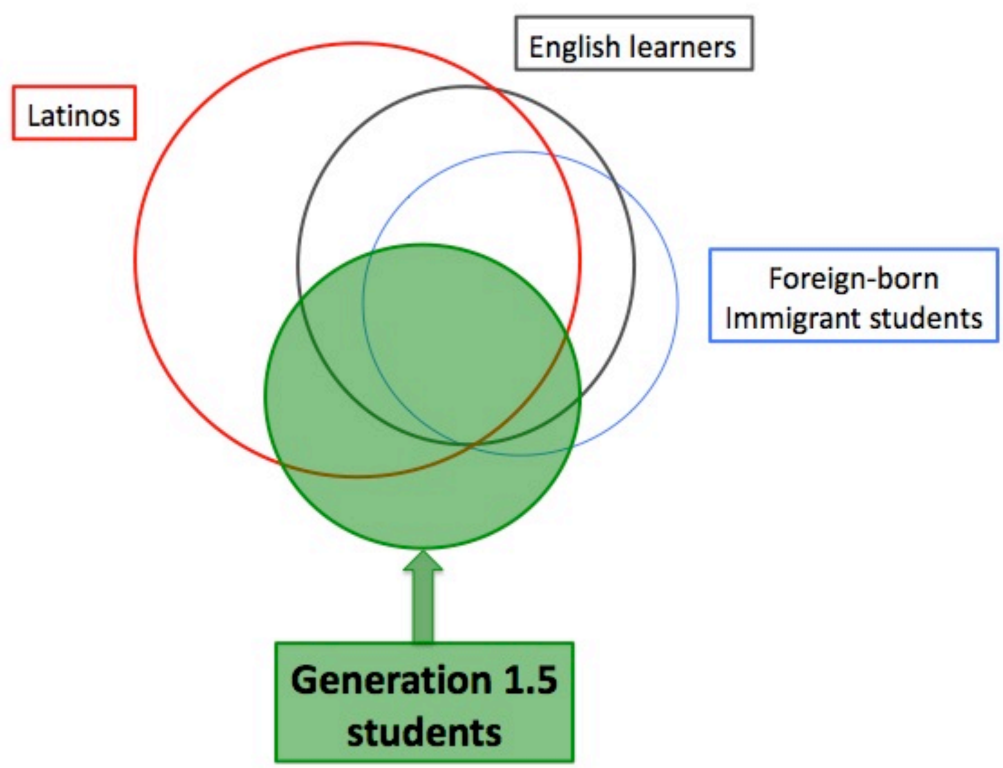
[4] An article on the Spanish-language news company Univision's website, for example, has the title "Los latinos deciden" and describes how the Latino vote was crucial in the 2008 Democratic presidential primaries (Retrieved February 23, 2008, from http://www.univision.com/content/content.jhtml?cid=1440404). The term "Latino" is used frequently throughout the article, both as a noun and as an adjective, modifying the word "community."

[5] One further term that is sometimes used in the literature to refer to a group of students that has substantial overlap with generation 1.5 students is the term "language minority students." In the U.S. context this term refers to students who grew up speaking a language other than English at home – regardless of whether the students are now fluent in English or not.

majority of immigrant students in K-12 schools, as well as the majority of English learners, speak Spanish as their first language (California Department of Education, 2009b; Ruiz-de-Velasco et al., 2000).

Figure 1.

Generation 1.5 students overlap with Latino students, English learners and immigrant students in particular ways. Approximately half of all Latinos are English learners, and approximately half of all foreign-born immigrants are Latino. Most English learners are Latino, and many foreign-born immigrant students are English learners. Generation 1.5 students are predominantly Latino. Many are foreign-born immigrants and some are English learners. Incorporating information from multiple sources, an attempt has been made to size the circles representing each of these groups to approximate the relative size of the corresponding populations. (Sources: California Department of Education, 2009a; California Department of Education, 2009b; National Center for Education Statistics, 2008c; National Center on English Language Acquisition, 2006; Ruiz-de-Velasco, Fix, & Clewell, 2000; Thompson, 2009; U.S. Census Bureau, 2000).



Meanwhile, at the postsecondary level the available data do not allow us to track large-scale trends for immigrant students or English learners. However, the data do show a rapid increase in both the number and share of the college student population that is Latino. From 1990 to 2005, Latino student enrollment in degree-granting postsecondary institutions increased almost two-and-a-half times, jumping from 782,000 to 1.9 million (National Center for Education Statistics, 2008c). During the same time period, the share of the college student population that is Latino almost doubled, rising from 5 percent in 1990 to 9 percent in 2005 (National Center for Education Statistics, 2008c). Meanwhile, Latino students are more likely to enroll in community colleges than in other types of postsecondary institutions, with two-thirds of Latino postsecondary students beginning their higher education career in community colleges (Solórzano, Rivas, & Velez, 2005). In 2003-04, Latino students made up 14 percent of the community college population but only 9 percent of the population at four-year public universities (National Center for Education Statistics, 2008a). In California, 30 percent of community college students are Latino (California Community Colleges Chancellor's Office, 2009), and close to 75 percent of the state's first-time college students who are Latino enroll in community college (Woodlief, Thomas, & Orozco, 2003, cited in Bunch, 2008). Not all the Latino students in the nation's community colleges have both characteristics of generation 1.5 students – being nonnative English speakers and having completed a substantial amount of schooling in the U.S. But many Latino community college students do have both these characteristics (Bunch, 2008). As community college administrators themselves report, community colleges find themselves serving large and increasing numbers of generation 1.5 students (Klein & Wright, 2009).

The needs of generation 1.5 students in community colleges

Generation 1.5 students have distinct academic needs, which may not be met by current community college structures. Having completed substantial amounts of schooling in the U.S. and having developed oral English proficiency, generation 1.5 students typically do not benefit from typical English as a Second Language (ESL) classes offered by community colleges. In fact, generation 1.5 students may deliberately avoid ESL classes due to the stigma associated with them (ICAS ESL Task Force, 2006). Yet, as we will explore in more detail, academic disciplines, including mathematics, demand a sophisticated mastery of specific English vocabulary and syntax that generation 1.5 students may need targeted support to master.

Typically, students' high school transcripts, their standardized test scores, and their scores on language proficiency assessments from the K-12 educational system do not follow them into the community college system (Bunch, 2008). Students' ability to start with a clean slate in community college may prevent students previously designated as English learners from being shunted into an "ESL ghetto" (Valdés, 2001) and denied access to credit-bearing content-area classes. However, valuable information about students' educational trajectories and needs may also be lost, preventing them from receiving necessary services.

The language placement process suffers from other flaws as well. The process by which students are placed in ESL and English classes varies widely from campus to campus, with varying assessments, varying degrees of student discretion, and varying degrees of access to counselors (Bunch & Panayotova, 2008). Generally, students choose whether to take an ESL placement exam (for placement into an ESL class) or an English placement exam (for placement into a more traditional reading/composition class). Students' decisions about which placement exam to take have far-reaching consequences for their educational trajectories, and community colleges vary widely in the advice they provide to students about which exam to take (Bunch & Panayotova, 2008). The problems with the language placement process mirror those with the math placement process discussed earlier, in which there is also wide variability across campuses in the assessments used, the cutoff scores, the advice provided to students, the amount of student discretion involved in final course selection, the amount of information about high school course completion used in the placement process, and the linkages between the standards emphasized in high school courses and those assessed by the placement exams (Brown & Niemi, 2007; Marwick, 2004; Shelton & Brown, 2008).

As noted earlier, large proportion of incoming community college students get placed into non-credit-bearing classes in English and mathematics, variously labeled "basic skills," "developmental," or "remedial." Unfortunately, the majority of students placed into these classes never move on to credit-bearing classes in English or math and never complete a degree. Once students are placed in developmental courses – both ESL and basic math courses – they are unlikely to ever get out of these courses. In fact, as noted earlier, in mathematics almost half fail to complete the first course in the developmental sequence (Bailey, 2007). Whether students struggle in their developmental mathematics courses because of language issues, math issues, non-academic issues, or a complex combination of these factors is difficult to determine. However, thus far, little attention has been paid to helping generation 1.5 students – and others – master the specific disciplinary language necessary to be successful in mathematics. By reviewing the literature about the linguistic demands of mathematics, we will be better equipped to design a community college mathematics curriculum that enables all students – but especially generation 1.5 students – to succeed in their mathematics courses.

Methods for the Literature Review

For this literature review, we followed a backward mapping process (Elmore, 1983), first locating key articles that addressed all topics under consideration - community colleges, mathematics education, language in mathematics, and generation 1.5 students[6] – and then, using references from these articles, we traced backwards to find other articles on subsets of these topics. Our search included multiple sources, including online databases, journals, and organizational and governmental reports. We searched the ERIC database. We also pulled articles from relevant journals, including specialized journals such as *Educational Studies in Mathematics* and *Community College Journal of Research and Practice*, as well as general education journals such as *Review of Educational Research* and *Educational Researcher*. In addition, we located reports from relevant organizations such as the American Mathematical Association of Two Year Colleges, the Association of Community Colleges, California Tomorrow, and the American Association for the Advancement of Adult Literacy. Finally, we identified relevant reports and data from

[6] As noted earlier, the terminology used to refer to generation 1.5 students varies. Therefore, when searching for articles about nonnative English speakers who have completed substantial amounts of schooling in the U.S., we also included articles that referred to immigrant students, Latina/o students, and English learners, since students who fall into these categories may also be generation 1.5 students. (See Figure 1.)

government sources, such as those authored by the California Postsecondary Education Commission and the California Community Colleges Chancellor's Office.

Ultimately, we established a database of 341 articles related to our topic. We read the abstracts of each of these articles, tagging each article with a subset of 130 keywords we developed inductively in the course of the literature review process. (See Appendix A for a list of keywords used.) We then identified articles that focused on at least two of our four topic areas (community colleges, mathematics, language, and generation 1.5 students), and read these 102 articles in full. Table 1 lists numbers of articles addressing subsets of our topics areas. We will now summarize key themes in these 102 articles.

Table 1. Numberof articles addressing subsets of our four topics.

Topics	Number of Articles
Community college + mathematics education	14
Community college + language in mathematics	0
Community college + (generation 1.5 students OR Latino/a students OR immigrant students OR ELs)	16
Mathematics education + (generation 1.5 students OR Latino/a students OR immigrant students OR ELs)	28
Mathematics education + language in mathematics	76
Language in mathematics + (generation 1.5 students OR Latino/a students OR immigrant students OR ELs)	20
Total number of unique articles addressing at least two of the four topic areas	102

Key Ideas from the Literature on the Linguistic Demands of Mathematics

Unique Features of the Mathematics Register

As with other disciplines, linguists and scholars from within the discipline of mathematics have sought to define how the language of mathematics is distinct from the languages of other disciplines and from the language of everyday communication. Researchers have analyzed features of the language in mathematics textbooks and mathematics assessments (cf. Abedi & Lord, 2001; Mestre, 1988; Österholm, 2006), as well as features of the discourse in mathematics classrooms (cf. Chapman, 2003; Laborde, 1990; Pimm, 1989; Walshaw & Anthony, 2008). Defining features of the language of mathematics identified by researchers include:

- extensive borrowing of common, everyday terms that have particular, distinct meanings in the context of mathematics (e.g. *face*, *product*, *rational*);
- shifts in the grammatical categories of borrowed terms (e.g. the term *diagonal* functions as an adjective in general usage but as a noun in mathematics); and
- the use of metaphors to explain mathematical concepts (e.g. regrouping in subtraction is often referred to as "borrowing" and algebraic equations are often described as "balances," but students must understand the limits of these metaphors).

Summarizing across a variety of studies, Laborde (1990) describes additional linguistic features that have been shown to affect students' success in solving mathematical problems, including:

- how the relationships between given and unknown quantities are expressed;
- the order in which information is presented; and
- the complexity of the syntax and of the vocabulary.

When teachers think about the linguistic demands of their discipline, they often focus on the specific vocabulary students need to learn. However, as Laborde (1990) suggests, students often struggle with syntax as well. In fact, one study comparing nonnative English-speaking high school students' performance on mathematics assessments in English to their performance on equivalent assessments in their primary language found that confusing syntax created more problems for students than technical vocabulary did (Neville-Barton & Barton, 2005). For example, the sentence, "Subtract three from five," contains no sophisticated vocabulary. However, many students, particularly nonnative English speakers, are likely to be unfamiliar with this syntax for subtraction equations and may misinterpret which number is the minuend and which is the subtrahend, solving 3 - 5 rather than 5 - 3.

In Neville-Barton & Barton's (2005) study, 40 secondary students who spoke Mandarin as their primary language took parallel mathematics exams in both English and Mandarin. Seven weeks elapsed between the two testing sessions, and half the sample took the English exam first while half took the Mandarin version first. Students performed significantly worse in English than they did in Mandarin, even though their math instruction took place in English. While some students had difficulty with questions that involved mathematics vocabulary terms such as *perimeter* and *coefficient*, the questions in English that posed the greatest difficulty for students were those containing complex syntactical structures. For instance, only 11 percent of the students correctly answered a question in English that centered around the sentence, "The square root of one half of a number is 8." When the same question was posed in Mandarin, however, 64 percent of the students answered correctly.

In an interview with a fourth grade English learner, Martiniello (2008) provides a fascinating example of how difficulties with syntax and vocabulary can interact to produce misunderstandings. The problem, drawn from the Massachusetts standardized mathematics assessment for grade 4, read:

To win a game, Tamika must spin an even number on a spinner identical to the one shown below. A circular spinner divided into tenths is pictured, with the sections labeled with the digits one through ten. The question is then posed, "Are Tamika's chances of spinning an even number certain, likely, unlikely or impossible?" The student Martiniello interviewed did not understand the words *spinner*, *identical* or *even*. He instead focused on the word *one*, surmising that the question was asking what the chances were of landing on the number one. As Martiniello (2008) writes, the student "failed to recognize the syntactical function of the word *one*, used as a pronoun in this sentence, and instead misinterpreted it as the numeral *one*. Based on this linguistic misinterpretation, he offered a reasonable [but, in this case, incorrect] answer: 'It is 'unlikely,' maybe it will not fall'" (p. 344). In the remainder of her study, Martiniello documents how the combination of difficult syntax and unfamiliar vocabulary words led English learners to perform more poorly than fluent English speakers on certain items from the Massachusetts math assessment, preventing English learners from demonstrating their true mathematical knowledge.

Researchers have divided the mathematical problem solving process into two components, problem comprehension and problem solution (Lewis & Mayer, 1987). When the vocabulary and syntax of math problems create confusion, the problem comprehension process breaks down, preventing successful completion of the problem solution phase.

Specific Challenges Posed by the Mathematical Language Encountered by Community College Students

The linguistic challenges posed by mathematics textbooks, assessments and classrooms become even more complicated as the mathematics students are learning becomes more complicated. Algebra represents the key gatekeeper for community college students. In order to pass out of developmental mathematics classes, students must demonstrate competence in basic algebra. Yet researchers have clearly documented that the language in which algebraic problems are expressed poses unique challenges for students (cf. Humbertson & Reeve, 2008; Lewis & Mayer, 1987; MacGregor & Price, 1999; MacGregor & Stacey, 1993; Stacey & MacGregor, 2000).

MacGregor & Price (1999) conducted a study of 1500 secondary students in their first to fourth years of learning algebra in which they gave students an assessment designed to measure their understanding of symbolic notation in algebra, as well as their metalinguistic awareness in non-mathematical contexts. Commenting on students' difficulty in understanding algebraic notation, MacGregor & Price (1999) noted:

> Students have not learned how to use syntax as a guide to interpretation in arithmetic, and they are not likely to understand the significance of symbol order in algebraic notation. … They frequently misuse and misinterpret algebraic symbols and syntax even in simple tasks (p. 453).

For example, when students are presented with the following question: "Jason is 5 inches taller than Leo. Write an expression for Jason's height," some students assume that variables represent abbreviated words. Therefore, they express Jason's height as *Jh*, with *J* standing for *Jason* and *h* for height (MacGregor & Price, 1999).

Researchers have long recognized that students have difficulty understanding the role of variables in mathematics. In a series of recent experimental studies, Malisani & Spagnolo (2009) presented secondary students with a series of algebraic word problems that involved different uses of variables. They found that students were more likely to conceive of a variable as representing a single unknown quantity rather than as element in a functional relationship representing a set of quantities. For example, students were asked to solve the following problem: "Charles and Lucy won the total sum of €300 in the lottery. We know that Charles won triple of the betted money, while Lucy won the quadruple of her own. Calculate the sums of money Charles and Lucy betted." Most students used trial and error to solve this problem, imagining that they were trying to find two fixed unknown quantities, one representing the amount that Charles betted and the other representing the amount Lucy betted. Only a small percentage of students recognized this as a functional relationship with multiple possible answers, constructing an equation such as $300=3x+4y$, transforming that equation into the conventional format of an equation of a line, $y=mx+b$ (in this case, $y=-3/4x+75$), and plugging in multiple values for x to generate various solutions. Furthermore, Malisani & Spagnolo (2009) found that very few students could successfully generate their own word problems from a given algebraic equation. Only 7 percent of students wrote an acceptable word problem that could be solved by the equation $6x-3y=18$. The researchers concluded that students have difficulty switching between natural and algebraic language (and vice versa), in part because students have incomplete conceptions of what variables represent. In a landmark study, Lewis & Mayer (1987) demonstrated that students answer algebraic word problems incorrectly more often when those problems are posed using inconsistent language. Table 2 displays examples of simple algebraic comparison problems using

Table 2. Algebraic word problems using consistent and inconsistent language (adapted from Lewis & Mayer, 1987).

	Consistent Language	Inconsistent Language
Addition	Maria has three apples.	Maria has three apples.

example	Susana has two more apples than Maria. How many apples does Susana have?	Maria has two less apples than Susana. How many apples does Susana have?
Subtraction example	Jeff has $9 Eric has $4 less than Jeff. How many dollars does Eric have?	Jeff has $9. Jeff has $4 more than Eric. How many dollars does Eric have?

consistent and inconsistent language. Both types of problems are identical except for their second sentences, which contain the key relational statement. In the problems with consistent language, this relational statement introduces a new unknown quantity as its subject and explains how this unknown quantity relates to the known quantity introduced in the first sentence. Furthermore, in problems with consistent language, the necessary arithmetic operation is appropriately keyed by the relational term in the second sentence (i.e. problems that require addition contain a phrase such as *more than* and problems requiring subtraction contain a phrase such as *less than*). However, in problems with inconsistent language, the relational statement contained in the second sentence has two features that seem to confuse students. First, the new unknown quantity is the object, not the subject, of the sentence. Second, the necessary arithmetic operation conflicts with the relational phrase used in the sentence (i.e. problems that require addition contain a phrase such as *less than* and problems requiring subtraction contain a phrase such as *more than*). To solve problems with inconsistent language, students must reverse the order of the quantities and the operation expressed by the relational sentence. Using the subtraction example with inconsistent language from Table 2, for example, students must recognize that the sentence, "Jeff has $4 more than Eric," can be expressed with an equation such as $x = 9 – 4$ (since the previous sentence stated that Jeff had $9). Here, the student must recognize that the unknown quantity – the amount of money Eric has – is the object of the sentence, and they must recognize that to find the unknown quantity, 4 needs to be subtracted from 9. Numerous researchers have since replicated Lewis & Mayer's (1987) findings, demonstrating that inconsistent algebraic comparison problems pose difficulty for students at all ages, including college students (cf. Stacey & MacGregor, 2000; Pape, 2003).

But students' difficulties in translating relational statements into algebraic equations run even deeper than Lewis & Mayer (1987) might lead us to believe. In fact, in one oft-cited study, a majority of college students could not correctly solve the following problem: "Write an equation using the variables *S* and *P* to represent the following statement: 'There are six times as many students as professors at this university.' Use *S* for the number of students and *P* for the number of professors" (Rosnick & Clement, 1980, p. 4). Some researchers (cf. Mestre, 1988) have postulated that students may be engaging in "syntactic translation" of natural language sentences into equations, literally translating word-by-word from left to right. In the student/ professor example above, such a syntactic translation might lead to the incorrect equation $6S = P$. However, MacGregor & Stacey (1993) demonstrate that syntactic translation accounts for only some of students' errors in creating equations from sentences. Students seem to have pervasive confusion about what variables represent and persistent difficulties in mapping words to symbols (MacGregor & Price, 2000).

Humbertsone & Reeve (2008) gave high school students an "English Phrase to Algebra Test" specifically designed to assess how well students could write equations when presented with simple comparative statements. Students were given 20 phrases, such as, "Seven is subtracted from *t*," and asked to represent those phrases using algebraic notation. On average, students completed 55.7 percent of the items on this assessment correctly. After analyzing students' responses in more detail, Humberstone & Reeve found that students often used incorrect mathematical operators in their equations and, even more frequently, ordered mathematical terms incorrectly. Thus, the language of algebra – specifically, the task of translating statements from natural language into algebraic notation – poses great difficulty for all students.

As numerous researchers have described, the difficulties all students face in mastering the language of mathematics can be even greater for generation 1.5 students since they may have less familiarity with the unique vocabulary and syntactic patterns that they encounter in the mathematics classroom (cf. Gorgorió & Planas, 1999; Mestre, 1988). While no study specifically documents the difficulties that the language of algebra poses for generation 1.5 students in community colleges, other research demonstrates that bilingual students are more successful at solving mathematical word problems when the problems are presented in their first language – even if they are receiving mathematics instruction in their second language (Bernardo & Calleja, 2005; Neville-Barton & Barton, 2005).

Furthermore, as Barwell (2005a) demonstrates, students for whom English is an additional language must attend to both language and content in their mathematics classes to a greater degree than other students. Barwell (2005a) spent time in elementary school classrooms, observing and recording interactions between English learners during mathematics instruction. His detailed analysis of students' discourse clearly illustrates the complex layers of linguistic and mathematics knowledge that students are attending to during their content-area classes. For example, consider this interaction between two English learners (F and P) working together to write a word problem:

> F: if we had/ wh-/ five people/ and we have twenty/ twenty books/ you know what we going to do with them
> P: yeah/ that is a hard one// (*writing*)
> F: had
> P: **have**
> F: twenty books
> P: I know/ twenty/ twenty/ no no no/ five children
> F: five children/
> P: and/ twenty/ books// can/ can/ we/ how many/
> F: is/ wait/ (. . .)
> P: how many/ can/ we/ gave/ *G A V E*/
> F: **give** them
> (Barwell, 2005a, pp. 211-212, emphasis in the original)

The students' attention alternates between constructing the context for the mathematics problem and deciding on the appropriate form of the verbs in the word problem (*had* vs. *have*, *gave* vs. *give*). While we do not have specific data about the discourse of generation 1.5 community college students during mathematics instruction, they likely also alternate between attending to issues of content and issues of language.

Strategies for Supporting Students in Building Fluency in the Language of Mathematics

As Moschkovich (2002) points out, by focusing only on what students need to learn about the language of mathematics, we risk perpetuating a deficit perspective, ignoring what students do know and the resources they bring to the mathematics classroom. As numerous researchers have found, students' primary languages can serve as valuable assets for mathematics learning (cf. Gorgorió & Planas, 1999; Moschkovich, 2002; Setati & Adler, 2000), particularly when teachers themselves can use students' primary languages to provide explanations and clarification as needed, serving as a bridge to mathematical fluency in English. For example, in a series of observational studies of multilingual mathematics classrooms, Setati & Adler (2000) illustrated how teachers supported students' mathematics learning by selectively switching from English to students' primary language to provide translations for certain unfamiliar vocabulary words, to clarify a concept, or to press students to elaborate their thinking.

Researchers have found other powerful ways in which teachers can support their students' growing fluency in the language of mathematics, as well. Yackel & Cobb (1996) found that mathematics teachers establish not just social norms about how members of the classroom community interact with one another but also "sociomathematical norms" that define for students what kinds of mathematical communication and thinking are valued in the classroom:

> Normative understandings of what counts as mathematically different, mathematically sophisticated, mathematically efficient, and mathematically elegant in a classroom are sociomathematical norms. Similarly, what counts as an acceptable mathematical explanation and justification is a sociomathematical norm (p. 461).

Other researchers have discussed how Yackel & Cobb's (1996) notion of sociomathematical norms applies to multiethnic, multilingual classrooms, like those found in most community colleges. As Gorgorió & Planas (1999) note, "In these settings the possible interpretations of the norms by some of its participants are often difficult to understand by the others, and are, therefore, a potential source for cultural conflicts that may interfere with the learning process" (p. 13). Gorgorió & Planas (1999) provide an example in which a group of Urdu-speaking secondary students think a mathematical problem is unsolvable simply because they have misunderstood a key word in the problem. By taking extra time to look carefully at diagrams the students had drawn and understand the students' reasoning, the teacher recognized their confusion and was able to provide clarification, thus reinforcing for the students the sociomathematical norm that good-faith problem solving efforts and attempts at mathematical communication are valued within that classroom.

Other researchers have investigated how curricular innovations could support students in better understanding the language of mathematics. Reed (2006) conducted a series of training studies to test the effectiveness of two strategies for supporting students in correctly translating word problems into algebraic equations. For the first study, Reed taught students a new strategy for solving problems involving multiple units. With this new strategy, students were taught to cancel units to simplify expressions. For example, the problem, "You travel 65 mph for 2.3 hours. How far have you traveled?" can be solved with the equation:

$$\frac{65 miles}{1 hour} x 2.3 hours$$

Students using the canceling units strategy were taught to cross out units that appeared in the numerator and denominator, just as they would cancel numerical quantities when multiplying fractions (in this case, they would cancel the unit *hours*). Following this procedure, the equation would simplify to:

$$\frac{65 miles}{1} x 2.3 = 149.5 miles$$

Reed found that following training students who were taught the canceling units strategy performed worse than a control group on related word problems. He hypothesized that the failure of this curricular innovation to facilitate students' problem solving may have been a result of cognitive overload, with the strategy simply being too confusing for students to master during the training time allotted. Alternatively, Reed suggested that the canceling units strategy may have been unsuccessful because it was a mechanical, procedural strategy that failed to build students' understanding of the problems themselves.

The second strategy that Reed tested for improving students ability to correctly translate word problems into algebraic equations involved identifying referents for quantities in word problems. As part of the training for this strategy, students were presented with pairs of numerical expressions involving quantities, and asked to circle the expression in each pair that represented a possible quantity in the real world. For example, students were shown the expressions "3 ft x 4 ft" and "3 lb x 4 lb." Since it is possible to have square feet but not square pounds, the first is the only sensible expression. After this training, students were given a variety of rate problems in which they could apply this strategy, and their results were compared to a control group that had received different training. For this strategy, Reed demonstrated that after initial training in identifying which mathematical expressions represented particular real-world referents – in other words, after practicing translating from natural language to algebraic expressions – college students were more successful in constructing algebraic equations in later assessments.

Stacey & MacGregor (2000) noted that although high school students in their overall sample struggled to solve word problems algebraically, "Students in particular classes had been well trained in the setting up and solving of equations. In these classes, most students used conventional formats and manipulation procedures, and their solutions were correct and usually concise" (p. 153). While investigating the teaching strategies in use in these particular classes was outside the scope of Stacey & MacGregor's (2000) study, this observation does suggest that certain curricular and pedagogical interventions may improve students' success with algebraic word problems.
Finally, research from language acquisition demonstrates the importance of extended contact with fluent English speakers to English learners' language acquisition. Contact with trusted, fluent speakers is vital for both first and second language acquisition to

occur. In a series of experiments with young children, Sabbagh & Shafman (2009) demonstrate that children develop judgments about whether particular speakers are reliable sources of linguistic information and block learning from speakers they conclude are unreliable. Such research illustrates the importance of contact between fluent and emergent English speakers in all educational contexts, including community colleges, so that those still building English proficiency will have exposure to reliable sources of linguistic information. Yet, as Gifford and Valdés (2006) document, Latino students generally and Spanish-speaking ELLs in particular experience hypersegregation in the U.S. K-12 education system, attending schools with very limited racial and linguistic diversity. Such hypersegregation has profound, negative consequences for students, since, as Gifford and Valdés argue, "For ELLs, interaction with ordinary English-speaking peers is essential to their English language development and consequently to their acquisition of academic English" (p 147). Given the limited data on generation 1.5 students at community colleges, precise information about the level of segregation such students experience is not available. However, the language acquisition research underscores the importance of creating instructional settings in which generation 1.5 students who are still in the process of building fluency in academic language generally and the language of mathematics in particular have extended opportunities for interaction with native English-speaking peers.

Innovations in the Mathematics Curriculum at Community Colleges

A separate, small body of literature documents efforts to improve student success in community college mathematics courses. While none of the curricular innovations specifically focus on how to support students in mastering the language of mathematics, a description of the curricular innovations that were tried can inform future efforts to develop additional innovations that focus on the language of mathematics.

As noted in Table 1, we identified only 14 articles that specifically focused on mathematics education in community colleges. We summarize these 14 articles in Appendix B. Of these 14 articles, nine address curricular innovations and none of these nine describe randomized, controlled trials or quasi-experimental results. Four provide descriptive information or recommendations only with no outcome data, three report results but provide no data about the comparability of students in the control or baseline group and do not isolate the effects of specific curricular innovations, and two are literature reviews. From this limited body of research, curricular innovations in mathematics that hold promise include:

- connecting course content to everyday life and to other subject areas;
- integrating technology into the classroom;
- instituting peer tutoring and other types of academic assistance and support for students;
- fostering inquiry and professional development among faculty members; and
- modifying the syllabi of courses to prioritize key concepts.

Students in developmental math courses are, by definition, learning material to which they have already been exposed. Therefore, numerous studies stress the importance of making the materials relevant to students by connecting it both to other courses and to everyday life (Bond, 2008; Kane, Beals, Valeau, & Johnson, 2004; Klein & Wright, 2009; Schwartz, 2007). One particular strategy for increasing the material's relevance to students is to create learning communities. In these learning communities, groups of students take the same classes together. For example, a group of students enrolled in an automotive technology course might also take the same developmental English and developmental math course. Therefore, the instructors in the developmental English and developmental math courses could draw on the examples from automotive technology for their readings and assignments. Additionally, students could study together, and instructors could collaborate as well. President Obama singled out learning communities as one innovation his newly announced American Graduation Initiative aims to foster across community colleges (White House Press Office, 2009). One randomized, controlled field trial investigating the effectiveness of learning communities in community colleges is currently underway, with its impact findings slated for release in 2011 (Visher, Wathington, Richberg-Hayes, & Schneider, 2008).

Technology also appears in a variety of studies as a potentially powerful strategy for increasing student success in community college math classes (Bond, 2008; Golfin, Jordan, Hull, & Ruffin, 2005; Schwartz, 2007). Technology mentioned ranges from specific mathematics software packages to interactive whiteboards. However, in the experience of some community colleges, increased integration of technology has led to increased student interest and participation in mathematics classes but not increased student success in these classes (Bond, 2008). More research is needed to determine the specific types of technologies that are associated with improved student achievement in community college mathematics classes. In particular, future research could explore whether particular technologies could support generation 1.5 students and others in developing greater proficiency in the language of mathematics.

Peer tutoring is mentioned as a promising curricular innovation in five articles (Blum, 2007; Bond, 2008; Carnegie Foundation for the Advancement of Teaching, 2008; Center for Student Success, 2007; Kane, Beals, Valeau, & Johnson, 2004). While generation 1.5 students are not mentioned specifically in these articles, perhaps when a generation 1.5 student tutors another generation 1.5 student, she can provide first-hand recommendations for strategies to master the linguistic demands of mathematics that present special challenges to non-native English speakers. Future research could explore the effectiveness of generation 1.5 students serving as peer tutors for other generation 1.5 students.

Five articles also mention fostering collaboration among community college mathematics faculty as a strategy for improving student achievement (Bond, 2008; Carnegie Foundation for the Advancement of Teaching, 2008; Center for Student Success, 2007; Grubb, 1999; Klein & Wright, 2009). With time and space to work together, instructors can collaboratively modify curriculum, instructional strategies, and assessments, creating more coherence across classrooms and establishing best practices. Furthermore, faculty members can learn from one another and combat the isolation many community college faculty experience. Again, no article describes a collaboration among faculty specifically focused on meeting the needs of generation 1.5 students. This remains an area for future research.

Finally, two articles mentioned modifying syllabi of community college mathematics course to either reduce or increase the number of concepts addressed in a particular course (Blum, 2007; Klein & Wright, 2009). In one case, in response to student focus groups, a community college created a more fast-paced basic algebra course (Blum, 2007). The college combined two developmental courses into one by devoting less class time to reviewing basic arithmetic and instead offering a two-week arithmetic refresher course to students in the summer before they began the algebra course. With this new condensed algebra course, students had fewer non-credit-bearing courses to complete. In another case, following a faculty inquiry project, community college instructors reduced the number of concepts covered in their pre-algebra courses (Klein & Wright, 2009). Rather than briefly introducing a multitude of concepts quickly, instructors decided to spend more time helping students understand select key concepts in greater depth. Initial data show higher student retention rates in the less-is-more courses, though given the non-experimental nature of the study, differences in retention rates cannot be definitely attributed to the curricular modifications.

Conclusion

As President Obama indicated when announcing his effort to increase degree attainment among community college students, millions of students enter community colleges with dreams of obtaining a degree or developing job skills (White House Press Office, 2009). However, too many community college students do not reach their goals. As we have seen less than half of those intending to obtain a degree or certificate ultimately do so, and degree attainment rates are even lower for Latino and African-American community college students (National Center for Education Statistics, 2009). Remedial math courses represent a major bottleneck for many students. According to recent studies, over half of entering college students are placed in remedial math courses, yet less than one-third of those assigned to remedial math courses ever complete their remedial mathematics sequence, and half do not even complete their first remedial course (Bahr, 2008; Bailey et al, 2008).

Scholars have documented the linguistic challenges that mathematics courses present to all students; these linguistic challenges are perhaps greatest in algebra, the branch of mathematics in which community college students must demonstrate proficiency. The vocabulary and syntactic difficulties students face in translating word problems into algebraic equations, for example, are compounded for the growing numbers of generation 1.5 students in community colleges who do not speak English as their native language. Researchers have described a small number of instructional practices designed to help students master the linguistic demands of mathematics, including using students' primary languages for selected explanations and clarification, creating a classroom environment with positive socio-mathematical norms, and teaching students specific strategies to connect everyday language with algebraic language, such as recognizing algebraic expressions with real world referents. In addition, a small number of studies documenting curricular innovations in community college mathematics classes also exist. Innovations at the community college level include: organizing students into learning communities; integrating technology into math classes; initiating peer tutoring; facilitating professional development and faculty collaboration; and modifying course syllabi to emphasize key concepts.

However, as of yet, no research exists which documents curricular innovations specifically designed to support generation 1.5 community college students in mastering the linguistic demands of their mathematics classes. Future research could explore how mathematics interventions that have been designed for non-native English speakers at other grade levels and mathematics interventions that have been designed for the general community college population could be combined to support generation 1.5 students' success in mathematics at community colleges. In order to harness the potential of the large number of generation 1.5 students enrolling in community colleges, developing mathematics interventions that effectively target this population is vital.

Appendix A: Keywords used to tag articles in our database of relevant literature (terms used to identify key articles in bold)

ability grouping
abstraction
academic language
activity theory
affect
after-school programs
algebra
animation
assessment
benchmark assessment
bilingual education
bilingualism
calculus
classroom exemplars
classroom inquiry
classroom interaction
cognition
cognitive factors
cognitive psychology
communication
community colleges
computational strategies
conceptual understanding
constructivism
cooperative learning
cultural psychology
culturally relevant pedagogy
culture
curriculum material
developmental disabilities
dialectics
differentiation
disciplinary literacy
discourse
documentation
early arithmetic
education funding
efficacy
effort
elementary schools
ELs
embodiment
engagement
epistemology
equity
generation 1.5
geometry
gesture
graphs
grouping practices
high schools
higher education
identity
immigrant students
instructional strategies
international education
intervention
language development
language in mathematics
Latina/o students
learning disabilities
literacy
mathematical ideas
mathematical texts
mathematical thinking
mathematics
mathematics achievement
mathematics education
mathematics in the workplace
mathematics learning
mathematics teaching
mental representation
meta-analysis
metalinguistics
middle schools
motivation
multilingual issues in mathematics
multilingualism
multimodality
number and operations
out-of-school mathematics
partnerships
pedagogy
performance assessments
phenomenology
policy
preschool
problem solving
professional development
proof
psychometrics
reading
reading comprehension
real analysis
reasoning
reform
register
research methodology
school districts
science education
semiotics
situated cognition
social justice
social practice theory
social studies
sociocultural theory
sociolinguistics
spatial reasoning
standards
strategy development
student achievement
student beliefs
student conceptions of learning
student demographics
student interviews
summer school
symbolic representation
teacher beliefs
teacher change
teacher education
teacher knowledge
technology
testing
tracking
transfer of learning
transnational youth
video
visualization
word problems
writing

Appendix B: Analysis of studies about mathematics in community colleges.

Authors	Title	Sample	Topic	Key Findings	Addresses curricular innovations?	Peer-reviewed ?
Bahr, 2008	Does mathematics remediation work?: A comparative analysis of academic attainment among community college students	85,894 California community college students	Compared completion of college-level mathematics course(s) and credential/degree attainment of students who successfully competed remedial math courses to that of students not placed in remedial courses	Students in both groups experienced comparable outcomes, suggesting that, for some students, remedial programs successfully resolve skill deficiencies. However, three-fourths of students placed into remedial math courses do not complete these courses successfully.	N	Y
Bailey, Jeong, & Chu, 2008	Referral, enrollment, and completion in developmental education sequences in community colleges	~250,000 community college students from 57 colleges in 7 states	Analyzed patterns of course-taking from initial referral to remedial courses onward.	Only 31 percent of students referred to math remediation and 44 percent referred to reading remediation completed their sequences within three years. More than half of students referred to remedial courses did not complete their first course.	N	N
Blum, 2007	Getting students through remedial math is a constant struggle, but this college keeps trying	One community college	Described curricular innovations designed to improve student success in remedial math classes. Innovations included: condensing two courses into one; offering a two-week math refresher course in the summer; and starting a peer-tutoring program.	Anecdotal description of curricular innovations only; no outcome data provided	Y	N

Bond, 2008	Toward informative assessment and a culture of evidence: Results from strengthening pre-collegiate education in community colleges	Eleven California community college campuses	Described curricular innovations designed to improve student success in developmental math and English classes. Innovations included: establishing learning communities around particular courses or course sequences; developing faculty inquiry; using assessment in new ways, such as pre- and post-testing; use of technology; and use of peer assistance among students	Preliminary data suggested increased student success rates in developmental math classes at four out of five community college campuses with sustained innovations in the mathematics curriculum. Seven out of nine campuses with sustained innovations in the developmental English curriculum had increased success rates for students in these classes. There were mixed results for student retention and persistence.	Y	N
Brown & Niemi, 2007	Investigating the alignment of high school and community college assessments in California	Analyzes 16 different community college placement assessments in English and math	Identifies the standards represented by the placement assessments and then compares these standards to what high school students are expected to know in the 11th grade.	The California Standards Tests in English Language Arts showed strong alignment with community college placement tests but the California Standards Tests in math did not.	N	N
Carnegie Foundation for the Advancement of Teaching, 2008	Strengthening pre-collegiate education in community colleges: Project summary and recommendations	Eleven California community college campuses	Connected to same project as Bond, 2008 (see above). Lists recommendations for improving student outcomes through actions at the faculty, college, and system level.	Connected to same project as Bond, 2008 (see above), but this particular report does not focus on student outcome data.	Y	N
Center for Student Success, 2007	Basic skills as a foundation for student success in California community colleges	Literature review of best practices in developmental education	Best practices were categorized as organizational or administrative practices; program components; staff development; or instructional practices.	Instructional best practices included faculty collaboration; ongoing monitoring of student learning; support services for students, including tutoring; and	Y	N

				culturally responsive teaching		
Golfin, Jordan, Hull, & Ruffin, 2005	Strengthening mathematics skills at the postsecondary level: literature review and analysis	Literature review of studies pertaining to adult mathematics learning	Focused on three questions: (1) What is the definition of adequate student preparation in postsecondary level math?; (2) What institutions provide developmental math education, and how does instruction differ across these institutions?; and (3) What strategies appear to help adult learners strengthen their math skills and move to college level math courses or work assignments requiring higher level math?	From the limited literature available, successful instructional practices in developmental math classes seemed to include: greater use of technology; integration of classroom and laboratory instruction; giving students the option to select from among different instructional methods; use of multiple approaches to problem solving; project-based instruction; low student to faculty ratios; assessment and placement of students into the appropriate mathematics courses; and integration of counseling, staff training, and professional development.	Y	N
Grubb, 1999	Honored but invisible: An inside look at teaching in community colleges	Observations and interviews of 257 community college instructors in 32 community colleges	Describes patterns across the 257 instructors observed, analyzing pedagogy, working conditions, innovations, funding, and institutional influences on teaching.	Since this is a descriptive, qualitative piece on instructors, student outcome data is not the focus. However, innovations mentioned that seem associated with student success include learning communities, integrating academic and vocational learning, and providing institutional support for faculty collaboration.	Y	N
Kane, Beals, Valeau, & Johnson, 2004	Fostering success among traditionally underrepresented student groups:	One community college	Describes college's attempt to increase underrepresented students' enrollment and success in math, science, and engineering	Students participating in MESA workshops received grades a full point higher than students not participating in the workshops.	Y	Y

	Hartnell College's approach to implementaiton of the Math, Engineering, and Science Achievement (MESA) program		courses through innovations including: outreach and recruitment; orientation activities, a MESA student center; student cohort clustering; academic excellence workshops; and academic planning and counseling support	However, the two groups of students may have differ on other dimensions, as well, such as motivation. Student outcomes cannot be causally linked to the innovations.		
Klein & Wright, 2009	Making prealgebra meaningful: It starts with faculty inquiry	One community college	Describes college's attempt to improve student success in prealgebra through faculty inquiry groups that focused on modifying curricular and instructional practices. Innovations included: reducing the number of concepts taught, making connections between course content and other subjects; and improving assessments	Students taught by faculty in the inquiry groups showed somewhat higher success and retention rates than other students. However, student outcomes cannot be causally linked to the innovations.	Y	Y
Marwick, 2004	Charting a path to success: The association between institutional placement policies and the academic success of Latino students	One community college	Describes college's experiment with modifying the placement process for mathematics courses	Results showed that when placement methods considered multiple measures of academic preparedness, students were initially placed into higher level mathematics courses in which they achieved equal or greater academic success than when only standardized test scores or only high school preparation were considered.	N	Y
Schwartz, 2007	New standards for improving two-year mathematics	N/A	Describes how community college mathematics instructors can implement the recommendations of	Recommendations only; no outcome data provided	Y	N

	instruction		the American Mathematical Association of Two-Year Colleges, which include integrating technology; aligning placement tests with high school exit exams; using multiple measures for the placement process; and connecting course content to quantitative skills needed in everyday life			
Shelton & Brown, 2008	Measuring the alignment of high school and community college math assessments	Analyzes 16 different community college placement assessments in math	"The California Community College placement test content was compared to the high school level California Standards Tests in General Mathematics, Algebra 1 and Geometry" (p. 2).	"Only the General Mathematics was aligned across a substantial number of standards. … It appears that the major source of misalignment between the two testing systems occurs within the content areas of Integers and Rationals, Trigonometry and Graphing" (p. 2).	N	N

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Appendix 1
Description of the Three Community Colleges

East Los Angeles College

East Los Angeles College (ELAC) is part of the Los Angeles Community College District (LACCD). The LACCD is the largest community college district in the United States and is one of the largest in this world. The LACCD consists of nine colleges and it encompasses an area that is more than 882 square miles. Although ELAC is considered one college, ELAC presently has two additional satellite campuses (South Gate campus and Rosemead campus).

ELAC main campus provides students various academic, non-credit community services and vocational courses. In addition, students have access to all campus services (admission, counseling, financial aid, transfer center, child care, disabled student programs and services, academic programs, student clubs, special-funded programs, library, computers, tutoring, and laboratories that supplement student learning such as science, mathematics and English). The college has institutionalized a program for high school students (Escalante Program) so that high school students could take mathematics courses. The college not only provides a program for high school students but for first-year college students (Adelante Program) where first-year college students are placed in academic learning communities and simultaneously getting the academic and student support services. Furthermore, the college offers a variety of programs that assist students focusing in specific academic disciplines.

South Gate Educational Center offers a variety of career and academic courses. In addition, students have access to a computer lab, bookstore, library and student services. Students who take courses at the South Gate campus could take courses at the main campus simultaneously. A free shuttle bus transports students from the South Gate campus to the main campus throughout the day thereby giving students more flexibility in course offerings.

Rosemead Center offers students academic and non-credit community service courses. Although the center does not provide students with any student services, the center will be implementing (fall 2009) a computer laboratory that will consist of forty computers for student use. Rosemead Center will begin its third year of operation this fall 2009.

El Paso Community College

El Paso Community College has five campuses. Mission del Paso campus is located east of El Paso and offers a full range of classes including a state-of-the-art Law Enforcement Training Academy. In addition, the campus serves instructional services for students such as labs for English as a Second Language (ESL), reading and general tutoring services. Furthermore, the campus established an early college program for high school students (Mission Early College High School) where students earn an associate's degree and high school diploma concurrently.

Northwest campus provides students with a full range of classes (academic, technical and non-credit) and student services (admission, registration, financial aid and counseling). In addition, the campus provides students with facilities for mathematics, biology, geology, ESL and reading. The Northwest campus library in partnership with the City of El Paso and the El Paso Public Library, serves as the "Community Library." Furthermore, the campus established an early college program for high school students.

Rio Grande campus offers a variety of courses that include the arts, sciences, basic academic skills, credit courses in ESL and occupational education programs. In addition, students have access to all of the college and student services (admission, financial aid, counseling, registration, bookstore, library and cafeteria) that are needed.

Transmountain campus is located northeast of El Paso. The campus provides students with educational programs and all college services (admissions, registration, financial aid, counseling, full-service library, bookstore and child care). Transmountain is the only college that has a performance/ lecture facility for concerts, films, large meetings and community events. In addition, the campus established a program for high schools students.

Valle Verde campus is the largest and most centrally located facility. The campus provides students with educational programs and all college services (admissions, registration, financial aid, counseling, full-service library, bookstore and child care). In addition, students have access to a computer laboratory of 100 stations networked with Internet access, state-of-the-art laboratories for foreign language and ESL courses, as well as community interest non-credit classes (e.g., floral arrangement and cooking). The campus established an early college program for high schools students.

San Jose City College

San Jose/Evergreen Community College District serves 950,000 residents within the 303 square miles, including the San Jose and Milpitas Unified School Districts and East Side Union High School District. The district includes San Jose City College and Evergreen Valley College. A new science building includes new facilities for physical education, cosmetology, mathematics, arts & humanities and health sciences.

College Enrollment Data – See pages 1 - 9

Every college generates its own data, collecting data at various times. East Los Angeles College collects their data every fall semester. Students who enroll in the college during the winter session, spring semester and summer sessions, are included in the college enrollment data collection for the following fall semester. In other words, a student could begin her or his college career in the winter session and continue until the summer session. This particular student would not be counted as part of the data enrollment until the student registered for the fall semester. El Paso Community College collected data from the EPCC's website. The data specifically focused on the fall semester. Data after fall 2006 was unavailable. San Jose City College's data collection schedule isn't known.. SJCC's website did not provide any research data.

Total number of students enrolled:

El Paso Community College has the largest enrollment compared to East Los Angeles College and San Jose City College. When comparing ELAC and EPCC, there were similarities in gender enrollment for the fall 2006 and fall 2007. For both colleges, where approximately 60 percent of the students were females and 40 percent were males. In terms of ethnicity on campus, approximately 76 percent of the students were Hispanics at ELAC whereas 86 percent were at EPCC. Although the comparison is between ELAC and EPCC (SJCC did not provide data), the ethnic demographics, gender and enrollment were similar.

Number of non-English background students –international students who will return to their home countries

ELAC does not generate data on the number of students who will return to their home countries. ELAC students begin their education at the college and are highly encouraged to transfer to a four-year institution. Presently ELAC does not have the resources to track international students if they transferred to a four-year institution, transferred to a different community college, remained in the country illegally/legally, or returned to their home country. ELAC provided date on the number of students who enroll at ELAC with a "student visa." For the fall 2006, 1.4 percent (298 students) of the students were enrolled at ELAC with a student visa. For the fall 2007, 1.9 percent (424 students) of the students were enrolled with student visas and 2.5 percent for fall 2008. As for EPCC and SJCC, no data was provided.

Number of non-English background students – immigrant students who were schooled outside the United States

ELAC does not specifically track this information. ELAC only accounts for the student's current status when students enroll at the college. For instance, if a student is naturalized before enrolling to ELAC, then the student is counted as a "US citizen." For the fall 2006, 13 percent of students had permanent residency (2,738 students), 0.1 percent had temporary residency (30 students), 1.2 percent had a refugee/asylee residency (246 students), and 6.6 percent of students are classified as "other" (1,393 students). For the fall 2007, 12.5 percent of students had permanent residency (2,791 students), 0.1 percent had temporary residency (31 students), 1.1 percent had a refugee/asylee residency (253 students), and 6.6 percent were classified as "other" (1,472 students).. For the fall 2008, 11.0 percent of ELAC enrolled students had permanent residency, 0.1 percent had temporary residency, 0.9 percent had a refugee/asylee residency, and 6.2 percent are classified as "other." As for the other two colleges, data was not provided.

Number of non-English background students –immigrant origin students who were schooled in the United States (1.5 Generation)

ELAC does not track this information (see above). As for the other two colleges, data was not provided therefore uncertain if the colleges collect this information.

ESL Assessment Instrument(s) used – See page 10

Both ELAC and EPCC assess their students using the Combined English Language Assessment (CELSA). SJCC, uses the Compass reading, Compass listening and an ESL essay. In general, the two largest community colleges in the study use the same ESL assessment instruments.

ESL Placement Data – See pages 11 - 15

Number of students who took the ESL placement exam

SJCC did not provide any data. The data below will only reflect ELAC and EPCC. At ELAC, students are highly encouraged to take the placement exam for both English and mathematics. The college does not require that students must first take the assessment test before registering for a course. Students may register for a course without taking the assessment exam except for courses that have a mathematics or English pre-requisite. Those students who take the English assessment examare referred to a specific English course or *ESL Referral*. *ESL Referral* means that a student's English score was below the "cut-off score," therefore the student was referred to take the ESL placement exam. Students do not need to take the English assessment test in order to be referred to take the ESL placement exam. Students could self-select to take the ESL exam. Thosetudents who take the ESL placement exam, they are referred to a specific ESL course or *ENL Referral*. *ENL Referral* means that a student's English score is above the "cut-off score," therefore he or she is referred to take the English assessment exam. As for EPCC, the ESL placement exam does not place a student into or out of the ESL program. The exam determines the appropriate level of courses to be taken by a student who chooses to participate in the ESL program.

For ELAC, 1,810 students and 1,634 students took the ESL placement exam in the academic years 2006 – 2007 and 2007 – 2008, respectively. In addition, 314 students and 386 students were referred to take the ESL placement exam. At EPCC, 1,146 students, 993 students and 1,098 students took the ESL placement exam in the academic years 2006 – 2007, 2007 – 2008 and 2008 – 2009, respectively. In general, more students took the ESL placement exam at ELAC. One might suspect that EPCC, a college that is physically located closer to the United States/Mexico border, would have had more students taking the ESL placement exam.

Number of students who placed out of ESL courses and who took the ESL placement exam

SJCC did not provide any data. The data for this question was gathered in two different methods. ELAC track the students by the number of students who took the ESL placement exam but were referred to an ENL assessment exam. EPCC data includes the number of students who took the ESL placement exam during a term and the number of students who completed ESL Level 6 (the last ESL course at EPCC) during that term or any subsequent term. The ESL placement exam does not place a student into or out of the ESL program. The exam determines the appropriate level of courses to be taken by a student who chooses to participate in the ESL program.

At ELAC, 20 students (academic year 2006 – 2007) and 14 students (academic year 2007 – 2008) took the ESL placement exam but where referred to take the ENL assessment exam. As for EPCC, their collection of data is different from ELAC. At EPCC, 59 students (academic year 2006 – 2007), 9 students (academic year 2007 – 2008) and no students (academic year 2008 – 2009) were identified. In general, it is difficult to compare both colleges given that the data was generated differently.

Number of students placing in various courses

Information regarding the ESL placement exam for all three colleges was collected; however SJCC did not provide any data. The data will only reflect ELAC and EPCC. At ELAC, students are allowed to repeat the CELSA placement exam once a semester and there is no fee to take the exam. ELAC ESL courses are divided into two separate departments, ESL credit and ESL non-credit. Students taking ESL courses through the non-credit department are allowed to take the courses numerous times (four courses are available). Students are highly encouraged to meet with a non-credit ESL coordinator to recommend a placement; however, the student makes the final decision as to which course to take. Students taking courses through the ESL credit department are placed in specific course based on the student's ESL placement scores. The ESL credit courses sequence consists of four levels (one class per level, a total of four courses). Most of the students who took the placement exam for the academic years 2006 – 2007 and 2007 – 2008, were placed in level four (23 percent and 25.7 percent, respectively) which is the highest ESL level at ELAC.

As for EPCC, according to the college's website, students are allowed to repeat the CELSA exam once every three months (90 days). If a student would like to retest, they would need to submit a petition form. EPCC students must pay a fee in order to take the assessment exam with the exception of the first assessment exam which is free unless a student misses his/her appointment. EPCC ESL sequence of courses consists of six levels (four courses per level, a total of 24 courses). Most of the students who took the placement exam for the academic years 2006 – 2007 and 2007 – 2008 were placed in level one which is the second lowest ESL level at EPCC. Based on EPCC discussions with instructors and administration, some students are not placed correctly. Rather than having students focus on information that they are familiar with, instructors encourage students to continue with the next level simultaneously and then reassess; thereby, students are completing their courses at a faster rate.

As for SJCC, according to the college's website, students are allowed to retake the English placement exam after12 months and six months if students took the ESL placement exam; however, if a student has begun the English sequence, he or she is exempt from retaking the assessment. The placement exam is for initial placement and cannot be used to skip levels. For SJCC students whose first language is not English, their assessment exam is conducted by appointment only. SJCC students do not pay a fee to take the placement exam. SJCC ESL sequence of courses consists of six levels where students are taking a total of 29 courses.

In comparing the three colleges, there was a similarity with SJCC and EPCC in that more than 20 ESL courses are available. Again, depending on where students place in their ESL placement exam, some students may take more than 20ESL courses while others might take less than 20ESL courses. Based on data provided by EPCC on ESL placement, most of the students will take more than 20 ESL courses. Once students complete the ESL sequence courses, students would then be eligible to take the non-transferable English courses and then the transferable English courses. When comparing EPCC with ELAC, most of the ELAC students are placing in the highest level of ESL courses. Since students are not required to pay to take the placement exam, students could assess every semester in hopes of skipping a course. Although EPCC provides the same opportunity for their students to reassess, EPCC does not provide the same incentive of a non-charge to reassess. Data on the number of students who reassess and skip English courses are not available for either EPCC or ELAC.

ESL Completion Data – See page 16

SJCC did not provide any data. The following data will only reflect ELAC and EPCC. As for ELAC data, ELAC was only able to collect data from 1994 and current data. The following data reflect the number of awards, however this data may include duplicate awards, meaning that students could have received one or more degrees or certificates. As of July 27, 1366 students were awarded an associate of arts degree, 110 students were awarded an associate of science degree, 406 were awarded a certificate and 406 were awarded a certificate of skills, for a total of 2,618 degrees and/or certificates awarded. EPCC was able to collect data from 1988 and current data.. The following data reflect the number of students who originally took ESL Placement and who completed an associate of arts degree, associate of science degree, AAS or AAT degree. As of July 22, 316 students at EPCC were awarded a degree.

ESL Policy Documents – See page 17

ESL Policy Documents – Documents that guide the enrollment/education of students who take the ESL placement exam

All three colleges did not provide any data; perhaps information can be obtained from the instructors' interviews.

ESL Policy Documents – Policies on courses that ESL students can and cannot enroll in

SJCC and EPCC did not provide any information. As for ELAC, students may register for any course with the exception of courses that have mathematics or English pre-requisites. Students are highly recommended to meet with an academic counselor so that the counselor could guide students in taking appropriate courses.

ESL Policy Documents – Policies on Credit or Non-Credit basis of ESL sequence course

All three colleges did not provide any data; perhaps information can be obtained from the I\instructors' interviews.

List of Developmental Mathematical Sequence Courses – See page 18 & 19

For all three colleges, the sequences of courses are similar. The lowest mathematic course is a basic math course that focuses on arithmetic. The next mathematic course is a pre- algebra course. After that course is a beginning algebra course and finally, intermediate algebra. These courses are needed in order for students to begin to take transferable courses. Furthermore, all three colleges have an analytical geometry course that is considered non-transferable but is needed for some mathematical courses such as trigonometry and the calculus series.

Mathematics Assessment Instruments used – See page 20

All three colleges usea different mathematical placement instrument. ELAC is in the process of changing its assessment instrument and may potentially use *The Accuplacer*, the assessment instrument that is EPCC presently uses. EPCC does not have the flexibility of selecting from a variety of assessment instruments. The state of Texas mandates that EPCC and other Texas community colleges use either *The Accuplacer* or another assessment instrument. EPCC chose *The Accuplacer.*

Do the Mathematics Assessment Procedures Include Language Accommodations for Non-English Background Students – See page 20

EPCC did not provide any information. As for ELAC, students from a non-English background do not receive any language accommodations. The ELAC matriculation office tries to hire and schedule bilingual proctors for assistance. All students are provided with sample test questions that are available online. Similarly to ELAC, SJCC does not provide any language accommodations to non-English background students.

Data on Backgrounds of Students who Place into the Developmental Sequence Course – See pages 21 & 22

Data Background - Number of students who also took the ESL placement exam

All three colleges did not provide any data. For those students who took the ESL placement exam, ELAC does not track the student's mathematical level.

Data Background - Number of students who are graduates of US high schools

All three colleges did not provide any data. For those students who took the ESL placement exam, ELAC does not track the students who graduated from a U.S. high school.

Data Background - - Number of foreign students (educated outside the US)

All three colleges did not provide any data. For those students who took the ESL placement exam, ELAC does not track the students who are foreign students. ELAC data consist of students with student visas that took the mathematic placement exam. For the academic year 2007 – 2008, most of the students that enter ELAC with a student visa enrolled in an intermediate algebra course (29.6 percent), which is one level below the transferable courses. Other students are taking calculus 1 (23.5 percent), followed by beginning algebra (16.4 percent) and transfer level courses (12.3 percent). Again, beginning algebra is two levels below the transferable courses. In general, ELAC students who enter the college with student visas and who take the math assessment exam (only 89 percent of the students take the assessment exam) are taking developmental mathematics-level courses (172 students place into the non-transferable courses compared to 116 who place into the transferable courses). Although the data for ELAC show that 22 students were referred to a higher test and 14 students were referred to a lower test, it is unclear which mathematical test students took (transferable or non-transferable courses).

Data Background – Number of students who took algebra

ELAC does not specifically track this information. SJCC and EPCC did not provide any data. However, EPCC could provide a modification of this data. In Texas, a new law, "Algebra for all" has been implemented for students who graduate from high school.. Students must have completed at least three years of mathematics, including algebra 2. Given the new law in Texas and that EPCC documents students' graduation from high school, EPCC data would only reflect recent high school graduates.

Yearly Pass Rates in Developmental Mathematic Courses – See page 21

ELAC only provided data on students who took the assessment test. The data below will only reflect EPCC and SJCC data. EPCC's data was further broken down into three classifications of Level 6: ESL, No ESL and some ESL as well as per semester. However, the data problem occurs because some EPCC students could reassess and thereby place at a higher level. SJCC provided data for the academic year regardless of whether students were ESL or not. Although ELAC did not provide any data on the number of students passing, the college did provide the number of students who are taking the assessment test, specifically by mathematical level.

At ELAC, for the academic year 2006 – 2007, 78.8 percent of the students were assessed. From those students that were assessed, 44.8 percent of the students placed in Arithmetic for College Students, which is four levels below the transfer course. Arithmetic for College Students is the lowest mathematics course at East Los Angeles College. The next course that students placed (18.2 percent of the students) was beginning algebra, which is two courses below the transfer course. For the academic year 2007 – 2008, 84.7 percent of the students were assessed. From those students that were assessed, 22 percent of the students placed in pre-algebra, which is three levels below the transfer course. The next course that students placed (20 percent of the students) was Arithmetic for College Students, which is four courses below the transfer course. Most of the students at ELAC are placing at either the third or fourth level below the transfer course.

At SJCC, for the academic years 2006 – 2007, 2007 – 2008 and 2008 – 2009, most of the students took intermediate algebra, which is one level below the transfer course. The next course that most students took was beginning algebra, which is two courses below the transfer course. The number of students who passed intermediate algebra is approximately 50 percent53 percent and 55 percent, respectively. The number of students who passed beginning algebra is approximately 51 percent, 47 percent and 51 percent, respectively. Most of the students at SJCC place either one or two levels below the transfer course.

EPCC provided data on the number of students who passed the developmental courses, however, EPCC did not provide information on the number of students who attempted to take the course. Based on what was provided, most students passed an intermediate algebra course, which is one level below the transfer course. The next course that most students passed was a split between a beginning algebra course (two levels below) and a pre-algebra course (three levels below). In general, the data show that in both colleges, SJCC and EPCC, more students are pass mathematics courses that are either one or two levels below the transfer course. Trying to incorporate ELAC's data, it seems that most students at ELAC take courses that are three and four levels below the transfer level. However, since data was not provided, it is difficult to predict or assume that more students would be successful based on more students taking those courses. It could be that more students are passing the math courses in the upper levels of math than in the lower levels. It is difficult to make this claim given that EPCC and SJCC did not provide information on the number of students who are placed into the developmental math course based on the initial assessment.

Mathematical strands and topic areas that seem to be the most problematic for non-English background students – See page 31

SJCC and ELAC claimed that word problems would be more difficult for students. EPCC did not provide any information. Perhaps this question can be best answered using instructors' interviews.

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Institutional Data for Language and Mathematics Project

College Enrollment Data			
Total Number of Students Enrolled	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College	**FALL 2006** Concurrent HS Students: 531 First-Time Students: 3,860 Continuing Students: 13,768 New Transfer Students: 1,863 Returning Students: 2,298 Unknown: 57 Total: 22,377	**FALL 2007** Concurrent HS Students: 938 First-Time Students: 4,626 Continuing Students: 14,103 New Transfer Students: 1,732 Returning Students: 2,378 Unknown: 0 Total: 23,777	**FALL 2008** Concurrent HS Students: 7.9% First-Time Students: 16.3% Continuing Students: 46.8% New Transfer Students: 10.9% Returning Students: 18.8% Total: 24,892
El Paso College	**FALL 2006** Academic Transfer Students: 21,240 Occupational/Technical Students: 4,064 Average Age: 25 Males: 10,006 (39.5%) Females: 15,298 (60.5%) Total: 25,304 **FALL 2006** Continuing Education Students: 5,686 Average Age: 41 *Data was obtained from EPCC website*	**FALL 2007** Male: 10,055 (40.1%) Female: 15,005 (59.9%) Total: 25,060 *Data was obtained from EPCC website*	

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Institutional Data for Language and Mathematics Project

San Jose City College	17,127	18,228	
Total Number of Non-English Background Students Enrolled: International Students who will return to their home countries	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College *Data based solely on credit students*	**Fall 2006** **Citizenship** US Citizens: 16,404 (77.7%) Permanent Resident: 2,738 (13.0%) Temporary Resident: 30 (0.1%) Refugee/Asylee: 246 (1.2%) Student Visa: 298 (1.4%) Other: 1,393 (6.6%) Total: 21,109 *Based on students who provided the information*	**Fall 2007** **Citizenship** US Citizens: 17,315 (77.7%) Permanent Resident: 2,791 (12.5%) Temporary Resident: 31 (0.1%) Refugee/Asylee: 253 (1.1%) Student Visa: 424 (1.9%) Other: 1,472 (6.6%) Total: 22,287 *Based on students who provided the information*	**Fall 2008** **Citizenship** US Citizens: 79.3% Permanent Resident: 11.0% Temporary Resident: 0.1% Refugee/Asylee: 0.9% Student Visa: 2.5% Other: 6.2% Total: 24,892 *Based on students who provided the information*
Data include credit and noncredit students	**Residency Status** California Resident: 20,287 (90.7%) International: 1,562 (7.0%) Out-of-State: 528 (2.4%) Total: 22,377	**Residency Status** California Resident: 21,442 (90.2%) International: 1,840 (7.7%) Out-of-State: 494 (2.1%) Unknown: 1 (0.0%) Total: 23,777	

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Institutional Data for Language and Mathematics Project

El Paso College			
San Jose City College			
Total Number of Non-English Background Students Enrolled: Immigrant Students who were schooled outside the US	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College	See data above	See data above	
El Paso College			
San Jose City College			
Total Number of Non-English Background Students Enrolled: Immigrant Origin Students Schooled in the United States (1.5 Generation)			
East Los Angeles College	See data above	See data above	
El Paso College			
San Jose City College			
Other			
East Los Angeles College			
Educational Goal *Data may include credit and noncredit students.*	**FALL 2006** General Education: 2,046 (9.5%) Transfer: 6,439 (29.9%) Transitional: 1,121 (5.2%) Unknown/Undecided: 4,610 (21.4%)	**FALL 2007** General Education: 2,071 (9.1%) Transfer: 7,505 (32.9%) Transitional: 1,353 (5.9%) Unknown/Undecided: 4,788 (21.0%)	**FALL 2008** General Education: 10.1% Transfer: 34.3% Transitional: 5.9% Unknown/Undecided: 19.2%

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	Vocational: 7,284 (33.9%) Total: 21,501 *Based on students who provided the information*	Vocational: 7,063 (31.0%) Total: 22,780 *Based on students who provided the information*	Vocational: 30.5% *Based on students who provided the information*
Unit Load *Data based solely on credit students*	**FALL 2006** Less than 6: 7,396 (35.0%) 6 – 11: 8,537 (40.4%) 12 or more: 5,176 (24.5%) Total: 21,109 *Based on solely on credit students*	**FALL 2007** Less than 6: 7,854 (34.8%) 6 – 11: 8,739 (39.2%) 12 or more: 5,793 (26.0%) Total: 22,287 *Based on solely on credit students*	
Educational Background *Data based solely on credit students*	**FALL 2006** US high school graduate: 14,641 (69.4%) Foreign high school graduate high school: 1,540 (7.3%) Equivalency/Proficiency Certificate: 975 (4.6%) Concurrently enrolled high school student: 739 (3.5%) Not a high school graduate: 1,191 (5.6%)	**FALL 2007** US high school graduate: 15,355 (68.9%) Foreign high school graduate high school: 1,674 (7.5%) Equivalency/Proficiency Certificate: 985 (4.4%) Concurrently enrolled high school student: 869 (3.9%) Not a high school graduate: 1,297 (5.8%)	**FALL 2008** US high school graduate: 68.4% Foreign high school graduate high school: 7.4% Equivalency/Proficiency Certificate: 4.4% Concurrently enrolled high school student: 5.9% Not a high school graduate: 4.1% AA degree: 4.2% BA degree or higher: 5.5%

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	AA degree: 923 (4.4%) BA degree or higher: 1,099 (5.2%) Total: 21,109 *Based on students who provided the information*	AA degree: 933 (4.2%) BA degree or higher: 1,175 (5.3%) Total: 22,287 *Based on students who provided the information*	*Based on students who provided the information*
Gender *Data based solely on credit students*	**FALL 2006** Female: 13,218 (62.6%) Male: 7,891 (37.4%) Total: 21,109 *Based on students who provided the information*	**FALL 2007** Female: 13,798 (61.9%) Male: 8,489 (38.1%) Total: 22,287 *Based on students who provided the information*	**FALL 2008** Female: 15,223 (61.2%) Male: 9,669 (38.8%) Total: 24,892 *Based on students who provided the information*
Age *Data based solely on credit students*	**FALL 2006** Concurrent High School: 742 (3.5%) Under 20: 4,261 (20.2%) 20 – 24: 7,343 (34.8%) 25 – 34: 5,106 (24.2%) 35 and over: 3,658 (17.3%) Total: 21,109	**FALL 2007** Concurrent High School: 1,178 (5.3%) Under 20: 4,560 (20.5%) 20 – 24: 7,679 (34.5%) 25 – 34: 5,277 (23.7%) 35 and over: 3,592 (16.1%) Total: 22,287	**FALL 2008** Concurrent High School: 7.9% Under 20: 20.6% 20 – 24: 34.4% 25 – 34: 22.2% 35 and over: 14.9%
Ethnicity *Data based solely on credit students*	**FALL 2006** African-American: 492 (2.3%) Asian: 4,028 (19.1%)	**FALL 2007** African-American: 430 (1.9%) Asian: 4,478 (20.1%)	**FALL 2008** African-American: 1.9% Asian: 19.5%

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	Caucasian: 463 (2.2%) Hispanic: 15,965 (75.7%) Other: 161 (0.7%) Total: 21,109 *Based on students who provided the information*	Caucasian: 461 (2.1%) Hispanic: 16,739 (75.1%) Other: 179 (0.8%) Total: 22,287 *Based on students who provided the information*	Caucasian: 2.0% Hispanic: 75.8% Total: 24,892 *Based on students who provided the information*
Primary Language *Data based solely on credit students* *** Students could interpret primary language as language spoken at home or language of preference.*	**FALL 2006** Armenian: 55 (0.3%) Chinese: 1,967 (9.3%) English: 12,225 (57.9%) Farsi: 15 (0.1%) Japanese: 38 (0.2%) Korean: 60 (0.3%) Russian: 19 (0.1%) Spanish: 6,008 (28.5%) Filipino: 102 (0.5%) Vietnamese: 302 (1.4%) Other: 317 (1.5%) Total: 21,109 *Based on students who provided the information*	**FALL 2007** Armenian: 78 (0.4%) Chinese: 2,161 (9.7%) English: 13,053 (58.6%) Farsi: 17 (0.1%) Japanese: 40 (0.2%) Korean: 44 (0.2%) Russian: 18 (0.1%) Spanish: 5,806 (26.1%) Filipino: 97 (0.4%) Vietnamese: 376 (1.7%) Other: 598 (2.7%) Total: 22,287 *Based on students who provided the information*	**FALL 2008** Armenian: 0.3% Chinese: 9.1% English: 61.4% Farsi: 0.1% Japanese: 0.2% Korean: 0.3% Russian: 0.1% Spanish: 24.7% Filipino: 0.4% Vietnamese: 1.9% Other: 1.6% Total: 22,287 *Based on students who provided the information*
El Paso College			

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Institutional Data for Language and Mathematics Project

Gender *Data was obtained from EPCC website*	**FALL 2006** Academic Transfer Students: 21,240 Occupational/Technical Students: 4,064 Males: 10,006 (39.5%) Females: 15,298 (60.5%) Total: 25,304	**FALL 2007** Male: 10,055 (40.1%) Female: 15,005 (59.9%) Total: 25,060	
Ethnicity *Data was obtained from EPCC website*	**FALL 2006** Academic Transfer Students: 21,240 Occupational/Technical Students: 4,064 Hispanics: 21,625 (85.5%) Black: 542 (2.1%) White: 2,135 (8.4%) Foreign Born/ International/other: 724 (2.9%) American Indian: 65 (0.3%) Asian: 213 (0.8%) Total: 25,304 **FALL 2006** Continuing Education Students: 5,686	**FALL 2007** Hispanics: 21,429 (85.5%) Black: 537 (2.1%) White: 2,065 (8.2%) Foreign Born/International/other: 751 (3.0%) American Indian: 66 (0.3%) Asian: 212 (0.8%) Total: 25,060	

	Hispanics: 76.1% Black: 2.5% White: 13.4% Unknown: 0.2% Asians: 1.5% American Indian: 0.5% Foreign Born: 5.9%		
Awards Granted by Gender and Ethnicity *Data was obtained from EPCC website*	**AA degrees for Females** White: 84 (66%) Black: 17 (53%) Hispanic: 772 (62%) Asian/Pacific Islander: 9 (64%) American Indian: 3 (60%) Foreign: 21 (78%) Total: 967 (62%) **Associate of Applied Science** White: 27 (21%) Black: 10 (31%) Hispanic: 251 (20%) Asian/Pacific Islander: 2 (14%) American Indian: 1 (20%)		

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	Foreign: 4 (15%) Total: 311 (20%) **Certificates for Females** White: 16 (13%) Black: 5 (16%) Hispanic: 226 (18%) Asian/Pacific Islander: 3 (21%) American Indian: 1 (20%) Foreign: 2 (7%) Total: 285 (18%) **AA degrees for Males** White: 55 (70%) Black: 5 (33%) Hispanic: 361 (58%) Asian/Pacific Islander: 4 (100%) American Indian: 4 (100%) Foreign: 9 (39%) Total: 438 (58%) **Associate of Applied Science for Males** White: 10 (13%) Black: 5 (33%)		

	Hispanic: 105 (17%) Foreign: 3 (3%) Total: 123 (16%) **Certificate for Males** White: 14 (18%) Black: 5 (33%) Hispanic: 158 (25%) Foreign: 11 (48%) Total: 188 (25%)		
San Jose City College			

ESL Assessment Instrument(s) used	
East Los Angeles College	Combined English Language Assessment (CELSA)
El Paso College	Combined English Language Assessment (CELSA)
San Jose City College	Compass reading, Compass listening, ESL essay (local)

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Institutional Data for Language and Mathematics Project

ESL Placement Data			
Number of students who took the ESL Placement	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College			
Multi-Testers: English Placement *Students who took the exam multiple times throughout the year. Only the performance on their first assessment test is considered.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*	ESL Referral: 365 (3.4%) ESL Placement: 1,830 (17.2%) ENL Referral: 24 (0.2%)	ESL Referral: 424 (4.0%) ESL Placement: 1,655 (15.5%) ENL Referral: 14 (0.1%)	
Evaluated Students: English Placement *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*	ESL Referral: 314 (3.0%) ESL Placement: 1,790 (17.2%) ENL Referral: 20 (0.2%)	ESL Referral: 386 (3.7%) ESL Placement: 1,620 (15.6%) ENL Referral: 14 (0.1%)	
Evaluated Students: English Placement by Gender *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*		**Female** ESL Referral: 207 (3.7%) ESL Placement: 992 (17.7%) ENL Referral: 7 (0.1%) **Male** ESL Referral: 179 (3.7%) ESL Placement: 628 (13.1%)	

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		ENL Referral: 7 (0.1%)	
Evaluated Students: English Placement by Language *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*		**Spanish** ESL Referral: 193 (8.3%) ESL Placement: 391 (16.8%) ENL Referral: 5 (0.2%)	
Evaluated Students: English Placement by Age *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*		**Under 20** ESL Referral: 173 (3.3%) ESL Placement: 412 (7.8%) ENL Referral: 7 (0.1%) **20 – 24** ESL Referral: 97 (4.3%) ESL Placement: 394 (17.3%) ENL Referral: 1 (0.0%) **25 – 34** ESL Referral: 59 (3.6%) ESL Placement: 323 (19.5%) ENL Referral: 3 (0.2%) **35 – 54** ESL Referral: 50 (4.6%) ESL Placement: 3 (40.9%) ENL Referral: 105 (0.3%) **55 and Over**	

		ESL Referral: 7 (8.1%) ESL Placement: 46 (53.5%) ENL Referral: 0 (0%)	
El Paso College	See Attached	See Attached	
San Jose City College			
Number of students who placed out of ESL courses who sat for the ESL placement	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College	See Above	See Above	
El Paso College	See Attached	See Attached	
San Jose City College			
Number of students placing in various courses	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College			
Multi-Testers: ESL Placement *Students who took the exam multiple times throughout the year. Only the performance on their first assessment test is considered.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*			
English (ESL) 82	286 (15.6%)	285 (17.2%)	
English (ESL) 84	280 (15.3%)	287 (17.3%)	
English (ESL) 85	315 (17.2%)	323 (19.5%)	
English (ESL) 86	424 (23.2%)	425 (25.7%)	
ESL 40CE	210 (11.5%)	124 (7.5%)	

Institutional Data for Language and Mathematics Project

ESL 41CE	315 (17.2%)	211 (12.7%)	
Total	1,830	1,655	
Evaluated Students: ESL Placement *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*			
English 82	278 (15.5%)	274 (16.9%)	
English 84	274 (15.3%)	282 (17.4%)	
English 85	305 (17.0%)	316 (19.5%)	
English 86	412 (23.0%)	417 (25.7%)	
ESL 40CE	209 (11.7%)	124 (7.7%)	
ESL 41CE	312 (17.4%)	207 (12.8%)	
Total	1,790	1,620	
El Paso College			
Below Level 1	Fall 2006: 2 Spring 2007: 0 Summer 2007: 0	Fall 2007: 0 Spring 2008: 1 Summer 2008: 0	Fall 2008: 0 Spring 2009: 0 Summer 2009*: 0 ** Figures are preliminary as of July 22, 2009*
Level 1	Fall 2006: 334	Fall 2007: 299	Fall 2008: 322

	Spring 2007: 186 Summer 2007: 297	Spring 2008: 260 Summer 2008: 241	Spring 2009: 336 Summer 2009*: 258 ** Figures are preliminary as of July 22, 2009*
Level 2	Fall 2006: 89 Spring 2007: 83 Summer 2007: 38	Fall 2007: 39 Spring 2008: 49 Summer 2008: 31	Fall 2008: 33 Spring 2009: 42 Summer 2009*: 31 ** Figures are preliminary as of July 22, 2009*
Level 3	Fall 2006: 46 Spring 2007: 45 Summer 2007: 15	Fall 2007: 27 Spring 2008: 26 Summer 2008: 16	Fall 2008: 21 Spring 2009: 29 Summer 2009*: 17 ** Figures are preliminary as of July 22, 2009*
Level 4	Fall 2006: 2 Spring 2007: 1 Summer 2007: 3	Fall 2007: 0 Spring 2008: 0 Summer 2008: 0	Fall 2008: 3 Spring 2009: 2 Summer 2009*: 1 ** Figures are preliminary as of July 22, 2009*
Level 5	Fall 2006: 1 Spring 2007: 1 Summer 2007: 0	Fall 2007: 1 Spring 2008: 2 Summer 2008: 0	Fall 2008: 0 Spring 2009: 1 Summer 2009*: 1 ** Figures are preliminary as of July 22, 2009*
Level 6	Fall 2006: 1	Fall 2007: 0	Fall 2008: 0

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	Spring 2007: 1 Summer 2007:1	Spring 2008: 0 Summer 2008: 1	Spring 2009: 0 Summer 2009*: 1 ** Figures are preliminary as of July 22, 2009*
San Jose City College			

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ESL Completion Data			
Number of students who originally took the ESL Placement who completed an AA degree	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College	See Attached	See Attached	See Attached
El Paso College	See Attached	See Attached	See Attached
San Jose City College	See Attached	See Attached	See Attached

ESL Policy documents: **Documents that guide the enrollment/education of students who take the ESL placement exam.**	
East Los Angeles College	
El Paso College	
San Jose City College	
ESL Policy documents: **Policies on courses that ESL students can and cannot enroll in.**	
East Los Angeles College	
El Paso College	
San Jose City College	
ESL Policy documents: **Policies on credit or non-credit basis of ESL sequence courses**	
East Los Angeles College	
El Paso College	

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San Jose City College	

List of Developmental Mathematics Sequence Courses	
East Los Angeles College	Currently have: Math 105 – Arithmetic for College Students (3 units), *4 levels below transfer level math* Math 110 (5 units + 1 unit lab component), *3 levels below transfer level math* Math 112 – Pre Algebra (3 units + 1 unit lab component), *3 levels below transfer level math* Math 115 – Beginning Algebra (5 units), *2 levels below transfer level math* Math 125 – Intermediate Algebra (5 units), *1 level below transfer level math* The restructured course will be revised to: (scheduled to start in Spring 2010) Math 105 – Arithmetic for College Students (3 units), *4 levels below transfer level math* Math 110 (5 units + 1 unit lab component), *3 levels below transfer level math* Math 115 – Beginning Algebra (5 units), *2 levels below transfer level math* Math 125 – Intermediate Algebra (5 units), *1 level below transfer level math*
El Paso College	Currently have: Math 300 - College Prep Math Math 301 – Pre Algebra Math 303 - Introductory Algebra Math 305 - Intermediate Algebra. The restructured courses will include: (scheduled to start in Fall 2010)

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	Math ____ College Prep Math and Pre Algebra (not yet numbered) Math 303 - Introductory Algebra Math 305 - Intermediate Algebra
San Jose City College	Math 310 – Basic Mathematics (3 units), *3 levels below transfer level math* Math 311 – Pre Algebra (3 units), *3 levels below transfer level math* Math 11A – Elementary Algebra (5 units), *2 levels below transfer level math* Math 11R – Review of Introductory Algebra (3 units), *2 levels below transfer level math* Math 11S – Self-Paced Introductory Algebra (5 units), *2 levels below transfer level math* Math 14 – Geometry (3 units), *1 levels below transfer level math* Math 13 – Intermediate Algebra (5 units), 1 *level below transfer level math* Math 13S – Self-Paced Intermediate Algebra (5 units), *1 level below transfer level math*

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Mathematics Assessment Instruments(s) used	
East Los Angeles College	Mathematics Diagnostic Testing Project (MDTP) 4 levels; Algebra readiness, Elementary Algebra, Intermediate Algebra and Pre Calculus.
El Paso College	Accuplacer
San Jose City College	Compass Numerical Skills, Pre-Algebra, Compass Algebra, Compass College Algebra, Compass Trigonometry

Do the Mathematics Assessment procedures include language accommodations for non-English-background students?	
East Los Angeles College	No. Only sample test questions are provided to all non-exempt students and they are made available online. The matriculation office tries to hire and schedule bilingual proctors for assistance.
El Paso College	
San Jose City College	No – everyone gets the same test according to Laura Cordova, Assessment Specialist, San Jose City College, (408) 288-3170

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Data on backgrounds of students who place into the developmental sequence courses			
Number of students who also took the ESL placement exam	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College			
El Paso College			
San Jose City College			
Number of students who are graduates of US high schools	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College			
El Paso College			
San Jose City College			
Number of foreign students (educated outside the US)	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College			
Students who have a “Student Visa” *Figures based on the yearly testing cycle (e.g., from August 2007 through July 2008)*			
Referred to Lower Test		14 (4.3%)	
Referred to Higher Test		22 (6.8%)	
Math 105 – Arithmetic for College Students		3 (0.9%)	
Math 110		11 (3.4%)	
Math 112 – Pre Algebra		9 (2.8%)	
Math 115 – Beginning Algebra		53 (16.4%)	

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Math 125/120 – Intermediate Algebra/Geometry		96 (29.6%)	
Math 261 – Calculus		76 (23.5)	
Transfer Level		40 (12.3%)	
No Placement		0 (0%)	
Number Assessed		324 (89.0%)	
Number Not Assessed		40 (11.0%)	
Total		364	
El Paso College			
San Jose City College			
Number of students who took algebra	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College			
El Paso College			
San Jose City College			

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Yearly Pass Rates in Developmental Math Courses	**2006 – 2007**	**2007 – 2008**	**2008 – 2009**
East Los Angeles College – Students who took the Assessment Exam			
Multi-Testers: Math Placement *Students who took the exam multiple times throughout the year. Only the performance on their first assessment test is considered.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*			
Referred to Lower Test	790 (8.9%)	890 (9.2%)	
Referred to Higher Test	296 (3.3%)	346 (3.6%)	
Math 105 – Arithmetic for College Students	3,930 (44.2%)	1,891 (19.6%)	
Math 110	Course was not implemented	2,092 (21.7%)	
Math 112 – Pre Algebra	882 (9.9%)	930 (9.7%)	
Math 115 – Beginning Algebra	1,602 (18.0%)	1,778 (18.5%)	
Math 125/120 – Intermediate Algebra/Geometry	959 (10.8%)	1,167 (12.1%)	
Math 261 – Calculus	229 (2.6%)	281 (2.9%)	
Transfer Level	190 (2.1%)	235 (2.4%)	
No Placement	16 (0.2%)	19 (0.2%)	
Total	8,894	9,629	
Evaluated Students: Math Placement *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*			
Referred to Lower Test	728 (8.3%)	817 (8.7%)	

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Referred to Higher Test	280 (3.2%)	333 (3.5%)	
Math 105 – Arithmetic for College Students	3,918 (44.8%)	1,891 (20.0%)	
Math 110	Course was not implemented	2,075 (22.0%)	
Math 112 – Pre Algebra	880 (10.1%)	923 (9.8%)	
Math 115 – Beginning Algebra	1,590 (18.2%)	1,759 (18.6%)	
Math 125/120 – Intermediate Algebra/Geometry	938 (10.7%)	1,143 (12.1%)	
Math 261 – Calculus	220 (2.5%)	259 (2.7%)	
Transfer Level	178 (2.0%)	219 (2.3%)	
No Placement	16 (0.2%)	19 (0.2%)	
Number Assessed	8,748 (78.8%)	9,438 (84.7%)	
Number Not Assessed	2,350 (21.2%)	1,711 (15.3%)	
Total	11,098	11,149	
Evaluated Students: Math Placement by Ethnicity *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*			
HISPANICS			
Referred to Lower Test		614 (9.1%)	
Referred to Higher Test		111 (1.6%)	
Math 105 – Arithmetic for College Students		1,626 (24.1%)	
Math 110		1,792 (26.6%)	
Math 112 – Pre Algebra		714 (10.6%)	

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Math 115 – Beginning Algebra		1,250 (18.6%)	
Math 125/120 – Intermediate Algebra/Geometry		566 (8.4%)	
Math 261 – Calculus		9 (0.1%)	
Transfer Level		39 (0.6%)	
No Placement		15 (0.2%)	
Number Assessed		6,736 (91.6%)	
Number Not Assessed		614 (8.4%)	
Total		7,350	
Evaluated Students: Math Placement by Citizenship *Unduplicated number of students that underwent assessment and placement.* ***Based on the test cycle (e.g., from August 2007 through July 2008)*			
Referred to Lower Test		US Citizen: 619 (8.9%) Permanent Resident: 97 (7.7%) Temporary Resident: 0 (0%) Refugee/Asylee: 8 (6.4%) Student Visa: 14 (4.3%) Other: 77 (10.5%) Unknown: 2	

		(25.0%)	
Referred to Higher Test		US Citizen: 208 (3.0%) Permanent Resident: 78 (6.2%) Temporary Resident: 1 (7.1%) Refugee/Asylee: 8 (6.4%) Student Visa: 22 (6.8%) Other: 16 (2.2%) Unknown: 0 (0%)	
Math 105 – Arithmetic for College Students		US Citizen: 1,503 (21.5%) Permanent Resident: 188 (15.0%) Temporary Resident: 2 (14.3%) Refugee/Asylee: 14 (11.2%) Student Visa: 3	

		(0.9%) Other: 180 (24.5%) Unknown: 1 (12.5%)	
Math 110		US Citizen: 1,694 (24.3%) Permanent Resident: 241 (17.1%) Temporary Resident: 2 (14.3%) Refugee/Asylee: 5 (4.0%) Student Visa: 11 (3.4%) Other: 146 (19.8%) Unknown: 1 (12.5%)	
Math 112 – Pre Algebra		US Citizen: 749 (10.7%) Permanent Resident: 92 (7.3%) Temporary Resident: 1 (7.1%)	

		Refugee/Asylee: 14 (11.2%) Student Visa: 9 (2.8%) Other: 58 (7.9%) Unknown: 0 (0%)	
Math 115 – Beginning Algebra		US Citizen: 1,313 (18.8%) Permanent Resident: 227 (18.1%) Temporary Resident: 3 (21.4%) Refugee/Asylee: 18 (14.4%) Student Visa: 53 (16.4%) Other: 144 (19.6%) Unknown: 0 (0%)	
Math 125/120 – Intermediate Algebra/Geometry		US Citizen: 715 (10.2%) Permanent Resident: 203 (16.2%) Temporary Resident: 3	

		(21.4%) Refugee/Asylee: 24 (19.2%) Student Visa: 96 (29.6%) Other: 102 (13.9%) Unknown: 3 (37.5%)	
Math 261 – Calculus		US Citizen: 66 (0.9%) Permanent Resident: 88 (7.0%) Temporary Resident: 0 (0%) Refugee/Asylee: 20 (16.0%) Student Visa: 76 (23.5%) Other: 8 (1.1%) Unknown: 1 (12.5%)	
Transfer Level		US Citizen: 97 (1.4%) Permanent Resident: 61 (4.9%)	

		Temporary Resident: 2 (14.3%) Refugee/Asylee: 14 (11.2%) Student Visa: 40 (12.3%) Other: 5 (0.7%) Unknown: 0 (0%)	
No Placement		US Citizen: 15 (0.2%) Permanent Resident: 4 (0.3%) Temporary Resident: 0 (0%) Refugee/Asylee: 0 (0%) Student Visa: 0 (0%) Other: 0 (0%) Unknown: 0 (0%)	
Number Assessed		US Citizen: 6,979 (84.7%) Permanent Resident: 1,252 (83.4%)	

		Temporary Resident: 14 (93.3%) Refugee/Asylee: 125 (74.4%) Student Visa: 324 (89.0%) Other: 736 (87.4%) Unknown: 8 (50.0%)	
Number Not Assessed		US Citizen: 1,264 (15.3%) Permanent Resident: 249 (16.6%) Temporary Resident: 1 (6.7%) Refugee/Asylee: 43 (25.6%) Student Visa: 40 (11.0%) Other: 106 (12.6%) Unknown: 8 (50%)	
San Jose City College --			
Basic Mathematics -- Math 310 (1, 2, 3 units)	314/649 ≈ 48%	349/664 ≈ 53%	220/496 ≈ 44%

Appendix 2

Institutional Data for Language and Mathematics Project

Students did not necessarily complete the course			
Pre Algebra – Math 311 (3 units)	100/189 ≈ 53%	147/261 ≈ 56%	149/285 ≈ 52%
Elementary Algebra – Math 11A (5 units)	430/845 ≈ 51%	473/1007 ≈ 47%	587/1153 ≈ 51%
Review of Introductory Algebra – Math 11R(3 units)	12/20 = 60%	13/16 ≈ 81%	n/a
Self-Paced Introductory Algebra – Math 11S (5 units)	208/353 ≈ 59%	227/346 ≈ 66%	156/281 ≈ 56%
Intermediate Algebra – Math 13 (5 units)	464/932 ≈ 50%	549/1039 ≈ 53%	654/1185 ≈ 55%
Self-Paced Introductory Algebra – Math 13S (1, 2, 3, 4, or 5 units) *Students did not necessarily complete the course*	75/111 ≈ 68%	66/112 ≈ 59%	39/66 ≈ 59%
Geometry – Math 14 (3 units)	85/145≈ 59%	96/126 ≈ 76%	100/134 ≈ 75%
El Paso Community College	SEE ATTACHMENT		

Mathematical strands and topic areas that seem to be the most problematic for non-English-background students	
East Los Angeles College	Depending on the math course, certain mathematical strands and topics are difficult for students. However, in general, regardless of the mathematical level, students tend to struggle with word problems and fractions.
El Paso College	
San Jose City College	This is hard to answer because we have data on ethnicity but not on non-English background. I can say that the courses with the lowest success rates below 50% for Latino/a students between 2007 summer and fall and 2008 spring, summer and fall is Math 310 (47.93%), Math 11a (43.56%), Math 13 (49.33%) Math 21 (Pre Calculus) (29.04%) and math 25 (Pre Calculus with Trigonometry)(38.84%). I will send an attachment with all this data attached. Based on anecdotal data, the biggest issue for non-English- background students is word problems. Fractions in basic math & rational expressions in algebra are also very difficult concepts for these students. Pre Calculus is a big concern for these students as you can see from the numbers. The hunch is that the students entering Math 21 and Math 25 do not have the functional knowledge of the fundamental math from developmental classes they need to be successful in Math 21 and Math 25.

About the Problem Solution Exploration Papers

A series of background papers was prepared for Carnegie to support its work in developmental mathematics in community colleges, to devise measures for student success, and to help identify problems of practice for potential future work.

Student Learner Study
"What Community College Developmental Mathematics Students Understand About Mathematics," James Stigler. Because the research literature did not cover what mathematical knowledge students have, James Stigler undertook fieldwork to learn more about students' understanding of basic mathematics, and student perceptions of what they believe it means to *do* mathematics.

Language Learning
"The Developmental Mathematics and Language Project," Guadalupe Valdes and Bernard Gifford. Includes an extensive review of literature and field work, with interviews of students, faculty, and administrators at three community colleges –San Jose City College, East LA Community College and El Paso Community College.

Human Resources
"Community College Faculty and Developmental Education: An Opportunity for Growth and Investment," by Amy Gerstein provides a descriptive analysis of full- and part-time community college faculty, and their preparation for teaching.

Social/Cultural Support
The two parts of this paper are a review of literature of current student success courses by Laura Hope of Chaffey College, and a white paper on social and educational psychology by Carlton Fong of the Charles A. Dana Center. These two together map the landscape of current practice and new possibilities.

A more detailed introduction to the papers by Rose Asera is also available.

Download the series at:

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