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A multidimensional approach to overcoming challenges in leading community college math tutoring success

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ABSTRACT
The United States lags behind many countries in mathematics proficiency. Quite often, students after graduating from high school are not prepared to enter college and are required to take remedial courses before taking credit-bearing math courses. This is particularly true at two-year institutions such as LaGuardia Community College, which provides the opportunity for students from a diverse background to attend college and earn a degree. Our college has created numerous initiatives to support the least prepared students. Our Mathematics Learning Center offers support for courses ranging from remedial mathematics through calculus and differential equations. In recent semesters, the mathematics department decided to dedicate a select group of faculty members to identify new ways of improving services at the center. In this paper, we argue for the need to give faculty a central role in assessing and devising appropriate policies for running a tutoring center. We discuss several challenges and solutions that would provide a multidimensional approach to students' educational experience at a public two-year urban college.

Background: the growing needs for a mathematics support center

"Community College Students Face a Very Long Road to Graduation" is the truism and title of a recent article in the *New York Times* about a LaGuardia Community College student, Mr. Vladimir de Jesus. Mr. de Jesus faces numerous challenges, including the inability to pass developmental mathematics (failing thrice), on his long journey to an associate's degree (Bellafante, 2014). This student, like many of our others, attends college part-time, has children, has a full-time job, comes from an impoverished life, and often fails remedial math more than once. Community college students across the nation are facing dismal barriers to completing their college degree. Basic math has consistently presented problems to our students; many fail to pass remedial math and often end up as a drop-out statistic. In fact, according to the latest data from the National Center for Education Statistics (2014), at such public institutions, only 20% of first-time, full-time undergraduate students who began their pursuit of a certificate or associate's degree in fall 2009 obtained a degree within three years (i.e., 150% of the normal time required to do so). The article and statistics was indeed an eye-opener for many government leaders but something that our colleagues work through on a daily basis.

Nearly 60% of community college students across the United States enroll in at least one developmental reading, writing, or mathematics course (Bailey, 2009). There is an urgent need in the United States to develop mathematics literacy. A study done on American students of the class of 2011 concluded that the United States has a 32% proficiency rate in mathematics compared with 44% for Germany and 58% for Korea. The U.S. also came 32nd among the nations that participated in PISA (Programme for International Student Assessment). The study across 75 nations found that

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22 countries significantly outperform the United States in the share of students reaching the proficient level in mathematics. Surprisingly, some of our country's largest and most heavily funded states have a very low math proficiency rates—including New York with 30% and California with 24% pass rates (Peterson, Woessmann, Hanuske, & Lastra-Anadón, 2011).

Many European universities have created support centers to address the mathematics problem that students experience when transitioning from postprimary to tertiary education (Carroll, 2011; Hourigan & O'Donoghue, 2007; Pell & Croft, 2008). In this paper, we argue for the need to give faculty a central role in assessing and devising appropriate policies for running a successful tutoring center at LaGuardia Community College. The challenges faced by community college students in the United States go beyond those identified in other settings. Some students fail to retain past learning from an inadequate K–12 education, others return to college as adults and need to review past materials, and some lack study, organizational and self-assessment skills (Hall & Ponton, 2005; Merisotis & Phipps, 2000). Additionally, international students are also challenged by the transition to a new educational system using a new language. Other factors exacerbate these challenges. Specifically, a majority of students work outside the college and need to support their families and pay for college. While 50% of our students are of traditional college age (17 to 22 years), the remaining half is reentering college after several years away from schooling. Furthermore, many of our students in developmental mathematics had negative experiences in previous mathematics classes, which has likely contributed to a low level of self-confidence, poor motivation, and/ or high anxiety (Betz, 1978; Hammerman & Goldberg, 2003).

In order to succeed in college math, students must remain motivated and committed. The Mathematics Learning Center (MLC) can help students develop greater self-efficacy through a number of ways. Self-efficacy is defined as an individual's judgments of his or her capabilities to complete certain tasks (Schunk, 1991). Bandura (1977) emphasized the importance of goal-setting. By making self-rewarding reactions conditional on attaining a certain level of behavior, individuals can persist in their performance until they achieve desirable results; self-efficacy can thus be viewed as a mechanism to induce behavioral change. This is essential for some of our students who think that intelligence is not malleable and instead is fixed. To the contrary, research points out that self-efficacy can indeed be improved (Bandura, 1989; Rattan, Good, & Dweck, 2012). Personal performance accomplishments are the most influential when it comes to developing self-efficacy beliefs (Bandura, 1986). This concept is particularly applicable for our students in remedial mathematics who fear the subject due to poor performance during their earlier years. Many self-efficacious students will persist when faced with difficult materials (Gore, 2006; Komarraju & Nadler, 2013). Schunk and Gunn (1985) specifically applied this concept to the mathematics classroom; they showed that combining task strategies and achievement beliefs lead to the highest levels of self-efficacy. The implications to the classrooms are numerous including a higher rate of problem solving.

Most community colleges in the United States have learning support centers to help students improve their remedial needs and to increase academic preparedness. One of the central goals of these centers is to help students develop efficient learning processes (Carter & Wetzel, 2010; Perin, 2004). Learning centers are not unique to colleges serving a nontraditional student-body. In the United Kingdom (UK) for example, 85.44% of the surveyed institutions (n = 88 of 103) have been identified as having some form of mathematics learning support (Perkin, Croft, & Lawson, 2013). Opinions on what factors should determine the success of a learning center, however, vary widely (Lawson, Halpin, & Croft, 2001).

Research suggests that one cannot simply evaluate the effectiveness of a tutoring center based on passing rates alone, but rather on a combination of several factors, including retention rates, especially among the less well-prepared students (Symonds, Lawson, & Robinson, 2007). One important factor is the extent of student engagement with the center (Bhaird, Fitzmaurice, Fhloinn, & O'Sullivan, 2013). The authors detail reasons for nonengagement based on students' surveys: some think they do not need help, others claim that they never heard of the center or that they do not know its location, and others specify that the time of opening does not suit them. In addition to these reasons, some students claim that they are embarrassed or afraid to go, while others state that their hatred of math is the reason why they did not take advantage of the learning center. The students' fear of showing lack of knowledge might impact their decision in attending tutoring. Grehan (2013) detailed the fears that students expressed and how these fears prevented them from engaging with mathematics during their first year at National University of Ireland-Maynooth.

Research also supports the need to collect and analyze information about tutoring centers to understand factors that impact students' performance and reduce attrition (MacGillivray & Croft, 2011; Matthews, Croft, Lawson, & Waller, 2013). Attrition rates are of particular importance at community colleges. A recent report from the National Center for Education Statistics ([NCES], 2014) indicates that the one-year retention rate for public community colleges was only 58% for first-time, full-time students. A mere 20% of these students who began their pursuit of a certificate or associate's degree in fall 2009 attained it within 150% of the normal time required to do so (NCES, 2014). At LaGuardia, a majority of students either transfer or drop out before graduation. For example, for the cohort of students entering in fall 2012, 39% of those who were placed in remedial mathematics dropped out by the end of the academic year, versus 29% for those who did not need remediation.

In general, college student success has been tied to many factors. Kuh, Kinzie, Schuh, Whitt, and Associates (2005) maintained that an important component is the presence of an infrastructure of support that includes new programs and services to meet students' needs. Mathematics tutoring centers can be viewed as one example of these services to improve students' chances of success in college. Students must be engaged in meaningful learning experiences so that they are more likely to successfully complete their studies. When students enter college, they have their own expectations of learning experiences. These expectations may influence their responses to the learning environment at the college, and as a result, might impact their decision about staying or dropping out (Kuh, Gonyea, & Williams, 2005).

Institutional context

LaGuardia Community College is part of the City University of New York (CUNY) system. We are an urban two-year college with an open admission policy. Our students hail from over 150 countries, speak over 100 languages and reflect the ethnic diversity of the city. With open admissions, we offer opportunity to students with a diverse academic background. For many of our students, community colleges are the only viable solution to getting a college degree and to later be admitted in more selective four-year institutions. LaGuardia serves over 18,000 nontraditional and diverse matriculated students. Among the entering class of 2012, 40% worked part-time or full-time, 63% received financial aid, and many others have family responsibilities (LaGuardia Community College, The City University of New York, 2014).

After taking a mathematics placement exam, about 71% of the incoming freshmen every year need to enroll in one of two remedial mathematics courses, which are offered as a sequence (LaGuardia Community College, The City University of New York, 2014). The first course is prealgebra and the second course is elementary algebra. Students who place in prealgebra will need to take algebra before enrolling in credit-level courses. Remedial math pass rates for both courses are around 50% compared with 70% for credit-bearing courses. In any given semester, approximately 7,000 students enroll in a mathematics class; 59% of the enrollees take credit-bearing mathematics courses, while 41% take remedial mathematics.

Graduation rates at community colleges are low in general, as mentioned above. In particular, remedial (also known as developmental) mathematics has been noted as one of the greatest barrier to students' completing their degrees (Merseth, 2011; Stigler, Givvin, & Thompson, 2010). LaGuardia's innovative approach to student success in developmental skills encompasses a few major national initiatives to help us improve our remediation and graduation rates. As one noteworthy example, we previously participated in Achieving the Dream (AtD), a multiyear, nationwide project that aims to bolster success rates for community college students. (Review LaGuardia's participation and lessons learned from AtD at www.lagcc.cuny.edu/atd/.)

This initiative helped us better appreciate the importance of more systemic college initiatives. In our Department of Mathematics, Engineering, and Computer Science (MEC), the most widespread effort to serve basic skills students has been Project Quantum Leap (PQL), which links the study of math to social issues in order to fully engage students and help them connect math to their daily lives. Students enrolled in PQL courses demonstrated higher levels of student engagement and confidence, decreased course attrition rates, and higher course and final exit exam pass rates. PQL courses have also achieved substantially reduced attrition (LaGuardia Community College, The City University of New York, 2012). (Learn more about PQL at http://ctl.laguardia.edu/pql/sampler/.)

Support is provided to students by a broad array of tutoring services. In particular, the MEC department houses the MLC. The mission of the center is to improve students' mastery of concepts and procedures so they can gain a better understanding of the subject. In return, it is expected that tutoring will improve students' chances of passing a mathematics course. The MLC offers tutoring across all levels on a walk-in basis and is open 13 hours a day to accommodate day and evening students. For the academic year 2013–2014, it is estimated that the center served approximately 4,000 students. The center serves students during the regular fall and spring semesters and during the two six-week sessions in the winter and the summer. Around 35% of the students came in seeking help in remedial mathematics; the rest were split between statistics (24%), college algebra (25%), and precalculus and calculus series (16%).

Recently, faculty members and administrators (two of the three authors are faculty members; one is an executive officer in the Office of the Vice-President.) worked collaboratively to improve services provided by the MLC. We describe different types of challenges we face in running a tutoring center that serves an urban and diverse student body. We also detail initiatives to address these challenges, and discuss current implementations and recommendations to provide a multidimensional approach to students' educational experience. In fall 2013, a faculty team was assigned the task of collecting, analyzing, and understanding the challenges of the MLC. After a yearlong work effort, the team implemented in fall 2014 some changes including the use of a system that allows them to monitor traffic and track students' performance. This effort was supported by the college administration through the office of the Vice-President of Academic Affairs.

MLC challenges and solutions

Resources

A learning center should improve students' mastery of course material and, thus, contribute to higher success and retention rates across courses. However, inadequate funding can limit the services we provide to students. In the United Kingdom, mathematics support centers proliferated in the past decade thanks to national funding received by several universities (Matthews et al., 2013). Contrary to that model, tutoring centers in the United States are typically funded locally by colleges and universities. For example, at LaGuardia, the College and the City University central office jointly fund the center.

At a minimum, running a successful math support center requires adequate resources, which include space and location, computers and other specialized equipment, management personnel, tutoring personnel, and faculty support. When we first analyzed the state of our tutoring center, it was evident that additional resources were needed to deal with an overwhelming demand from our students. Too few tutors—dealing simultaneously with multiple students taking a variety of courses—is a common occurrence that affects the quantity and quality of help these students receive. Despite these limitations, students continued to attend in large numbers and evidently benefited from the services offered.

In an effort to better understand student needs and learning outcomes, we surveyed a number of students attending the center. Fifty-eight percent of the 132 respondents reported that "after receiving help from tutors, my grade improved." When asked whether "without tutoring, I would have dropped my class," 45% answered "Yes" or "Maybe." Forty-one percent indicated that "after receiving help from tutors, my understanding of the course became much better," and 27% indicated that their "understanding of the course became a little better." Sixty-five percent said that they would come back to seek tutoring. The negative results from the survey were about the number of tutors available at the center and the waiting time. Specifically, 77% indicated that the number of tutors on the floor was not enough; 36% reported waiting time to get help from a tutor to be between 10 and 20 minutes, and 44% reported more than 20 minutes. Surveys were typically conducted at the end of the semester. Although the MLC is open 80 hours a week, it's not enough to meet the needs of our students.

In an effort to address students' concerns about tutors' availability and waiting time given our limited resources, the faculty team looked at a number of possible solutions. We needed to address both the number of available tutors as well as coordinating their efforts more efficiently. In addition to requesting additional funds from the current providers, we considered other alternatives. First we looked for students who are required to work on campus as part of their financial aid requirements (also known as work-study students). The effort resulted in hiring two students for each semester. In a given semester, each one had approximately 160 contacts with students. The majority of these contacts lasted 5 to 10 minutes per contact, and about a quarter of them lasted over 10 minutes. Work-study students were also assigned to conduct small group tutoring for some courses. We also considered new ways of using the current tutors more efficiently by revising scheduling and the tutoring philosophy to include a more structured drop-in. More details on these efforts are described in subsequent sections of this paper.

MLC visibility appeared to also have been an issue. For the sake of greater dedicated tutoring space, the MLC recently moved further away from the MEC department. This, in turn, has necessitated the need for a better campaign to make the MLC more visible and accessible to new students. The MLC space has a room for small group tutoring, a classroom, and a main tutoring floor. The latter contains computers where students do their homework and tables for small group tutoring. It can accommodate a maximum of 70 students at a time. Those tables on the main floor and the classroom are also used to run the hour-long mandatory lab for developmental mathematics. This created a crowded-space at certain times of the day. To make efficient use of space, we are working closely with the registrar's office to avoid scheduling more than two mandatory lab hours concurrently.

Personnel

Many of the MLC tutors were originally serving as adjunct faculty with a master's degree in mathematics. Initially, the center's staff was in charge of hiring tutors; then the math department chairperson asked a faculty team (based on our research, a faculty-led math tutoring lab appears to be an uncommon practice in American community colleges) to take charge in devising center policies, hiring and supervising tutors, and taking action on the collected data. We recently decided to diversify our tutors by hiring upper level LaGuardia student-tutors. To ensure quality and student satisfaction, the faculty team trains new tutors on general policies and periodically stops by the MLC to observe tutors. Tutees can also fill out an exit survey about their tutoring experience. At the end of every semester, all tutors are invited to a MLC group meeting to share their experiences. If funding allows, this practice will be extended to regular meetings during the semester so tutors can advise each other on challenges and issues that arise. Hiring student-tutors can help tutees who are unwilling to show engagement of the subject in fear of demonstrating lack of knowledge. When students tutor their peers, tutees exhibit higher confidence and more comfort in showing their mistakes (Lawson et al., 2001). Students also value improving their confidence and comfort as part of the mathematics support they receive (MacGillivray, 2009). Furthermore, this approach gives our

Figure 1 Word cloud used to describe reasons students came to the tutoring center.

students a unique opportunity to gain some preprofessional experience, sharpen their mastery of the subject, and make some money toward their tuition expenses while staying on-campus. Our MLC tutors are instructed to focus on helping students without making any personal judgments. In addition, for privacy purposes, our tutors do not have full access to students' records and are instead limited to viewing students' current course enrollment.

We, as faculty, believe that teaching students study skills is as important as teaching them the course content. As such, our philosophy and approach at the MLC should help students in self-directing their studies (Perin, 2004). We also believe that students should study on their own and come to the center prepared. However, surveys indicate that many students use it to do their homework and prepare for their exams without prior preparation, and they expect the tutor to do most of the work for them. Because tutors specify the topics at the end of each tutoring session, we compiled all the topics in a word cloud. Figure 1 shows that students attend the center mainly to review for upcoming exams; the MLC is also used when devising training materials for tutors and to modify existing policies.

In developmental mathematics, students are required to use a computer-based learning platform. We advise tutors to help students while using the learning platform on the computer. These computer-assisted learning platforms also contain tutorials that students are encouraged to use when preparing for class, and tutors can assist students in locating the appropriate tutorials. MLC tutors are discouraged from providing one-to-one tutoring for upper level courses; instead, we ask them to conduct small group tutoring whenever possible. We also asked them to go over students' notes, advise them on *how* to study, and encourage them to ask specific questions. The MLC offers review sessions for final exams but not for midterms; this is due to instructors scheduling midterms at different points in the semester. We are currently working with tutors to give periodic reviews for all courses.

Assessment

Literature review

In this section, we discuss existing assessment and how technology helped us enhance data collection. Gill & O'Donoghue (2007) detail various ways to measure the success of the tutoring center at the University of Limerick in Ireland. These authors recommend some of the following metrics as a way to more accurately measure student math tutoring success: (1) number of students tutored, (2) department and college participation (measured by the number of departments the facility serves), (3) independent review, (4) external department reviews, (5) retention and grades, (6) research output, (7) development and expansion, (8) associated projects, and (9) links with other mathematics learning centers (at different universities). While it may be difficult to use all the metrics, experts in this field have documented evidence suggesting that attendance is a key measure of success (Lawson et al., 2001). The number of return visits is an indication of the overall satisfaction with the service provided. Some research details how the existence of the mathematics tutoring centers helped improve passing rates and student retention (Dowling & Nolan 2007; Patel & Little 2006; Symonds et al., 2007). Others were focused on tracking and supporting students who were deemed at-risk after taking an assessment given at the beginning of the semester (Matthews et al., 2013).

Croft (2008) details some of the challenges of data collection in a mathematics center and the difficulties in conducting longitudinal studies. In the case of the UK, a change in entry qualifications, syllabi, lecturing staff, and the fact that students come from many different departments at different stages in their studies make it hard to set a control group identical to the experimental group. Nonetheless, measuring the impact of a learning center needs to be quantified to help secure future funding. The need for accurate data collection and assessment goes beyond the necessity of justifying the existence of a learning center. It also provides an insight on what strategies appear more or less effective in improving math skills, and how to more appropriately allocate resources for greater student success.

Students' results for fall 2013

The lack of technology can negatively impact data collection. During the fall of 2013, data was collected manually using sign-in sheets given to individual tutors. This allowed us to estimate the total number of students who came to the center, the courses where students needed supplemental help, and reasons why students came to seek help. For that particular semester, it was estimated that the center provided help for 1,600 students. We analyzed the data using 600 students who attended tutoring during fall 2013. Table 1 shows that tutoring had a positive impact on their grades. To get a better sense on how well the tutees' performed when compared to other students taking similar courses, the Office of Institutional Research (OIR) provided us with the percentage of students who achieved a grade of B or higher (or C or higher) across all sections for particular courses during the same semester (see Table 1). In the majority of courses, a higher percentage of students achieved a grade of B or higher (or C or higher) compared with the overall percentage for all students enrolled in a particular course.

We tracked the cohort of students in Table 1, and we found that 45% of them took a mathematics course the following semester. Out of those, 26.4% took a remedial mathematics course (25% enrolled in Remedial 2 and 1.4% repeated Remedial 1). The distribution of students by course and their grades are shown in the first column of Table 2.

One cannot draw a strong conclusion from Table 2; however, over a third of students in each case achieved a grade of B or higher. Over 50% in college level courses pass with a grade of C or higher. Students' grades are in line with the percentage of students passing gateway mathematics

Table 1 Percent of tutored students and other students with a grade of B (or C) or higher for fall 2013.

Course	Percent of tutored students with a grade of B or higher	Percent of students with a grade or B or higher across all sections	Percent of tutored students with a grade of C or higher	Percent of students with a grade or C or higher across all sections
Remedial (pre-algebra)	42	40	75	71
Remedial (algebra)	30	21	53	42
College Algebra	42	41	70	63
Statistics	40	37	66	61
Pre-Calculus	45	45	60	61
Calculus 1	60	55	80	71
Calculus 2	40	45	40	56

Table 2 Performance of students in the next mathematics course (fall 2, 2014 or spring 1, 2014).

Course	Percent of students in the subsequent course	Percent of students with a grade of B or higher	Percent of students with a grade of C or higher
Remedial 2 (algebra)	25[a]	41[b]	41[b]
College Algebra	16.3	48	57
Statistics	19.5	36	58
Precalculus	14	41	61.5
Calculus 1	10	59	70
Calculus 2	3.5	33	50
Others (nonremedial)	10.3	66	–

Note. The table does not include 1.4% of students who were repeating prealgebra in the spring of 2014. [a]25% represents the percent of students who took remedial 2, the following semester after receiving tutoring in remedial 1. [b]41% reflects a passing grade (P). Students in algebra earn a passing grade if their final grade is C or higher.

courses with C or better (such as college algebra, statistics and precalculus). The passing rates in the second remedial course are also at par with the college-wide passing rates.

Survey results stated earlier show that a majority of our students (65%) would "come back to MLC to seek tutoring." Moving forward, we plan to send surveys at the end of every semester to both students and tutors to identify issues and challenges.

Students' results for fall 2014

Unlike other colleges that often track the impact of mathematics support centers by a specific major, such as engineering (see Parsons, 2005), the structure of our institution does not provide us the opportunity to track students by major. To address this issue and to improve data collection, we worked with the college's Information Technology department on the implementation of the automatic sign-in system integrated with the OIR. The Student Engagement Management System or SEMS should provide us with more critical data about peak time, an accurate estimate of the number of students we serve, and their performance in mathematics courses throughout their academic journey. We fully implemented the system in fall 2014. SEMS was originally designed for advisement purposes, but we decided to use it to track and retain students for tutoring. SEMS was developed by LaGuardia's IT division in consult with staff from Student Affairs and Academic Affairs to support our new advisement model.

Data collected using SEMS indicated that a total of 1,238 students made 2,919 visits to the MLC during fall 2014. The number of visits per student varied from one to 18. Of the 1,238, 29% came three or more times. Forty-four percent of students came for help in either remedial mathematics or statistics.

MLC visitors had an average grade in their math courses 33% higher than students in a control group. The control group was selected such that each student in the MLC visiting group was matched against students in his or her course section within the same initial cumulative grade point average (GPA) range and within the same range of earned credits. This difference was statistically significant. No attempt was made to design an experiment that isolated the effects of the MLC visit alone by randomly selecting students. The beneficial measured effect should be considered a joint product of the students' motivation and the benefit of visiting the lab for tutoring. Nevertheless, the method did remove many of the nonvisit effects by matching students on cumulative GPA and credits earned levels (freshmen were matched only against freshmen, for example). By matching students within sections, effects of different courses, levels, and faculty were also controlled. That is, students visiting the math lab had a higher course grade than students within the same course section with the same faculty member, having about the same previous GPA, and about the same number of earned credits. Table 3 summarizes those results.

Out of 1,238 students, we had a treatment group of 599 and a control group of 1,843 when matched by section (see Table 3). For that case, there is 33% grade improvement for the MLC visitors. Even when matched by course only, students who visited the MLC have an average grade 19% higher than the students in the control group. Furthermore, a higher percentage of students

Table 3 Grade improvement of MLC visitors.

	Section Match	Course/Faculty Match	Course Match Only
Mean Grade of MLC Visitors	2.15	2.14	2.08
Mean Grade of Control	1.62	1.63	1.75
Standard Deviation of MLC Visitors	1.49	1.49	1.51
Standard Deviation of Control	0.89	0.87	0.50
Number of MLC Visitors	599	630	855
Number of Control (unweighted)	1843	1976	4169
Percent Grade Improvement	33%	31%	19%

Table 4 Mean grade of MLC visitors.

	MLC Visitors	Control Group
Percentage (Number) of Students with a Grade of B or Higher	48% (290)	36% (215)
Percentage (Number) of Students with a Grade of F	25% (148)	42% (250)
Percentage (Number) of Students who Withdrew	0% (2)	8% (46)

who attended the MLC during fall 2014 achieved a grade of B or higher, and a smaller percentage obtained a grade of F when matched against a similar control group. Almost no visitors withdrew from their classes (see Table 4).

Methodology notes

We chose weighted cell matching over propensity scoring because propensity scoring was designed to minimize the costs of medical placebo tests on control groups, whereas we generally have "free" post hoc data. In addition, propensity scoring values the distance from the measured variable, while we were comfortable matching students with about the same cumulative GPA and earned credits. In addition, several of our variables required exact matches; for example, students must be taking the exact same course. Also, weighted cell matching allows us to use all possible control subjects who match the cell characteristics of treatment subjects. No useable data is thrown away. There are three steps with weighted cell matching. The first is to describe the *cell* of each potential treatment and control subject in terms of a set of characteristics. The second is to find the numbers of subjects in each cell and the number of control subjects with matching cell characteristics. The third is to determine the weight of each control individual such that the virtual number of control individuals in each cell is proportionate to the number of individuals in the matching treatment cell. When a treatment cell has no individuals in the control group with matching cell characteristics, those in the treatment cell may not be included in the analysis. For that reason, we tried three different sets of characteristics for this analysis. The more particular the set of characteristics, the more likely we would find treatment cells with no matching control subjects. In all three cases, however, students were matched on GPA and credits earned as shown in Table 5.

The three cell definitions were (including matching on GPA bracket and credits earned bracket): (1) the control student had to be in the same course section as the lab-visiting student, (2) the control student had to have the same course and the same faculty member as the lab-visiting student, and (3)

Table 5 GPA brackets and the corresponding credits earned.

GPA Bracket	Credits Earned Brackets
Null GPA	Null
< 2.00	0
> or = 2.00 and < 2.5	> 0 and < 6
> or = 2.50 and < 3.00	> or = 6 and < 12
> or = 3.00 and < 3.50	> or = 12 and < 30
> or = 3.5	> or = 30

the control student only had to have the same course as the lab-visiting student. In all three cases the mean grade of the lab-visiting students was significantly higher than that of the control students. Testing was done with student's *t* test (two-tailed, 95% confidence). Although the strictest test, matching against only those in the same section of the course with the same level of cumulative GPA and the same level of earned credits up to fall 2014, reduced the number of treatment grades to 599, the result was still statistically significant, see Table 3.

Scheduling strategies

Challenges

Many tutoring centers across the country offer comprehensive services such as diagnostics testing, tutorial teaching, and drop-in centers (Gill & O'Donoghue, 2007); some offer continued support through assessment for learning and individual learning plans (Gallimore & Stewart, 2014). Our MLC was originally designed for drop-in only, with scheduled review sessions for final exams. Given the limited resources, it became impractical to handle the volume of students for the entire 13 hours of operation. Thus, a hybrid model seemed more effective to respond to this issue. By hybrid, we mean that one-to-one and small group tutoring should take place concurrently. One-to-one tutoring gives more individualized instructions to students in remedial mathematics in the process of mastering algebraic skills. For courses such as statistics, precalculus and also calculus, we decided to implement *guaranteed hours*. The guaranteed hours promise the students the presence of a tutor to conduct small group tutoring for credit level courses at a particular day and time of the week for the entire semester. The hours vary from four hours a week to eight hours a week, depending on the tutors' schedule and area of expertise. Some math courses require the usage of software programs, and the center started offering specific hours for students seeking help in using them. With the use of SEMS, we were finally able to determine the peak times for our center. We decided to reduce the number of tutors at the MLC during periods where demand is very low, thereby allowing better repurposing of resources at peak periods. Next we describe our peak time.

Peak times

Monday through Thursday mornings are extremely busy as can be seen in Figure 2 (MLC visits by time and visits by day) and Figure 3 (combined day and time in a unique visual formatting). For fall I, 2014, as an example, we logged in via SEMS almost 1,000 visits by students for math tutoring just before our 12 o'clock lunch; the weekend, Fridays, and weekday afternoons have significantly fewer student visits. As a total, our MLC team has supported around 3,000 visits by students over this period. Matching students' related math class time and the time of each lab visit revealed a preference to visit the lab the day after the class (see Figure 4).

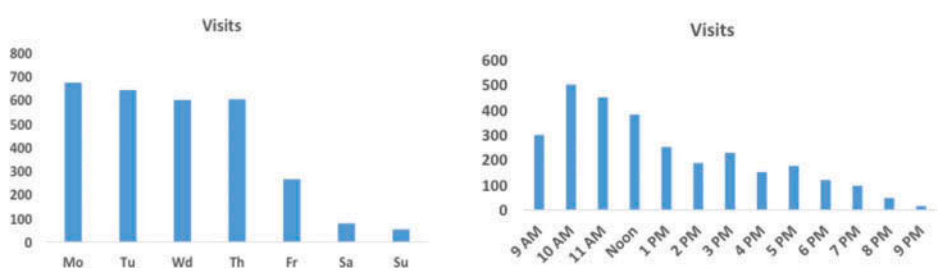

Figure 2 MLC number of visits by the day of the week, and by the time of the day during the fall of 2014.

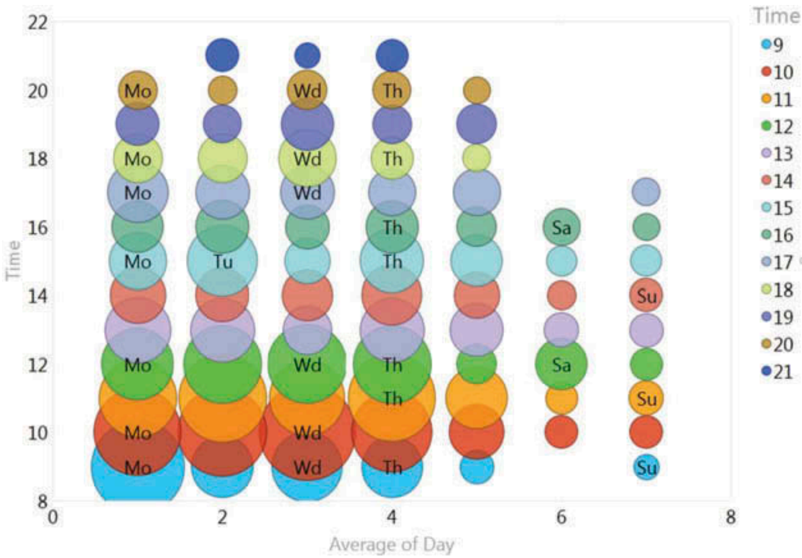

Figure 3 MLC average of day, time, and visits by weekday and time for fall of 2014.

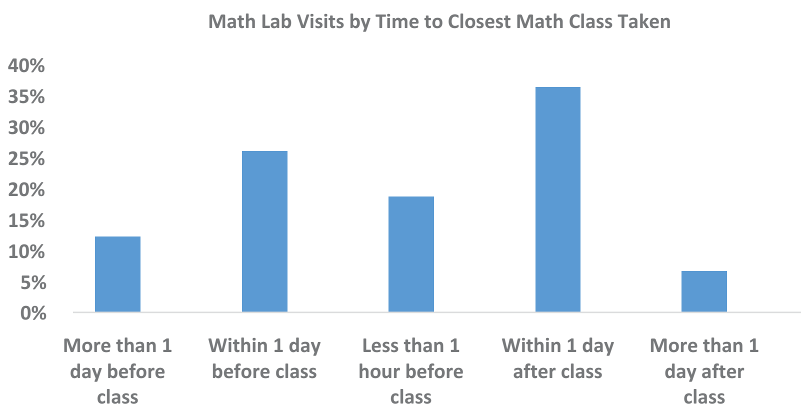

Figure 4 Number of visits matched with class time for fall of 2014.

A multidimensional approach to help students

Because students' learning experiences might impact their decision to drop-out of college (Kuh, Gonyea et al., 2005), we realized that we needed to restructure tutoring services to provide students with *different skills* in our MLC that may not typically be reinforced at other such labs: academic, personal, and study skills. By personal we mean that interaction with tutors and peer tutors should help in the social aspect of their educational experience. We need to also understand what motivates students to attend tutoring to be able to engage them and help them pass their mathematics courses. Students who are academically challenged fear showing a lack of knowledge (MacGillivray, 2009) argued for the role of tutoring centers in making students improve their confidence and comfort. There is a strong link between student support centers and affecting attitudes towards mathematics (Patel & Little, 2006). This dimension is crucial for tutors to understand and value their role in peer mentoring given the potential positive impact beyond simply sharpening students' math skills.

We still need to find better ways to motivate students to attend tutoring. According to Matthews et al. (2013), some areas have become evident where further research would be desirable, namely: "reasons why students do not avail themselves of the support available and mechanisms that could be employed to increase engagement" (p. 13) and "identification of the barriers to recognizing that support is needed and accessing it before it is too late" (Matthews et al., 2013, p. 13). We have anecdotal evidence that students do not avail themselves to attend tutoring either because of their work schedule or because they did not know about the center. A majority of students attending LaGuardia work outside of the college, often full-time. Many of our students are in fact workers who study rather than students who work (LaGuardia Community College, The City University of New York, 2014).

In any given semester over the past five years, over 7,000 students have been enrolled in mathematics courses, and it is difficult to devise a pre- and postassessment to refer them to tutoring. Direct and proactive input from faculty members referring students to the center is imperative given the large student math enrollment and need. To perhaps help decrease the lack of student engagement, one can give extra-credit for documented tutoring and/or give a make-up exam for underperforming students after attending five hours (for example) of tutoring in the MLC; evidence of attended tutoring is required in order to be allowed to retake a test. Faculty can also give a diagnostic test early in the semester to help identify the at-risk students and appropriately refer them to the MLC for additional support before students fall too far behind.

The department is currently moving towards acceleration in developmental mathematics, and we have been designing new accelerated courses (elementary algebra combined with the first college algebra course, or algebra combined with statistics). Faculty involved with the MLC are working with the design team to help weaker students succeed in those newly-designed courses. One proposal is to require students who have lower scores on the algebra placement test to attend tutoring on a particular day with a tutor. The instructor will provide the student a worksheet and he/she must complete a certain number of worksheets every week as determined by his/her instructor.

Additionally, course syllabi must include information about the mathematics tutoring center. We have also imbedded math tutoring information into all of our major-specific advisement guidebooks. The college has invested in many initiatives to improve students' rates of success and services provided by the MLC; we're working to streamline and integrate our services with other relevant initiatives.

Another promising program and tutoring model

LaGuardia has also thoughtfully invested in numerous tutoring-related initiatives over the past decade to continually improve pass rates (chiefly in remedial math). The college supports students with a variety of specialized tutoring centers and programs designed to address a wide array of academic needs and endeavors. One prominent example of a boutique program that has demonstrated impressive outcomes with remediation and graduation is CUNY's Accelerated Study in Associated Programs (ASAP), which was directed by one of the authors for over three-years at LaGuardia. ASAP's explicit goal is to graduate a minimum of 50% of their students within three-years—a lofty endeavor given the less than impressive national completion rates at urban community colleges. The program's defining features include intrusive advisement grounded in a caseload model (led by full-time program dedicated advisers), ample tutoring (offered by part-time staff), linked ASAP designated courses (including a first-year seminar), and several financial incentives (including free text books, school travel funds in the form of Metrocards, and tuition where qualified).

ASAP quickly garnered nationwide attention for its outstanding results that have been meticulously evaluated within CUNY, as well as by MDRC as part of a five-year random-assignment study, for example. In a recent MDRC policy brief, Scrivener and Weiss (2013) stated that the ASAP effects seem to be "unparalleled in large-scale experimental evaluations of programs in higher education" (p. 2). For contextual purposes, CUNY ASAP has supported over 6,300 students since 2007 (seven cohorts at the time of this writing), with over two-thirds of the students receiving some financial-aid

Table 6 Fall 2011 laguardia ASAP tutoring.

	Cohort 2	Cohort 3	Cohort 4	Cohort 5	Total
Number of ASAP students mandated for tutoring	11	20	36	90	157
Number of mandated students who met the minimum tutoring requirement as per LaGuardia's tutoring policy	9	15	28	81	133
Percentage of mandated students who met the minimum tutoring requirement	81.8	75	77.8	90.0	81.15
Total number of hours logged for students mandated for tutoring fall 2011 (Sept.–Dec.)	273	237	608.5	941	2059.5

Note. Cohort 1 was not included because the students were remedial free before they started the program, and they were not mandated to attend tutoring. Cohorts 2 through 5, that were largely comprised of students who started college with remedial needs, were required to attend mandatory tutoring.

(in the form of Pell grants), roughly three-quarters were identified as minorities (specifically either Black and/or Hispanic), and approximately 58% of the students are women.

ASAP's results have been certainly impressive. Based on preliminary data after three-years (from 2008–2010) of program support: 47% of ASAP students with developmental needs and 56% of fully-skills-proficient ASAP students have graduated versus 19% of non-ASAP students based on a comparable group) with developmental needs and 28% of fully-skills-proficient non-ASAP students (LaGuardia ASAP's outcomes were on par with the CUNY-wide results). ASAP data is detailed in the following marketing brief (from March 20, 2014). See: www.cuny.edu/academics/programs/notable/asap/about/evaluation/ASAPkeyeval032014.pdf

Our college prioritized efforts of ASAP and two other CUNY programs vis-à-vis a new joint tutoring facility. A snapshot of LaGuardia ASAP tutoring from the fall 2011 semester (see Table 6) revealed that 81.15% (n = 133 of the 155 who were mandated for tutoring across all cohorts) met the minimum tutoring requirement (of two hours per week for students enrolled for every developmental need and/or those who failed any course in the previous semester and need to repeat), logging in over 2,000 hours of tutoring. (Fall 2011 was the last full semester that one of the co-authors was the ASAP director.)

Importantly, ASAP students are programmatically required to register for their remedial needs immediately, without delay. The LaGuardia ASAP team created a number of firm accountability policies (with effective sanctions) to help support student success while they concurrently restructured the new tutoring center with well-trained and supervised tutors. ASAP tutoring services are monitored tirelessly to ensure the highest quality of service and support. ASAP students provided their adviser with signed evidence of the quota-based tutoring in order to obtain their Metrocard privilege. Although students had a few of other responsibilities, LaGuardia ASAP attained, on average, an over 80% compliance rate. We focused on changing our culture of distribution to, instead, earning the resources. Students were also mandated to provide faculty feedback based on our early alert system and/or a progress form we created.

LaGuardia's faculty and the ASAP staff were instrumental in students' achievements. On average, over 70% of our faculty continually provided progress updates about our students (in various formats); for fall 2011, we obtained faculty feedback from 80% of ASAP-blocked courses and 61.7% from nonblocked courses. By decreasing the stigma of tutoring through mandated actions, creating a culture grounded in earning program benefits, developing relationships with faculty and chairs, having the support from college leaders, and having a dedicated and competent team of advisors, we were able to bolster ASAP tutoring attendance and remediation. In turn, this helped us achieve the ASAP graduation goal. After a five-year evaluation, MDRC researchers concluded that the "ASAP model offers a promising strategy to markedly increase graduation rates."

Future directions and conclusion

Helping to remediate math students will certainly help improve our graduation rates. Although math tutoring is not a panacea for college success, remedial math remains a critical hurdle that most of our students need to overcome. To engage students through support services, the MLC offers the opportunity for students to engage with peers and with tutors. To take advantage of faculty expertise, a team of faculty, supported by LaGuardia's Provost and his staff, have worked closely to devise and implement policies and to nurture a culture of cooperation to improve students' experience at the MLC. Remediating math needs clearly remains a major impediment in the achievement of many community college students. An effective math-tutoring lab, supported by institutional leaders and driven by committed and empowered faculty members who are passionate about assessment-based actions and the need to continually improve students pass rates, is a great start for enhancing student achievement.

Technology has helped us better understand the structure of our math-tutoring center. Collecting and carefully reviewing data has allowed us to more efficiently reallocate resources in a way to benefit students. We now have a better understand of the MLC. We continue to collect data to keep improving our services. Data from fall 2014 show that the MLC has a positive effect on students' success when matching a treatment group to a similar control group. MLC visitors achieved higher grades, and almost no withdrawals have been recorded for the sample of students chosen for the study. As we move forward, SEMS will allow us to track MLC visitors throughout their journey at LaGuardia. We plan to create an automatic alert system to notify students who passed their courses with a grade of C or lower to come back to the MLC the next semester if they enroll in another mathematics class.

Our teams' proactive willingness to pilot technology driven tools for both assessment and tracking purposes in order to help the math lab function more effectively with resource allocation and student outcomes has garnered genuine interest from other tutoring labs across the college. Other lab leaders (from varied disciplines) have asked us to provide them with our data and strategies for how we improved our tutoring support services. Such sharing and interactions across other departments has led to a more collaborative environment. And it is the beginning of a more coherent and unified approach to LaGuardia's tutoring as we work off of the same technology platform towards continuous improvement grounded in the use of data. In addition, our Provost's Office has committed to a significant expansion of funds for this fiscal year to demonstrate support not just for our positive math lab outcomes, but principally for our overall efforts and needs.

Several metrics can help one evaluate the impact of math tutoring services. Attendance and pass rates are two key indicators of math lab effectiveness. Given ASAP's successful tutoring support model, we believe that a similar approach can be applied and expanded for tutoring at the MLC. To improve services offered, the MLC plans on holding workshops focused on mathematics study skills as we more directly address student engagement and self-efficacy skills. The math department and the MLC faculty are considering mandating tutoring for specific groups of students—as ASAP has effectively done and bolstered remediation and retention outcomes. As faculty, our affinity to other faculty is a more natural connection and understanding. We are, thus, also working towards connecting with other math department faculty—seeking their support in terms of both time that they can possibly devote to tutoring and also in providing us with appropriate referrals and feedback to improve student success.

At LaGuardia, we strive to provide a multidimensional approach to students' learning experiences in order to accomplish our college's mission "to educate and graduate one of the most diverse student populations in the country" (LaGuardia Community College, The City University of New York, n.d., para. 2). Faculty, administrators and tutors work cooperatively to improve the chances of achievement for all of our students. There is a measurable benefit to support the MLC; expanded funding is crucial for us to be able to more consistently focus our efforts where it is most likely to yield positive results in improving student success. We still have a long road ahead before we reap more widespread impact of our collaborative work with respect to student math tutoring, remediation, and graduation. We will continue to collect more data and implement accordingly in order to move the rigid needle of community college success.

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References

Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. In A. C. Beuschel & A. Venezia (Eds.), Special issue: Policies and practices to improve student preparation and success, *New Directions For Community Colleges, 145* (pp. 11–30). San Francisco, CA: Jossey-Bass.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, *44*(9), 1,175–1,184.

Bellafante, G. (2014, October 3). Community college students face a very long road to graduation. *The New York Times*. Retrieved from http://www.nytimes.com/2014/10/05/nyregion/community-college-students-face-a-very-long-road-to-graduation.html?_r=0

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology*, *25*(5), 441–448.

Bhaird, C., Fitzmaurice, O., Fhloinn, E., & O'Sullivan, C. (2013). Student non-engagement with mathematics learning supports. *Teaching Mathematics and its Applications*, *32*(4), 191– 205.

Carroll, C. (2011). *Evaluation of the University of Limerick Mathematics Learning* Centre (Bachelor's thesis). University of Limerick, Ireland. Retrieved from http://www.mathcentre.ac.uk/resources/uploaded/evalmaths-l- centrelimerick carrollgillpdf.pdf

Carter, E., & Wetzel, K. (2010). The Mathematics Outreach Center: Saving dreams. *Community College Journal of Research and Practice*, *34*(11), 901–903.

Croft, T. (2008, December). *Towards a culture of data collection and analysis in mathematics support centres*. Paper presented at the 3rd Irish Workshop on Mathematics Learning and Support Centres: "Is Mathematics Support Worthwhile?" National University of Ireland, Maynooth, Ireland.

Dowling, D., & Nolan, B. (2006, September). *Measuring the effectiveness of a math learning support centre—The DCU experience*. Paper presented at the CETL MSOR Conference, Leicestershire, United Kingdom.

Gallimore, M., & Stewart, J. (2014). Increasing the impact of mathematics support on aiding student transition in higher education. *Teaching Mathematics and its Applications*, *33*(2), 98–109.

Gill, O., & O'Donoghue, J. (2007). *Justifying the existence of mathematics learning support: Measuring the effectiveness of a mathematics learning centre*. Retrieved from http://www.mathcentre.ac.uk/resources/uploaded/alm14olivia.pdf

Gore, P. (2006). Academic self-efficacy as a predictor of college outcomes: Two incremental validity studies. *Journal of Career Assessment*, *14*(1), 92–115.

Grehan, M. (2013). *Critical events in students' engagement with mathematics* (Master's thesis). National University of Ireland-Maynooth.

Hall, J. M., & Ponton, M. K. (2005). Mathematics self-efficacy of college freshmen. *Journal of Developmental Education*, *28*(3), 26–30.

Hammerman, N., & Goldberg, R. (2003). Strategies for developmental mathematics at the college level. *Mathematics and Computer Education*, *37*(1), 79–95.

Hourigan, M., & O'Donoghue, J. (2007). Mathematical under-preparedness: The influence of the pre-tertiary mathematics experience on students' ability to make a successful transition to tertiary level mathematics courses in Ireland. *International Journal of Mathematical Education in Science and Technology*, *38*(4), 461–476.

Komarraju, M., & Nadler, D. (2013). Self-efficacy and academic achievement: Why do implicit beliefs, goals, and effort regulation matter? *Learning and Individual Differences*, *25*, 67– 72.

Kuh, G. D., Gonyea, R. M., & Williams, J. M. (2005). What students expect from college and what they get. In T. Miller, B. Bender, J. Schuh, & Associates (Eds.), *Promoting reasonable expectations: Aligning student and institutional thinking about the college experience* (pp. 34–64). San Francisco, CA: Jossey-Bass/National Association of Student Personnel Administrators.

Kuh, G. D., Kinzie, J., Schuh, J. H., Whitt, E. J., & Associates (2005). *Student success in college: Creating conditions that matter*. San Francisco, CA: Jossey-Bass.

LaGuardia Community College, The City University of New York. (n.d.). *Mission statement*. Retrieved from http://www.lagcc.cuny.edu/About/Mission-Statement/

LaGuardia Community College, The City University of New York. (2012). *Comprehensive institutional self-study for the Middle States Association of Colleges and Schools*. Retrieved from www.laguardia.cuny.edu/uploadedFiles/T2/middlestates/PDFs/Self- Study-Appendixes–.pdf

LaGuardia Community College, The City University of New York. (2014). *2014 institutional profile*. Retrieved from www.lagcc.cuny.edu/IR/IR-facts/

Lawson, D., Halpin, M., & Croft, T. (2001). After the diagnostic test: What next? *MSOR Connections*, *1*(3), 19–23.

MacGillivray, H. (2009). Learning support and students studying mathematics and statistics. *International Journal of Mathematical Education in Science and Technology*, *40*(4), 455– 472.

MacGillivray, H., & Croft, T. (2011). Understanding evaluation of learning support in mathematics and statistics. *International Journal of Mathematical Education in Science and Technology*, *42*(2), 189–212.

Matthews, J., Croft, T., Lawson, D., & Waller, D. (2013). Evaluation of mathematics support centres: A literature review. *Teaching Mathematics and its Applications*, *12*, 173–190.

Merisotis, J., & Phipps, R. (2000). Remedial education in colleges and universities: What's really going on? *The Review of Higher Education*, *24*(1), 67–85.

Merseth, K. K. (2011). Update: Report on innovations in developmental mathematics: Moving mathematical graveyards. *Journal of Developmental Education*, *34*(3), 32–39.

National Center for Education Statistics. (2014). *Institutional retention and graduation rates for undergraduate students* (Chapter 4). Washington, DC: Institute for Education Sciences, U.S. Department of Education. Retrieved from http://nces.ed.gov/programs/coe/pdf/Indicator_CVA/COE_CVA_2013_05.pdf

Parsons, S. (2005). Success in engineering mathematics through mathematics support and changes to engineering math lectures at Harper Adams. *MSOR Connections*, *5*(1), 1–4.

Patel, C., & Little, J. (2006). Measuring math study support. *Teaching Mathematics and its Applications*, *25*(3), 131–138.

Pell, G., & Croft, T. (2008). Mathematics support: Support for all? *Teaching Mathematics and its Applications*, *27*(4), 167–173.

Perin, D. (2004). Remediation beyond developmental education: The use of learning assistance centers to increase academic preparedness in community colleges. *Community College Journal of Research and Practice*, *28*(7), 559–582.

Perkin, G., Croft, T., & Lawson, D. (2013). The extent of mathematics learning support in UK higher education: The 2012 survey. *Teaching Mathematics and its Applications*, *32*(4), 165–172.

Peterson, P. E., Woessmann, L., Hanuskek, E., & Lastra-Anadón, C. X. (2011). Are U.S. students ready to compete? *Education Next*. Retrieved from http://educationnext.org/files/ednext_20114_research_peterson.pdf

Rattan, A., Good, C., & Dweck, C. S. (2012). "It's ok: Not everyone can be good at math:" Instructors with an entity theory comfort (and demotivate) students. *Journal of Experimental Social Psychology*, *48*(3), 731–737.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist*, *26*(3– 4), 207–231.

Schunk, D. H., & Gunn, T. (1985). Modeled importance of task strategies and achievement beliefs: Effect on self-efficacy and skill development. *The Journal of Early Adolescence*, *5*(2), 247–258.

Scrivener, S., & Weiss, M. J. (2013, December). *More graduates: Two-year results from an evaluation of Accelerated Study in Associate Programs (ASAP) for developmental education students* (Policy brief). New York, NY: MDRC. Retrieved from www.mdrc.org/sites/default/files/More_Graduates.pdf

Stigler, J., Givvin, K., & Thompson, B. (2010). What community college developmental mathematics students understand about mathematics. *MathAMATYC Educator*, *1*(3), 4–16.

Symonds, R. J., Lawson, D. A., & Robinson, C. L. (2007). The effectiveness of support for students with non-traditional mathematics backgrounds. *Teaching Mathematics and its Applications*, *26*(3), 134–144.