## Abstract Title Page

**Title:**

Mainstreaming Remedial Mathematics Students in Introductory Statistics: Results Using a Randomized Controlled Trial

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## Abstract Body

### Problem / Background / Context:

Nationally, about 60% of new college freshmen are assessed as needing remedial (developmental) courses (Grubb et al., 2011), with students having the greatest difficulty with mathematics remediation. Less than 50% of students assigned to remediation complete the whole sequence, and students designated as remedial are less likely to complete college (Bailey & Cho, 2010; Bonham & Boylan, 2012). The completion blockages associated with remedial courses may be due to the additional time, expense, and/or stigma involved with having to take these courses. Remedial courses, particularly in mathematics, constitute the largest specific blockage to students graduating with a college degree. It has been stated that: "providing effective 'remedial' education would do more to alleviate our most serious social and economic problems than almost any other action we could take" (Astin, 2000, p. 130).

At The City University of New York (CUNY), 69% of the 18,434 fall 2012 new community college freshmen were assessed as needing remediation in mathematics, and only 38% of students who started the highest-level mathematics remedial course (elementary algebra) in fall 2012 passed that course. At CUNY, as is the case nationally, the need to pass remedial mathematics delays or prevents more students from graduating than any other specific cause.

One approach for addressing the large proportion of students for whom remedial mathematics is a block to a college degree is simply to place them in college-level courses which, it is claimed, many of them can pass. However, quasi-experimental analyses of the success of remedial students taking college-level courses have yielded conflicting results (Calcagno & Long, 2008; Scott-Clayton & Rodriguez, 2012).

A related approach is to mainstream many such students, placing them in a college-level, credit-bearing mathematics course but with extra support. Two examples of this approach are the Accelerated Learning Program (ALP) for remedial writing students at the Community College of Baltimore County and a similar program with remedial mathematics students at Austin Peay State University. However, although both programs have shown encouraging results, research involving controlled experiments has not yet been conducted with either (Boatman, 2012; Jenkins, Speroni, Belfield, Jaggars, & Edgecombe, 2010).

### Purpose / Objective / Research Question / Focus of Research:

The present research used a randomized controlled trial to determine whether students, assessed by their community colleges as needing an elementary algebra (remedial) mathematics course, could instead succeed at least as well in a college-level, credit-bearing introductory statistics course with extra support (a weekly workshop).

**Improvement Initiative / Intervention / Program / Practice:**

We randomly assigned one-third of the participants to one of three types of courses: traditional elementary algebra; traditional elementary algebra plus a weekly workshop; or college-level, credit-bearing, introductory statistics plus a weekly workshop. The statistics course was a standard introductory statistics course. The weekly workshops were each two hours in length. Students assigned to elementary algebra with workshops or statistics with workshops were required to attend the workshops, which were facilitated by a trained, supervised, advanced undergraduate student (the workshop leader) who also attended each of the statistics course sessions attended by the students in his/her workshop. During the workshops the students, individually and in groups, reviewed and discussed what they had learned so far, including the specific topics that they were finding difficult.

**Setting:**

The experiment was conducted at three urban CUNY community colleges: Borough of Manhattan Community College, Hostos Community College, and LaGuardia Community College. The number of Fall 2013 first-time freshmen at each of these colleges was 5403, 1237, and 3008, and the percentages of those students assessed as needing remediation in mathematics was 67%, 74%, and 65%, respectively. Most of the students at these three colleges are from underrepresented groups; the percentage of White students at each of these colleges is 12%, 3%, and 16%, respectively. Across all CUNY community colleges, 40% of students were born outside of the United States, 45% have a first language other than English, 51% are the first in their families to attend college, and 57% are Pell recipients.

**Population / Participants / Subjects:**

There were 721 participants combined across the three colleges. Their mean age was 21.1 years (SD = 5.5), and 54% of them were female. At the time of their recruitment into the experiment, participants were not intending to major in a subject requiring college algebra.

**Research Design**

Just prior to the start of the fall 2013 semester, at each college, research assistants spoke or emailed with students whose mathematics placement was elementary algebra, a remedial course, describing the experiment to these students. Students indicated their desire to participate by signing a consent form. They were then randomly assigned to one of the three course types (Group 1: traditional elementary algebra, Group 2: traditional elementary algebra plus a weekly workshop, or Group 3: college-level, credit-bearing, introductory statistics plus a weekly workshop). To control for instructor effects (Weiss, 2010), a full-time faculty member taught one section of each of the three types of courses, with a total of four sections of each type (and thus four participating full-time faculty members) at each of the three colleges.

**Data Collection and Analysis:**

We collected the final grades for each participant in the experiment, as well as collecting their high school records and assessment test scores.

**Findings / Outcomes:**

Table 1 shows the overall pass rates of the students who started each of the three types of course. The pass rate for Group 1 (38%), traditional remedial elementary algebra, is identical to the overall pass rate for the same course the preceding year (fall 2012). The pass rate for Group 3 (56%), college-level introductory statistics with a workshop, is less than the overall pass rate for introductory statistics at these colleges in the preceding year (69%).

Although adding the workshop to the traditional remedial course resulted in a higher pass rate for Group 2 as compared to Group 1 (from 38% to 45% of the students who started the course), this difference does not reach statistical significance with these sample sizes ($X^2[1] = 2.279$, $p = .131$). However, the greater pass rate of the students in Group 3 (statistics with a weekly workshop) as compared to Group 2 (56 vs. 45%) is significant ($X^2[1] = 5.658$, $p = .017$).

In order to assess which remedial mathematics students might be most likely to succeed in college-level introductory statistics, we examined the relationships between passing statistics and various student characteristics. First, within Group 3, of the 217 students who had COMPASS (placement) test scores, these students' final grades are positively correlated with their scores on the two components of the COMPASS (component 1 [arithmetic]: $r[215] = 0.135$, $p < .05$; component 2 [algebra]: $r[215] = 0.292$, $p < .01$). Examined in another way, of the 105 Group 3 students with a score of greater than or equal to 43 on Compass component 1 (arithmetic) and a score of greater than or equal to 19 on Compass component 2 (algebra), 71 (68%) passed statistics (almost identical to the 69% pass rate in introductory statistics at these three colleges in fall 2012). Group 3's students' final grades are also positively correlated with these students' overall high school grade point averages ($r[167] = 0.231$, $p < .01$), as well as with their high school grade point averages for mathematics ($r[114] = 0.260$, $p < .01$). Further, students' final grades in Group 3 are negatively correlated with the date at which the student agreed to participate in the experiment and registered for the class ($r[244] = -0.152$, $p < .05$). Additional analyses will assess the relative weights of these variables and others in predicting which students are likely to pass statistics.

**Conclusions:**

This experiment treated remedial mathematics students differently in three ways: by placing them into a college-level instead of a remedial course, by placing them into introductory statistics instead of the traditional elementary algebra course, and by the addition of a weekly workshop for extra support.

Adding a weekly workshop to a traditional remedial elementary algebra course seemed to improve students' performance above the usual (low) pass rate. However, students in college-

level introductory statistics with a weekly workshop passed at an even higher rate. Students with relatively high placement test scores and grades in high school, and students who registered for their classes relatively early, were particularly likely to pass this statistics course.

Due to ethical considerations and CUNY remedial mathematics policies, we could not place remedial mathematics students into introductory statistics without any additional support, and thus could not directly assess the role of the weekly workshop in the relatively high pass rate of the students randomly assigned to introductory statistics (Group 3). However, the results comparing Groups 1 and 2 (elementary algebra without and with the workshop, respectively) suggest that the weekly workshops were a useful factor in the relatively high pass rate of Group 3 (statistics).

Given that the course content for Groups 1 and 2 (elementary algebra) was different from that for Group 3 (statistics), it is also not possible to assess whether the students in Groups 1 and 2 learned more or less than the students in Group 3. However, what can be stated definitively is that, with instructors who were experienced at teaching both elementary algebra and statistics, more students passed statistics than passed elementary algebra. Further, it can be argued that, for students who do not need college algebra for their majors, as was the case for the participants in the current experiment, statistics is ultimately a more useful quantitative course than is college algebra (see http://www.carnegiefoundation.org/statway).

In conclusion, many remedial mathematics students can be successfully placed into college-level statistics with extra support. Such placement will help these students progress more quickly to a degree, incurring less personal, college, and state expense, and may also decrease any stigma that these students feel in being labeled remedial. Mainstreaming some remedial mathematics students in college-level statistics with extra support should therefore result in higher graduation rates.

## Appendices

### Appendix A. References


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**Appendix B. Tables and Figures**

Table 1
Pass Rates in the Three Course Types

| Group 1 | | Group 2 | | Group 3 | |
|---|---|---|---|---|---|
| Number of Students | % Passing | Number of Students | % Passing | Number of Students | % Passing |
| 245 | 38.0% | 230 | 44.8% | 246 | 55.7% |

*Notes*. Group 1 consisted of traditional remedial elementary algebra, Group 2 consisted of traditional remedial elementary algebra plus a weekly workshop, and Group 3 consisted of a college-level, credit-bearing, introductory statistics course with a weekly workshop (Group 1 compared to Group 2: $X^2[1] = 2.279$, $p = .131$; Group 2 compared to Group 3: $X^2[1] = 5.658$, $p = .017$). "Number of Students" indicates the number of students who started each of these three types of courses, and "% Passing" indicates the percentage of the starting students who received a grade of pass (Groups 1 and 2) or a grade of D or above (Group 3).