Student Mathematics Performance in Year One Implementation of

Teach to One: Math

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TEACHERS COLLEGE COLUMBIA UNIVERSITY

Douglas Ready & Ellen Meier
Dawn Horton, Caron Mineo, & Jessica Yusaitis Pike
with support from
Tsan-Jui Cheng, Kenneth Graves, Elisabeth Kim, & Rita Sanchez

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Contact:
Dr. Ellen Meier
Co-Director, Center for Technology and School Change
Teachers College, Columbia University
525 West 120th Street, Russell Hall 501A
New York, NY 10027
ebm15@tc.columbia.edu
(212) 678-3829

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Executive Summary

This report examines mathematics test data from the first year of implementation (2012-13) of the *Teach to One: Math* (*TtO*) approach in seven urban middle schools in Chicago, New York City, and Washington D.C. Researchers addressed the question: How did *TtO* students' growth on the Measures of Academic Progress (MAP) mathematics assessment compare with national norms?

To answer this question, the researchers analyzed student performance on the MAP test, an established instrument developed by the Northwest Evaluation Association (NWEA). The researchers then compared these results to the national norms published by NWEA (2011). Please note that these analyses cannot attribute *TtO* student results to the *TtO* model: the data available did not permit the use of an experimental design, which would be necessary to establish a link between the implementation of the program and the student test results. While the *TtO* results are promising, its performance beyond one year should be analyzed using an experimental design, in order to remove unmeasured differences between *TtO* students and schools with an appropriate comparison sample.

Key findings from the first year of implementation include:

- *TtO* students started the 2012-13 academic year significantly below national norms
- The average gains of *TtO* students in sixth, seventh, and eighth grades surpassed those made by students nationally
- The average gains of *TtO* students in most demographic subgroups outperformed national norms
- *TtO* students who started with the weakest mathematics skills made the greatest gains
- Student gains were uneven across *TtO* schools, and within schools, grade level averages varied considerably

These findings should be interpreted in light of three considerations. First, the data provided by New Classrooms, the developers of *TtO*, do not allow for experimental approaches. Therefore, the findings in this report simply describe test score differences between *TtO* students and national norms and do not establish causality. Further, *TtO* students are socially and academically less advantaged compared to the student samples on which the national MAP norms are based. As such, the test score differences between *TtO* students and demographically and academically similar students would likely be larger. Third, a one-year intervention is too short a time period to draw substantive conclusions about student performance.

Overall, the results from the first year of implementation show positive gains for students in the *TtO* program. Given that this was a first-year initiative implemented with an underserved population, the early data are encouraging. Although the results cannot be attributed to the *TtO* approach without further study, the model deserves continued exploration to understand what factors might be influencing the performance of *TtO* students.

Introduction

Given the evolving demands of the 21st century, it is imperative for educators to create new approaches to schooling in order to adapt to a more diverse population of learners and foster high expectations for all students. The challenges have never been more critical and the opportunities never more far-ranging.

One of the most pressing *challenges* is narrowing the gap between high-achieving and low-achieving students—particularly in critical areas of need such as middle school mathematics, where U.S. children lag behind some of their peers in other countries (OECD, 2010). At the same time, the *opportunities* for education are sweeping. Burbules and Callister (2000) suggest "...we are in the midst of a process of rethinking the meaning and ends of education, and not just trying to find ways to do what we used to do, better, faster, or more economically" (p. 17). As we rethink pedagogy, classroom spaces, and technology use, our understanding of the learning process continues to evolve.

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Recently, *personalized learning* has received increasing attention for its potential to address the individual needs of each student. New Classrooms, a blended learning nonprofit founded in 2011, has developed one approach to personalized learning, *Teach to One: Math* (*TtO*). The *TtO* model has generated interest as an innovative approach to teaching mathematics. Implementation of the *TtO* model began in the 2012-13 school year in eight schools in Chicago, New York City, and Washington, D.C.

This report analyzes the results of a mathematics test administered fall and spring of the first year of *TtO* implementation across seven of the eight participating schools.[1] A brief review of literature relevant to school innovation and technology precedes the results.

[1] One school was excluded from the study because the impact of Hurricane Sandy interrupted its implementation of *TtO* for an extended period of time.

Research Context

A growing body of literature identifies key issues related to the emergence of technology-supported approaches to personalized learning. Likewise, our ideas for new educational environments, our standards for gauging performance, and our understanding of what constitutes effective teaching have all shifted over the last few decades (Darling-Hammond, Bransford, LePage, & Hammerness, 2007; Resnick, 2010). These topics are briefly explored below.

Personalized Learning

Personalized learning can be defined as a student-centered instructional approach that involves technology and pedagogical considerations focused on the learning needs of each student (Dabbagh & Kitsantas, 2012, p. 4). Personalized learning is generally acknowledged as an umbrella concept; the term is often used alongside "individualized instruction" and "differentiated learning" to describe the multiple ways in which a student's unique educational needs can be addressed in the classroom (Keefe & Jenkins, 2008).

Key elements of personalized instruction may include:

- A focus on student mastery of content as a critical component (Jenkins, 1998)
- Assessment of student progress, and instruction tied to that assessment (with technology, this often involves algorithms built into the software or program) (Capuano, Gaeta, Marengo, Miranda, Orciuoli & Ritrovato, 2009)
- A cycle of assessing students and providing responsive instruction (Chung, Delacruz, Dionne, Baker, Lee & Osmundson, 2007; Herd, 1971)
- Student interests that direct the focus of study (Dabbagh & Kitsantas, 2012)
- Interactive learning environments that respond to student needs or interests (Jenkins & Keefe, 2002)
- Flexible pacing and scheduling (Keefe & Jenkins, 2002; Casteel & Johnson, 1989)
- Consideration of students' learning styles in selecting assignments or methods of instruction (Worsley, 2003; Jenkins, 1998)
- The expectation that students will master key understandings (Horn & Staker, 2011)

Educators are always looking for innovative and meaningful ways to put students at the center of the learning process. These elements of personalized learning open up new ways of thinking about educational options, including the spaces and resources used for learning.

Environment and Tools for Learning

Advances in technology offer additional opportunities to rethink the design of learning spaces beyond traditional classroom organizations. However, the "integration" of technology can just as easily reinforce status quo arrangements. To avoid fitting 21st century learning resources into outdated organizational molds, it is important for educators to recognize both digital and physical provisions as integrated parts of designing meaningful learning experiences for students (Skill & Young, 2002; De Gregori, 2011).

Just as technology influences the way in which learning spaces are changing, technology is used to support different educational visions that drive instruction and curriculum. Decisions about the use of technology reflect choices about pedagogy. Although technology may widen the range of instructional designs, we must be aware of the foundational learning theories that inform and shape our design decisions (Dede, 2008).

There are many ways in which technology can be used in the classroom, making it difficult to determine the overall effectiveness of technology on student achievement (Wenglinsky, 2005). Ross, Morrison, and Lowther (2010) maintain that, "educational technology is not a homogenous 'intervention' but a broad variety of modalities, tools, and strategies for learning. Its effectiveness, therefore, depends on how well it helps teachers and students achieve the desired instructional goals" (p. 19). Looking specifically at technology-enhanced math programs, one recent meta-analysis found that computer-assisted instruction, particularly when implemented as a supplement to classroom teaching, exerted a modest effect when compared to traditional instruction (Cheung & Slavin, 2013).

Middle School Mathematics

There is a consensus regarding the need for improving mathematics instruction in the U.S. The 2013 National Assessment of Educational Progress (NAEP) mathematics assessments reveal that just 42 percent of 4th graders and 36 percent of 8*th* graders are at or above proficiency (NCES, 2013). Researchers have identified the middle school years, in particular, as a period when mathematics achievement starts to plateau (Lee, 2010). Furthermore, when students enter middle school behind grade level in mathematics, it is particularly difficult for them to close the gap in achievement by the time they enter high school (Balfanz & Byrnes, 2006). Compounding these issues, students at a social and academic disadvantage face even greater struggles to meet grade level expectations (Fryer & Levitt, 2004; Sirin, 2005).

The Common Core State Standards (CCSS) have established new expectations for mathematics learning, which were developed using "research-based learning progressions detailing what is known today about how students' mathematical knowledge, skill, and understanding develop over time" (Common Core State Standards Initiative, 2010, p. 4). Implementation of the CCSS requires districts to take new strategic approaches to developing and supporting high-level mathematics curriculum (Kober & Rentner, 2011). As new standards continue to be institutionalized across schools, a commitment to informed teacher practice is required (Ball & Forzani, 2011).

Changing Role of the Teacher

Teachers have a particularly important role to play in these newly designed classrooms as they shift from conveyers of knowledge to facilitators of the knowledge-building process (Ravitz, Becker, & Wong, 2000; Scardamalia & Bereiter, 2006). Such a shift requires deep understanding of students: what they know, and how to engage them (Bransford, Brown, & Cocking, 2000).

To make these shifts, teachers need a working knowledge of new approaches to instruction, available tools and resources, and curriculum aligned to the new Common Core State Standards (Fullan, 2007; Darling-Hammond, et al., 2007). Teachers also need to be actively involved in the process of understanding and implementing innovation, in ways that leverage their knowledge of students and the learning process to help shape the innovation (Cochran-Smith & Lytle, 2009).

Summary

This literature frames the multifaceted context for the *TtO* model. The very nature of schooling may be changing as we shift our expectations for what students should know and what they should be able to do. In the midst of a changing educational landscape, personalized learning—often characterized by a cyclical approach involving instruction and assessment—is described as one means to address students' individual needs. *TtO* has developed its own approach to personalized learning, which includes a reconfiguration of the learning space, an extensive use of technology, and a commitment to mathematics as a high need content area.

Teach to One: Math

New Classrooms describes *Teach to One: Math* as a personalized learning model that aims to supplement teacher-led instruction with targeted strategies to meet individual student needs. The *TtO* program focuses on middle school mathematics (grades 5-8). Students are assessed daily to determine current skill levels, and an algorithm is used to target content delivery. Students are assigned to one of multiple instructional approaches based on assessment results. These approaches include live teacher-led instruction, student collaboration, software, and virtual tutors/instructors.

In using this approach of daily assessment and targeted learning stations, the goal of the *TtO* program is to offer instruction that is continually responsive to the student's current demonstrated abilities. According to *TtO*, the process also provides teachers with real-time information about student performance and frees their time to support individual and collaborative groups of students.

Teach to One: Math has a history within the New York City Department of Education system; the co-founders were instrumental in the development of the city's *School of One* (*SO1*) initiative from Summer 2009 to Spring 2011. According to New Classrooms, the *TtO* model, while different algorithmically, draws on understandings learned through the *SO1* experience. *Teach to One* now includes performance tasks and advisory periods for students, and greater involvement of teachers in the process of supporting students' mathematical development. The *TtO* program also used the Common Core State Standards in the construction of its curriculum.

Early evaluation results of the *SO1* approach demonstrated initial promise for personalized learning with the Summer 2009 and Spring 2010 pilot studies, in which *SO1* was implemented within the context of summer and after-school programs (Center for Children and Technology, 2009; New York City Department of Education, 2010). Results from the first full year of implementation of *SO1* during the 2010-11 school year were inconclusive, yielding mixed results across student groups and highlighting a need for deeper and wider investigations of student impact in future development efforts (Cole, Kemple, Segeritz, 2012).

Data and Measures

We examined data on 2,264 *TtO* students who attended one of seven participating schools in sixth (n=832), seventh (n=819), or eighth grade (n=613) during the 2012-13 academic year.[2] As indicated in Table 1, the demographic backgrounds of these students differed considerably from those of their public school peers nationally. The *TtO* students were far more likely to be black, Hispanic, or Asian, and far less likely to be white. Similarly, nearly all *TtO* students received free/reduced-price lunch, compared to fewer than half of students nationwide. *TtO* students were also over twice as likely to be English Language Learners (ELL) and were somewhat more likely to receive special education services. The schools attended by these students were located exclusively in three large, urban school districts—Chicago, New York City, and Washington, D.C.—that face unique challenges in terms of fiscal constraints and the clientele they serve.

[2] Our analyses only include *TtO* students who attended at least 70% of *TtO* classes during the 2012-13 academic year, completed both the fall and spring MAP mathematics assessments, and spent at least six minutes taking the MAP assessment. Analyses were run without these exclusions, and the differences were negligible.

Table 1. Characteristics of *Teach to One* Students (*n*=2,264) and Public Schools Nationally

Demographic Characteristic	*Teach to One* Students	Nationwide
Race / Ethnicity		
% American Indian / Alaskan Native	0.5	1.2
% Asian / Pacific Islander	15.2	5.2
% Black	38.5	15.8
% Hispanic	32.8	23.9
% White	12.9	51.4
% Multiracial	0.1	2.5
% Free / Reduced Lunch	91.3	48.1
% English Language Learners	22.7	9.8
% Special Education	13.8	12.9

Source: *Teach to One* data provided by New Classrooms Inc.; national data retrieved from National Center for Education Statistics (available at: http://nces.ed.gov/programs/digest/2012menu_tables.asp)

To explore mathematics skills development among these *TtO* students and to compare that development to national norms, we used student-level data on the Measures of Academic Progress (MAP) mathematics assessment, created and managed by the Northwest Evaluation Association (NWEA). The MAP assessments are untimed, computer adaptive tests that draw on thousands of possible questions, depending on each student's ability level.[3] *TtO* students completed the MAP assessment in Fall 2012 and again in Spring 2013, which allowed the researchers to measure student academic growth and not simply student achievement. Because both assessments were administered during the same academic year—rather than during the Spring of two consecutive years, as is often the case with state assessments—we can be confident that our estimates of student learning were not influenced by the considerable time students were not in school during the summer months.

NWEA has released national MAP math assessment norms for all grades for both achievement and achievement gains. We compared mathematics performance among *TtO* students in our sample to these national norms. Unfortunately, NWEA has not released national MAP norms broken down by student subgroups. This represents an important limitation, given that *TtO* students are far from nationally representative (see Table 1 above). Given the differences between *TtO* students and the typical public school student, and the fact that the MAP norms are based on student samples that are more nationally representative, the results presented below can be viewed as conservative estimates of the performance differences between *Teach to One* students and similar students nationally (Xiang & Hauser, 2010).

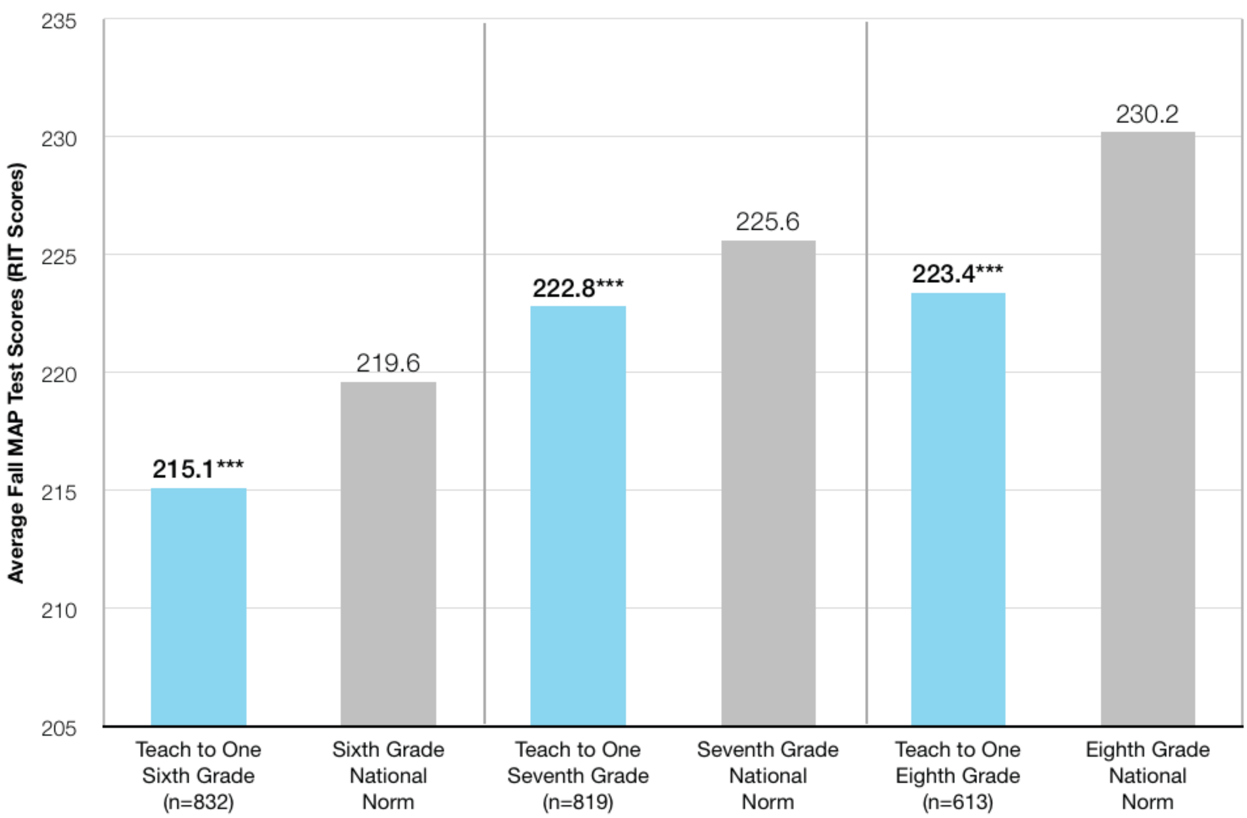
[3] For more information on the MAP assessments, see www.nwea.org.

Findings

As indicated in Figure 1, on average across all grades, *TtO* students started the 2012-13 academic year with mathematics skills that lagged behind national norms. In sixth grade, we found that *TtO* students began the academic year at a statistically significant disadvantage of 4.5 points compared to their peers nationally (ES = -0.29; p<.001).[4] We found a somewhat smaller (but still statistically significant) initial gap of 2.8 points among seventh graders (ES = -17; p<.001), and a much larger deficit of 6.8 points in eighth grade (ES = 0.40; p<.001).[5] These initial differences prior to the start of *TtO* were understandable given the fact that, as noted above, *TtO* students were more likely to come from disadvantaged backgrounds compared to the students on whose skills these national norms were based.

The question, however, and our primary focus in this study, was how much *TtO* students learned while in the program. *TtO* students began the year with weaker math skills. But was their subsequent academic growth generally below, comparable to, or above the gains made by students nationally on the same assessment?

Figure 1. Initial (Fall) MAP Math Test Score Differences between *Teach to One* and National Norms



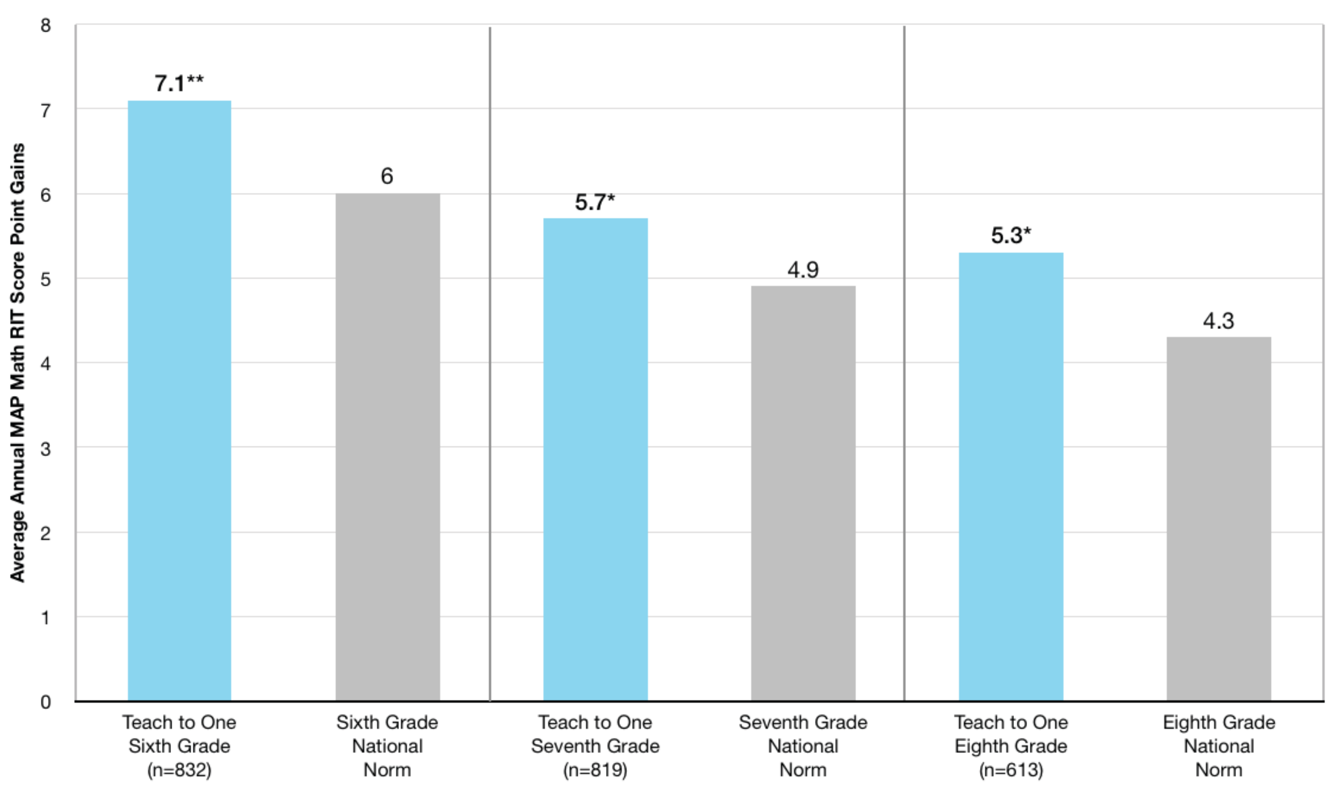
***p<.001; significance tests compare to same-grade national norm. Includes students who spent at least 70% of the academic year in a *Teach to One* classroom, and who spent at least six minutes on both the fall and spring MAP assessments.

[4] An effect size (ES) is the mean difference between two groups divided by the standard deviation of the outcome being explored. A general rule is to interpret ESs smaller than 0.1 SD as trivially small; 0.1-0.3 SDs as small; 0.3-0.5 SDs as moderately large; and ESs larger than 0.5 as large.
[5] As indicated by one-sample t-tests.

Figure 2 indicates that across all grades, the average gains made by *TtO* students surpassed those made by students nationally. In sixth grade, *TtO* students gained 1.1 point more than the national average (ES = 0.18; p<.01). *TtO* seventh graders gained 0.8 point more compared to the national norm (ES = 0.13; p<.05), while *TtO* eighth graders gained one point more on the MAP mathematics assessment than did the typical student nationally (ES = 0.16; p<.05). We can also interpret these findings in terms of one-year expected growth. If we understand the national norms to represent one year of academic growth, *TtO* students achieved almost 1.2 years of growth in each grade, or almost 20% more than the typical student nationally.

We should stress again, however, that *TtO* students are by no means nationally representative. Considering the relatively disadvantaged backgrounds of *TtO* students, the fact that their academic gains were above the national norms is noteworthy.

Figure 2. Average Annual MAP Math Point Gains
Teach to One Students and National Norms



*p<.05; **p<.01; significance tests compare to same-grade national norm. Includes students who spent at least 70% of the academic year in a *Teach to One* classroom, and who spent at least six minutes on both the fall and spring MAP assessments.

It is important to also consider, however, that student gains varied across *TtO* schools. Describing only average gains across all seven *TtO* schools masks these differences. Individual results for each school are presented in Appendices 1-3.[6] They show that within each grade, students attending certain schools enjoyed mathematics gains that were indeed far above the national norms. Gains among students attending other *TtO* schools, however, were below national norms. We again stress that *TtO* students are not representative of same-age students nationally; interpretations of the below-average gains observed in particular schools should take this fact into account. It is important to note that the sample sizes associated with these school-level analyses are quite small. As such, our ability to identify statistically significant differences is somewhat limited.

We also conducted additional analyses for each grade, in which we removed the highest scoring school, School A. In doing so, we found that *TtO* students in the 6th and 7th grades still had gains above the average national gain, but were no longer statistically significant. Moreover, differences in achievement gains between *TtO* 8th graders and the 8th grade national norms moved slightly below the national average, and were no longer significant.

Subgroup Student Performance

Figures 3 and 4 disaggregate student performance by social and academic background in comparison to national norms. Figure 3 indicates that overall, when all three grades were combined, mathematics gains among *TtO* students were roughly 19 percent higher than national norms. Surprisingly, gains even among language minority, special education, and low-income *TtO* students were above the national norms, which were calculated using all students. The only group that gained less than the national all-student average was black *TtO* students, whose gains were roughly ten percent below the average national gain.[7]

Figure 4 indicates that the *TtO* students who made the largest academic gains were actually those who started with the weakest mathematics skills. Students who started the year below grade level gained over 50 percent more than the average national gain. In contrast, students who started off the school year above grade level gained slightly below average.

[6] Note that the sample sizes limit somewhat the ability to identify statistically significant differences between *TtO* and national norms. This is particularly true for the by-school analyses in the appendix.

[7] It would be helpful to compare gains made by *TtO* black students to gains made by a national sample of black students who also completed the MAP assessments. Again, NWEA has unfortunately not released MAP performance norms by demographic subgroups. Other national tests such as NAEP that do release subgroup norms do not measure yearly progress of the same students over time. However, we do know that the gap on the spring MAP assessment between black *TtO* eighth graders and the national average (.58 SDs) is comparable to the gap between black NAEP eighth-grade math test takers and the NAEP eighth-grade math average (0.61 SDs; see http://nces.ed.gov/nationsreportcard/naepdata/report.aspx). Bear in mind that the *TtO* sample of black students is socially and academically less advantaged compared to black students nationally, so even this comparison to NAEP data is not wholly appropriate.

Figure 3. Demographic Subgroup Performance:
Average *Teach to One* Gains Relative to National Norms

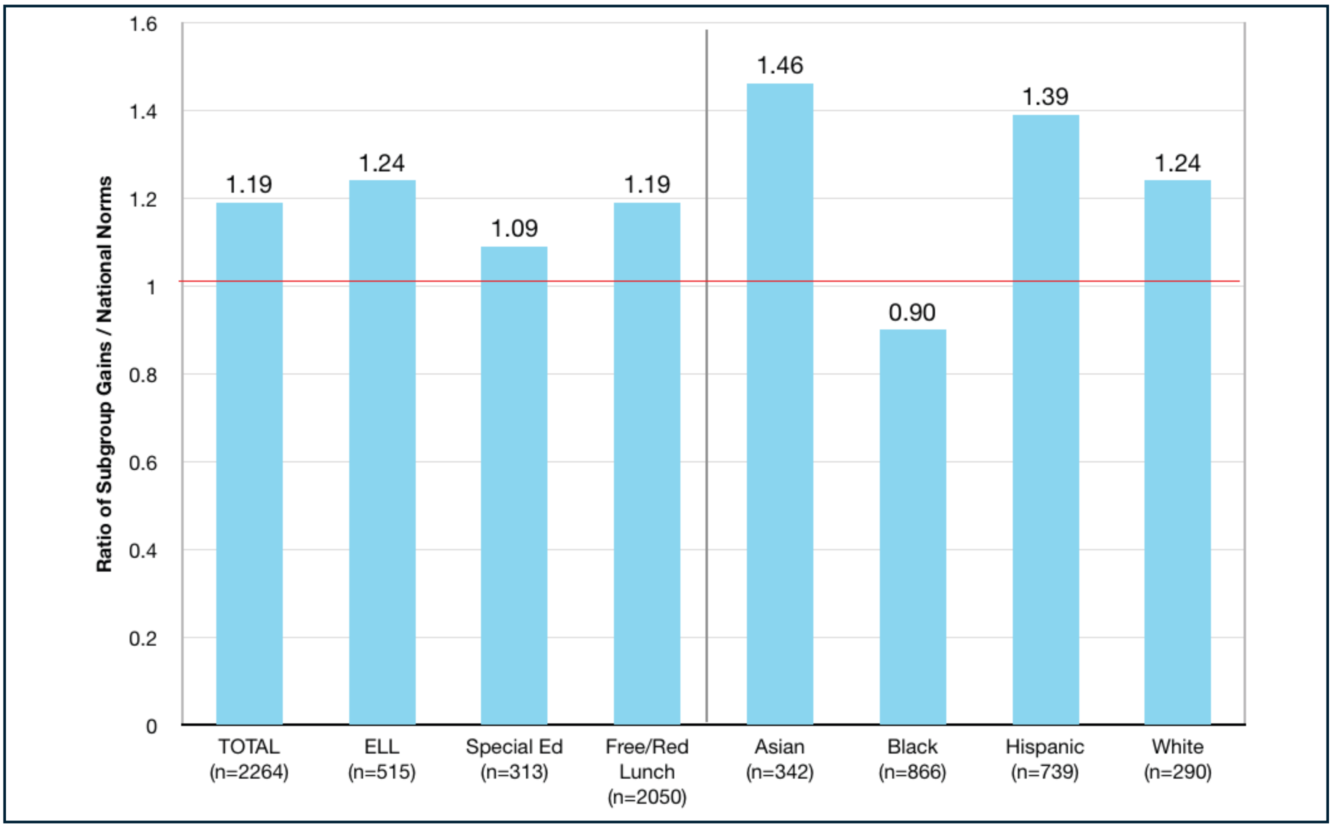
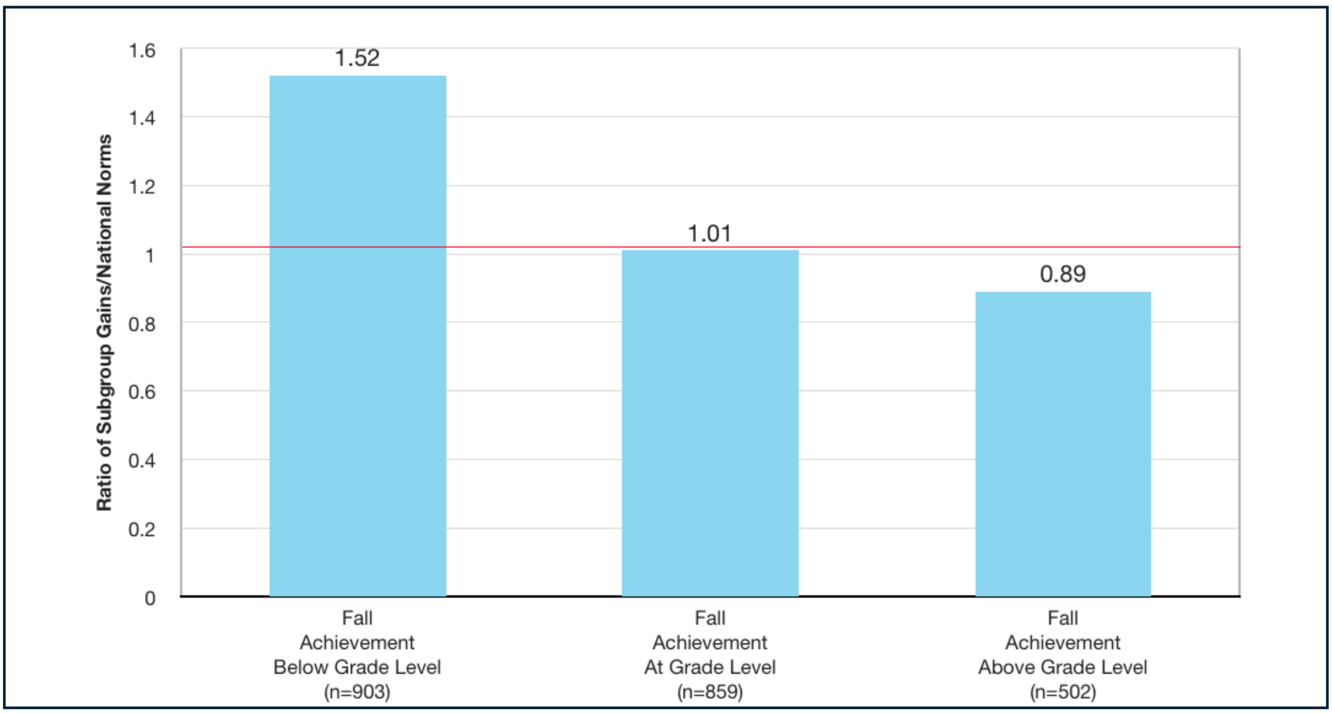


Figure 4. Academic Subgroup Performance:
Average *Teach to One* Gains Relative to National Norms



One School Pre and Post *Teach to One*

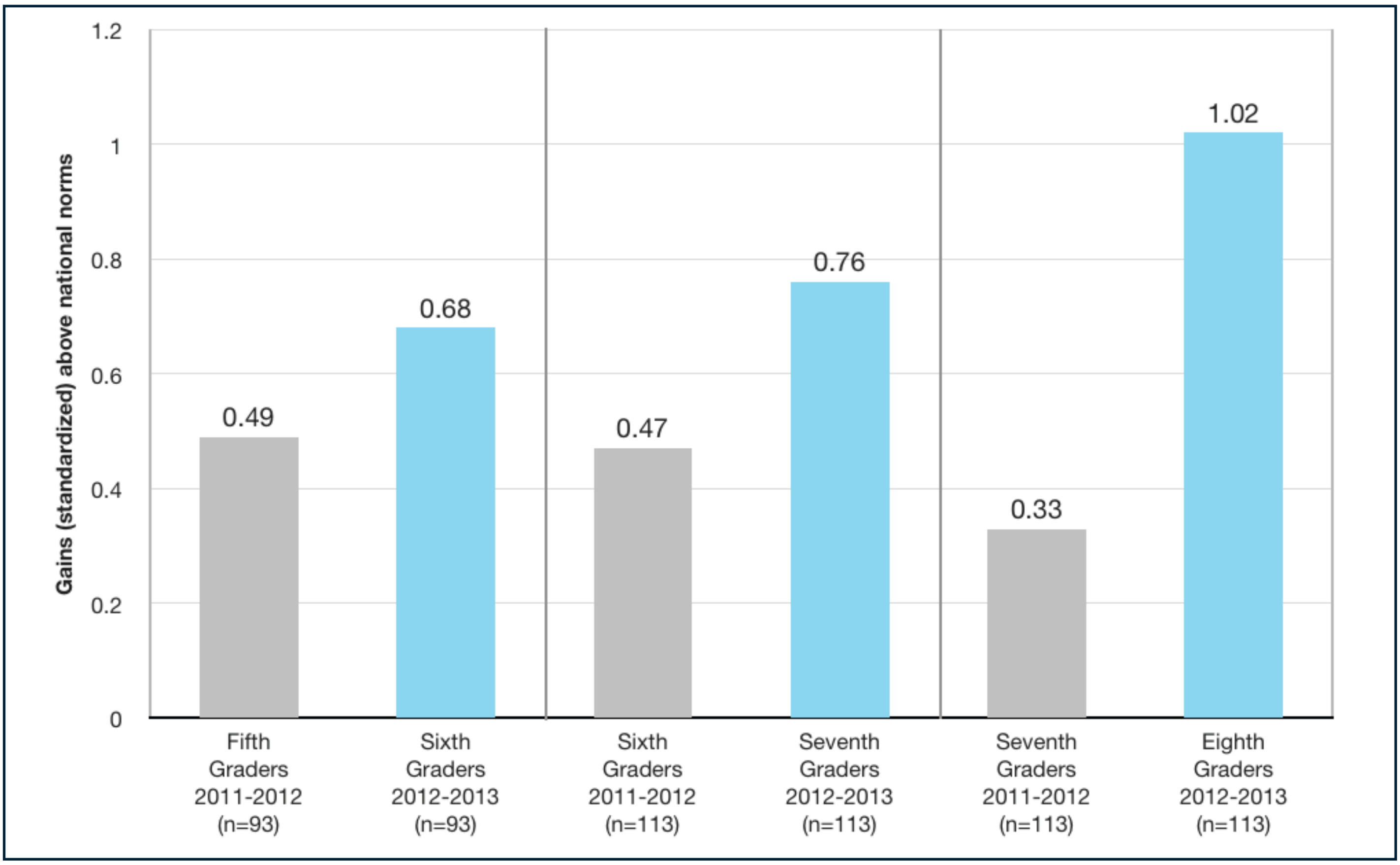
The analytic challenge faced by all studies that seek to link student outcomes to policies or programs is that such efforts invariably entail causal claims, with the explicit aim being identification of a counterfactual. In other words, within this study, the question becomes: How much less (or more) would *TtO* students have learned in the absence of the program? Any non-experimental study seeking to attribute academic development to particular processes faces serious questions of selection and unmeasured variable bias. We clearly cannot simultaneously observe the outcomes for individual schools or students in both treatment and control settings and, therefore, can make no overall claims about the program. We were fortunate, however, in one instance to have MAP data on one of the *TtO* schools, School A, for the year prior to its adoption of the program. This allowed us to compare MAP gains among a group of students the year prior to the school's adoption of *TtO* to gains made by the same students during the first year of *TtO* in this school. In this sense, each student serves as his/her own counterfactual. Although this comparison clearly does not meet the strict assumptions required for causal claims, it does provide an interesting view of the potential effects of *TtO* on student outcomes.

Please note, 319 students comprise this sample, of which approximately 0.9 percent are American Indian/Alaskan Native, 1.9 percent are Asian, 1.6 percent are black, 83.6 percent are Hispanic, 11.6 percent are white, and 0.3 percent are multiple races. In addition 8.5 percent are English Language Learners, 92.0 percent are on free or reduced-price lunch, and 13.8 percent receive special education services.

Figure 5 indicates gains each year relative to national norms. During the 2011-12 school year, fifth graders at this school gained almost one-half standard deviation more than did students nationally. This indicates that even prior to *TtO* participation, these students were doing well. But when these students became sixth graders and experienced *TtO: Math*, their mathematics gains rose to over two-thirds of a standard deviation above national norms. Similarly, sixth graders' mathematics gains in 2011-12 were also roughly one-half standard deviation above the national average, while gains among these students in seventh grade, when they experienced *TtO*, were over three-quarters of a standard deviation above national norms. An interesting story occurs in School A with seventh graders in 2011-12 who became eighth graders in 2012-13. In the year prior to *TtO*, they gained one-third of a standard deviation above national norms; but after, their gains tripled relative to national norm gains, reaching one full standard deviation above the national average.

Again, although these findings are suggestive rather than causal, it is helpful to compare gains among the same students pre- and post-*TtO*. Although students in this school were already outperforming their peers nationally during the 2011-12 school year, with the introduction of *TtO* in Fall 2012, their mathematics gains increased substantially.

Figure 5. MAP Gains in School A Pre and Post *Teach to One: Math*



Conclusions

This analysis provides student test results from the first year of implementation of *Teach to One: Math* (*TtO*) at the middle school level in seven schools. The *TtO* students generally started the 2012-13 academic year with mathematics skills that lagged behind national norms. Researchers found that the average growth of by *TtO* students surpassed the growth achieved by students nationally. Although these findings cannot be attributed to the program without the use of an experimental design, the results appear encouraging. Achievement gains of *TtO* students, on average, were strong—especially given the fact that the *TtO* students began the academic year substantially behind their peers nationally, and were far more likely to face social and academic challenges.

Personalized learning has both vocal supporters and detractors; it means different things to different people. The *Teach to One* model represents a particular approach to personalized learning in mathematics, and includes such key features as multiple modalities, open learning space, daily assessments, and a learning plan driven by an algorithm.

While the key features of the model are clear, the research described herein is limited to analyses of test data; it does not provide insights into the "black box" of *TtO*. What works, in what context, and why?

Future research should investigate key elements of the model to better understand the overall *TtO* approach. Moreover, researchers should look into implementation at different sites to understand the conditions that influence the fidelity of the innovation. Future evaluations should also consider the extent to which the *TtO* model influences student outcomes beyond standardized test scores. In particular, it seems important to understand the effect of this unique approach to mathematics instruction on student engagement, motivation, and other non-cognitive characteristics.

Other aspects of the model should be addressed with further research, including the organization and administration of the programs, the selection of schools, and support via professional development. To understand the impact of the model more fully, researchers should use an experimental design and collect data—both quantitative and qualitative—that explains the innovation. The various perspectives of teachers, administrators, students and parents should be represented. By continuing to study the model, researchers can capture data that may help the educational community better understand which aspects of this approach have resonance for learning in the new century.

While the key features of the model are clear, the research described herein is limited to analyses of test data; it does not provide insights into the "black box" of *TtO*. What works, in what context, and why?

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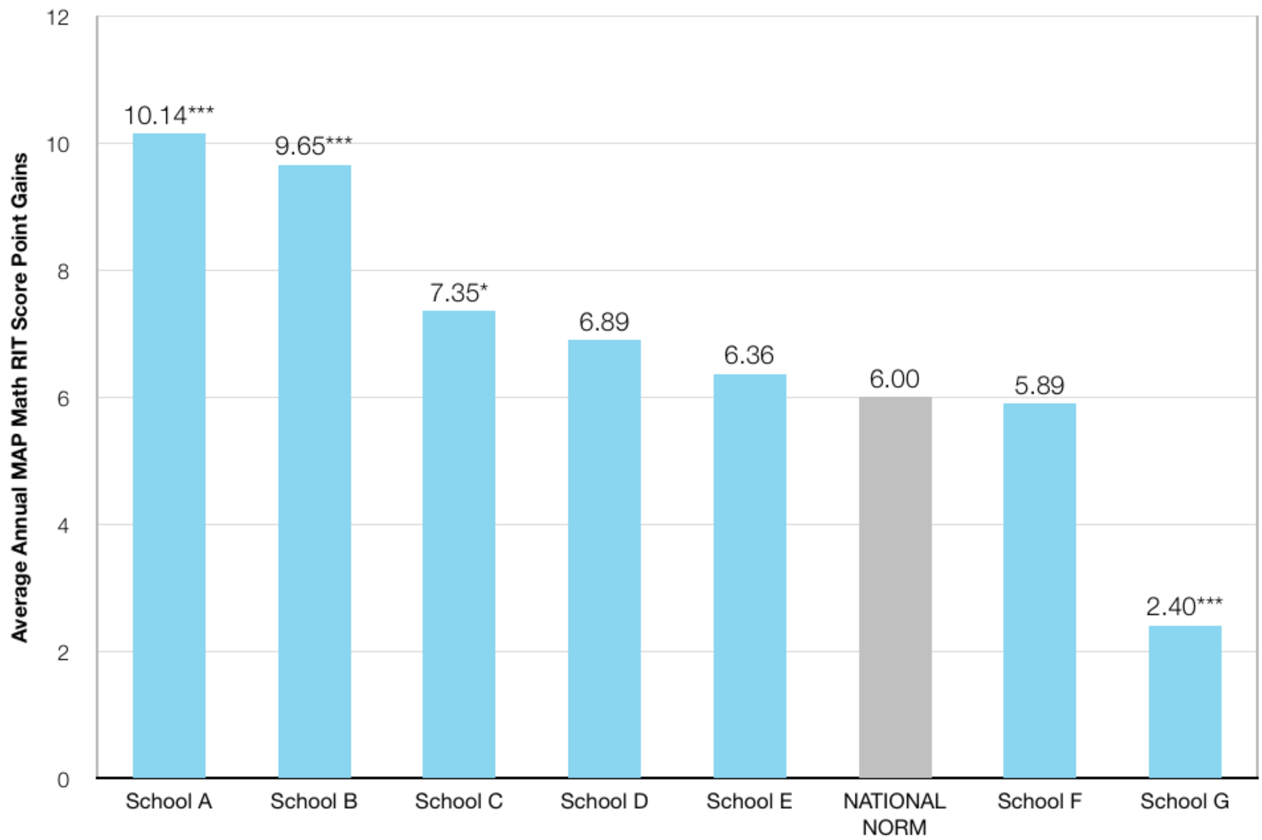
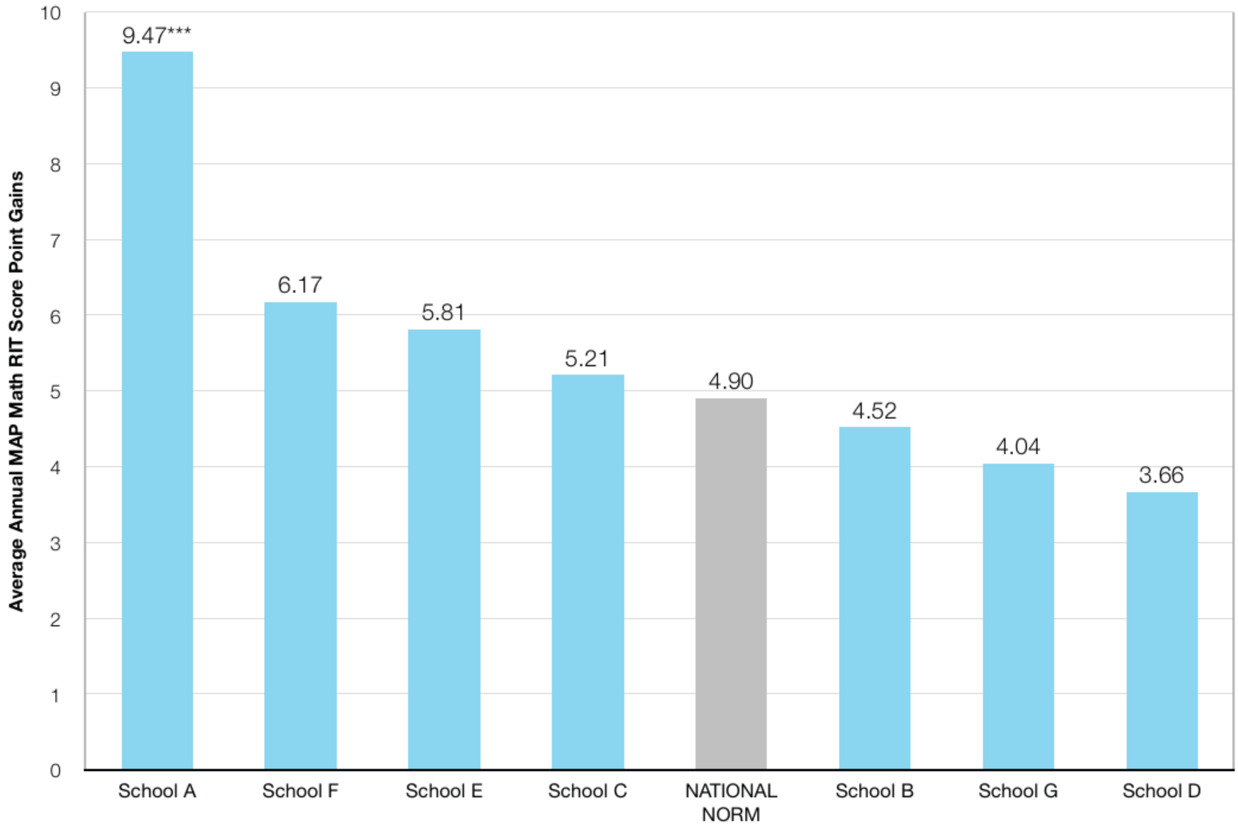
APPENDICES

Appendix 1. Average Annual Sixth Grade MAP Math Point Gains: *Teach to One* Students vs. National Norm



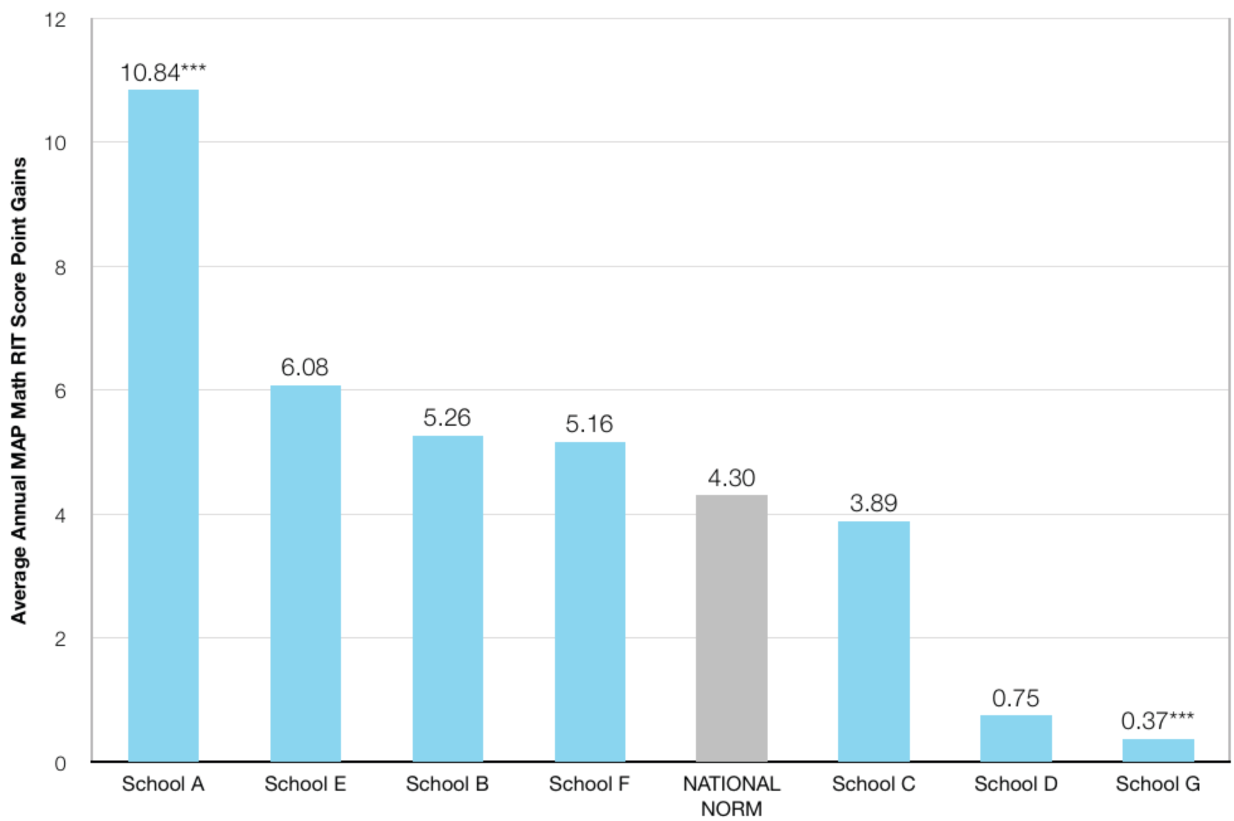
*p<.05; ***p<.001; significance tests compare to same-grade national norm.

Appendix 2. Average Annual Seventh Grade MAP Math Point Gains: *Teach to One* Students vs. National Norm



***p<.001; significance tests compare to same-grade national norm.

Appendix 3. Average Annual Eighth Grade MAP Math Point Gains: *Teach to One* Students vs. National Norm



p<.001, significance tests compare to same-grade national norm.

center for
technology & school change
TEACHERS COLLEGE COLUMBIA UNIVERSITY

525 West 120th Street
Russell Hall 501A
New York, NY 10027

Phone: (212) 678 - 3829
Fax: (212) 678 - 6619
http://ctsc.tc.columbia.edu