

# Teacher Development and the Achievement Gap<sup>1</sup>

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Despite much investment aimed at closing the achievement gap between ethnic minorities and white students (see Kitchen & Berk, 2016), success stories are rare. Research (e.g., Balfanz & Byrnes, 2006; Symonds, 2004; Desimone & Long, 2010) suggest that a focus on conceptual learning, in-class time spent on teaching, teachers' analyses of students' difficulties and strategies, activities on measurement and geometry, and teacher collaboration may contribute to closing the achievement gap. However, by and large, research has failed to identify specific aspects of teaching that promote learning among underperforming minority students and we still need studies clarifying how teacher development programs may play a constructive role. This paper describes a mathematics teacher development program and its contribution towards narrowing the gap between grades 5-8 minority students and their white counterparts. Even though the program wasn't specifically designed to address the achievement gap, its results suggest that it would contribute to better learning among all students, including those performing at the lowest levels.

## **The Program's Foundations**

The program is based on the belief that a functions approach to mathematics can enrich and promote learning throughout the grades, minimizing difficulties created by overly computational and syntactic approaches (Kaput, 1998). It focuses on functional relations and their representations as a thread unifying arithmetic operations, fractions, ratios, proportions, algebra, and geometry, topics often taught in isolation. Building upon Piaget's theory of cognitive development and Vygotsky's ideas on the role of cultural tools and social interaction, it promotes teaching that takes into account students' views as they discuss and reflect upon relations between

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quantities and appropriate new mathematical tools, procedures, and representations. Findings from early algebra studies (Carraher & Schliemann, 2016) further support course activities.

Over 18-months, the program offers three graduate-level courses. These are hosted online and engage teachers in regular discussions and activities online and in their schools. Since 2011, four cohorts of 60 teachers each, from ten school districts took the courses. Teachers invested an average of 10 hours per week in course assignments. These include reading and discussing notes about mathematics content and students' reasoning and solving and discussing mathematical problems in online groups of eight to ten teachers. They also worked in small groups, analyzing videotaped classroom lessons, interviewing students about particular topics, and planning, implementing, evaluating, and improving classroom activities.

The first course re-interprets key topics in K-12 mathematics through the lens of functions. This brings variables onto the scene and facilitates the early introduction of algebraic and graphical representations. By emphasizing relations among physical quantities (as opposed to pure numbers), semantic aspects take on importance alongside syntactic considerations. The second course focuses on transformations—functions consisting of the mapping of a set onto itself that can be depicted on the line or in the plane. Equations and inequalities are interpreted as comparisons of two functions, expressed algebraically and graphically. Steps in solving equations are interpreted as the application of the same transformation on two functions. The third course deals with non-linear functions and with rates of change. At the end of each course, teachers individually implement and analyze a classroom lesson they design with their peers.

### **Method**

We examined mathematics results of students in a target district, chosen because of its substantially larger proportion of African American and Hispanic-Latino students, in comparison

to the other participating districts. In 2014, it enrolled 4,940 students, with 1,255 in the grades 5-8 reports. Of these, 35.7% were White, 13.1% African American, and 40.6% Hispanic-Latino. Of the 47 district teachers in grades 5-8, in all subject areas, the program enrolled 11 teachers of mathematics and nine special education or enrichment teachers. Nine districts of similar size, population, and 2010-2011 MCAS results *for all students* were chosen as comparison groups. Target district data ([http://profiles.doe.mass.edu/state\\_report/mcas.aspx](http://profiles.doe.mass.edu/state_report/mcas.aspx)) from 2010-2011 to 2013-2014 were compared to those for the state and to the average for the similar comparison districts.

### Results

Table 1 shows, for *all students* in grades 5-8, the percentage of those classified in each of the MCAS categories in 2011 and 2014. In the target district, from 2011 to 2014, the percentage of students in Warning/Failure dropped by 4.7 points and that of those in Advanced increased by 4.5-point. Meanwhile, the state and comparison districts showed smaller than 1.2% changes.

Table 1. Percentage at Each Performance Level for All Students

Grades 5-8 All Students	Year	W/F	NI	Prof.	Adv.
State	2011	18.7%	26.2%	31.8%	23.4%
	2014	18.4%	26.1%	31.7%	23.8%
Target District	2011	31.7%	28.9%	25.1%	14.3%
	2014	27.0%	28.6%	25.6%	18.8%
Similar Districts	2011	28.8%	31.6%	27.2%	12.4%
	2014	28.8%	31.3%	26.3%	13.6%

Figure 1 shows percentages and changes *for each of the three ethnic groups*. As the tables and graphs show, progress for each ethnic group in the target district (orange bars) was consistently better than progress of similar districts (gray bars) and state (blue bars).

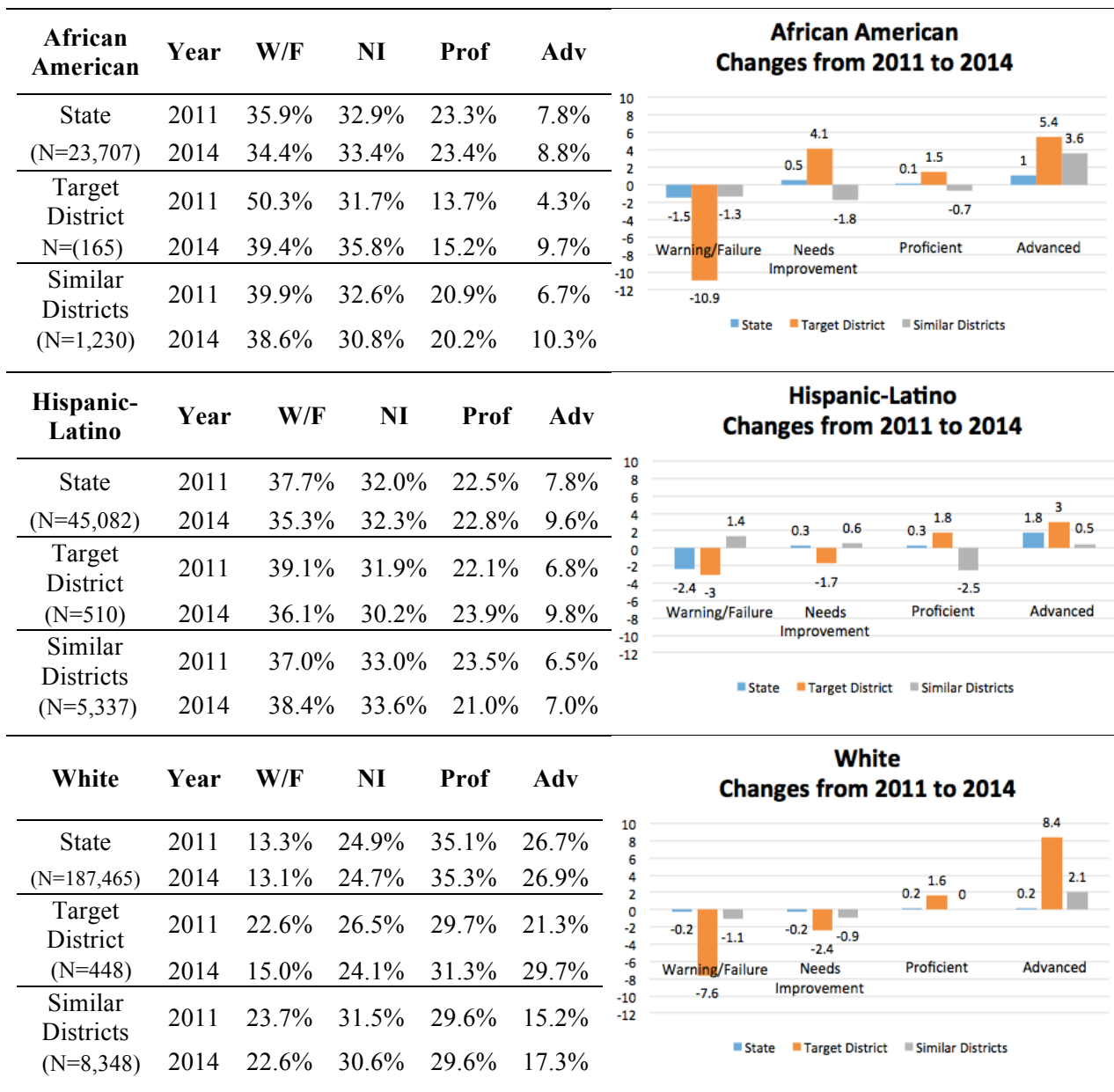


Figure 1. Percentage of Students (Left) and Changes (Right) for each Ethnic Group

In 2011, the percentage of *African American students* in the Warning/Failure category in the target district was much higher (50.3%) than the corresponding percentages in the state (35.9%) and similar districts (39.9%). By 2014 those percentages became closer to each other, with the percentage of Warning/Failure decreasing by 10.9 percentage points for African Americans, by 3.0 points for Hispanic-Latinos, and by 7.6 for Whites. At the same time, the percentage of those

in the Advanced category increased by 5.4 points for African Americans, by 3.0 for Hispanic-Latinos, and by 8.4 for Whites. Note that, while the percentage of African American students in the Warning/Failure category in the target district decreased by 10.9 points, this percentage remained practically unchanged in the state and in the similar districts. In all the other categories, the African American students did better in 2014 than in 2011, with increases of 4.1 points in the Needs Improvement category, 1.5 in Proficient, and as much as 5.4 (more than double the 2011 percentage) in the Advanced category. In the state and similar districts, these percentages remained, practically unchanged, with the exception of a 3.6 points increase in the Advanced category for African American students in similar districts.

Among *Hispanic-Latino students*, in the target district there was a decrease in the percentages of students in the Warning/Failure and Needs Improvement categories and an increase in the percentages of those in the Proficient and Advanced categories. In the state, for the same ethnic group, there was a smaller decrease in the percentage of those in Warning/Failure and a smaller increase in the Advanced category, while the percentage of students in the other two categories remained practically the same. For Hispanic-Latino students in similar districts, the percentage of those in the Warning/Failure category increased and that of those classified as Proficient decreased, with the other categories showing nearly no changes.

*White students* were moving faster (+8.4) into the Advanced category than the other two ethnic groups ( $\leq 5.4$ ). If we only look at this category, the gap between Whites and the other two groups did in fact increase. However, African American students were leaving the Warning/Failure level faster (-10.9) than White (-7.6) and Hispanic-Latino (-3.0) students. And Hispanic-Latino students were improving at the Proficient level faster (+1.8) than the other two groups ( $\leq 1.6$ ). While the gap between African American and White students in the Advanced

category, in the target district, increased by 3 points from 2011 to 2014, African American students showed improvement at the lower end of the scale as their percentages in Warning/Failure substantially decreased, with a corresponding increase in all the other categories.

Overall, *in 2011* the White student population in the target district had a different footprint across performance levels in comparison to African Americans and Hispanic-Latinos. White students' achievement distribution followed an "increasing pattern" from Warning/Failure towards Proficient, with a slight decline in Advanced, a distribution which somewhat resembles a "bell-curve" (23% Warning/Failure, 26% Needs Improvement, 30% Proficient, 21% Advanced). On the other hand, the distribution of achievement for African American students (50% Warning/Failure, 32% Needs Improvement, 14% Proficient, 4% Advanced) and Hispanic-Latino (39% Warning/Failure, 32% Needs Improvement, 22% Proficient, 7% Advanced) in the target district followed a decreasing trend from Warning/Failure to Advanced. *In 2014*, after the courses had been implemented for three years, the footprint of the distribution of achievement in the target district changed to a greater extent when compared to the state and similar districts: the White students "bell curve" became skewed to the right and towards the Advanced level (15% Warning/Failure, 24% Needs Improvement, 31% Proficient, 30% Advanced); the distribution footprint for African American students remained on the lower side but became much less "steep" (39% Warning/Failure, 36% Needs Improvement, 15% Proficient, 10% Advanced); the same happened for the Hispanic-Latino students (36% Warning/Failure, 30% Needs Improvement 24% Proficient, 10% Advanced).

### **Summary and Discussion**

Shifts in student achievements for ethnic groups across performance levels, more prominent in the target district than in the state or similar districts, highlight the positive effect of

the program. White and Hispanic-Latino students were leaving the two lower categories and moving to the two higher ones, whereas African American students were leaving the lowest category and moving towards the other three. This group's relative progress may be attributed to the fact that it was performing so low in 2011 that there was more room for improvement than in the other groups. However, as widely acknowledged, promoting progress among underperforming students is a most difficult task. Therefore, this progress may also be attributed to their teachers' participation in the program. Either way, it is noteworthy that, in the target district, the percentage of African American students in the Warning/Failure category was reduced by one fifth and the percentage of those in the Advanced category more than doubled.

The program was not designed with the aim of closing the achievement gap but, instead, tried to improve teaching and learning for all students. Teachers received no instruction regarding racial awareness or on the importance of closing the achievement gap between different ethnic groups, aspects we could make more explicit in future implementations of the program. On the other hand, there was an emphasis on high standards, on improving teachers' knowledge of mathematics, on conceptual learning, on taking into account students' ideas and strategies, and on teacher collaboration, factors that, as previous analyses suggest, may make a difference in closing the achievement gap. Moreover, the program only involved mathematics teachers and not all of those teaching in grades 5-8. Participation of other teachers, starting with earlier grades teachers, might further increase the intervention effect.

Our program touched upon the achievement gap and equity by giving all students access to a higher quality math education. Achievement distribution footprints strengthened for each ethnic group which, in turn, created a new baseline for each group to further grow from. A subsequent longitudinal analysis should evaluate the long-term effects and further trends in student

achievement. What our analysis does suggest is that a long-term teacher development program that focuses on algebra and functions, promotes a deep understanding of mathematics content, deals with multiple representations and quantities, and takes into account students reasoning processes, leads to better learning among students of all ethnic groups.

## References

Balfanz, R. & Byrnes, V. (2006) Closing the Mathematics Achievement Gap in High-Poverty Middle Schools, *Journal of Education for Students Placed at Risk*, 11:2, 143-159.

Carraher, D.W. & Schliemann, A.D. (2016). Powerful Ideas in Elementary Mathematics Education. In L. English & D. Kirshner (Ed.). *Handbook of International Research in Mathematics Education (3<sup>rd</sup> edition)*, pp. 191-218. New York: Taylor & Francis.

Desimone, L.M. & Long, D. (2010). Teacher Effects and the Achievement Gap. *Teachers College Record*, 112 (12), pp. 3024–3073.

Dubinsky & G. Harel (1992) (Eds.), *The concept of function: Aspects of epistemology and pedagogy*. Washington, DC: Mathematical Association of America.

Kaput, J. (1998). Transforming algebra from an engine of inequity to an engine of mathematical power by 'algebrafying' the K-12 Curriculum. In NCTM, MSEBCSMEE, and NRC, *The Nature and Role of Algebra in the K-14 Curriculum* (pp. 25-26).

Schwartz, J. & Yerushalmy, M. (1992a). Getting students to function on and with algebra. In E. Dubinsky & G. Harel (Eds.), *The concept of function: Aspects of epistemology and pedagogy* (pp. 261-289). Washington, DC: Mathematical Association of America.

Symonds, K.W. (2004). After the Test: Closing the Achievement Gaps with Data. Learning Point Associates, Naperville, IL, <http://216.243.142.37/resourcefiles/symonds.pdf> on 08/31/16.