Building Bridges in High School and Beyond: The Impacts of Apex High School's Academy of Information Technology

WAKE COUNTY PUBLIC SCHOOL SYSTEM

DATA, RESEARCH & ACCOUNTABILITY

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Abstract

Apex High School's Academy of Information Technology (AOIT), launched in 2001, is one of the nation's most highly regarded career academies. Despite its strong reputation, we know very little about the impact of AOIT on student outcomes. To measure these causal impacts, we leveraged the fact that AOIT has admitted students through a lottery, which creates "treatment" and "control" groups that are similar and have outcomes that we can compare. Results show that gaining admittance to AOIT and subsequently enrolling increases high school graduation and college enrollment rates by about 8 percentage points, with the attainment gains concentrated among male students. We also found that academy participation reduced 9th grade absences and participation in the concentrated curriculum did not reduce the likelihood of taking Advanced Placement (AP) courses or performance on the AP exams.

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SUMMARY

Apex High School's Academy of Information Technology (AOIT) is one of WCPSS's oldest career academies and one of the most recognized in the nation. Since 2001, AOIT has provided participants with the unique opportunity to specialize in an IT-based curriculum and job-preparation activities designed to prepare them for college and the workforce.

Throughout high school, AOIT students travel as a cohort and participate in "cornerstone" activities during each year. They participate in job shadowing and skills presentations as freshmen, resume writing as sophomores, mock interviews and pre-internship workshops as juniors, and internship presentations and banquet attendance as seniors. Students are supported throughout the program by the AOIT director, teachers, and board of directors.

AOIT is unique among career academies in that it has admitted students randomly using a lottery since the 2008-09 school year because interest exceeds the number of spots available. Thus, students interested in attending AOIT have essentially a coin-flip chance of being admitted to the academy. This acceptance mechanism provides us with an opportunity to measure the causal impact of AOIT on a range of academic outcomes since applicants who win the lottery and applicants who do not win the lottery are similar to each other in observed and unobserved ways. Thus, this evaluation provides us with results that meet the "gold-standard" of impact evaluation—experimental through a process that mimics a randomized controlled trial (Table 1).

Table 1

Nature of the Data Provided and Valid Uses

Research Design	Conclusions that Can be Drawn
☑ Experimental	We can conclude that the program or policy caused changes in outcomes because the research design used random assignment.
☐ Quasi-Experimental	We can reasonably conclude that the program or policy caused changes in outcomes because an appropriate comparison strategy was used.
☐ Descriptive ☐ Quantitative ☐ Qualitative	These designs provide outcome data for the program or policy, but differences cannot be attributed directly to it due to lack of a comparative control group.

Sources: List, Sadoff, & Wagner (2011) and What Works Clearinghouse (Clearinghouse, 2014).

Results

We measured the impact of AOIT on End-of-Course (EOC) test scores, Advanced Placement (AP) coursetaking and exam performance, absenteeism, high school graduation, and college enrollment. Since the mission of AOIT is to provide enrollees with "the personal, analytical, technical, teamwork and communication skills necessary to be successful in college and today's job market,"[1] we believe that AOIT participants are well-positioned to outperform their counterparts who were interested in attending AOIT but did not gain admittance.

We found that:

- The lottery process that randomly assigned applicants to AOIT (the "treatment" group) or the control group worked well over our years of study (graduating classes of 2013-2016), since both groups were balanced prior to enrolling in AOIT in 9th grade.
- AOIT did not impact overall student performance on the English II EOC, AP coursetaking or performance on the AP exams. The impact on the Biology EOC was moderately negative.
- Students who won the AOIT lottery had fewer absences in ninth grade than students who were not admitted.
- Students who won the AOIT lottery graduated on-time at rates nearly seven percentage points higher than their counterparts who applied to AOIT but were not admitted. Lottery winners who ultimately enrolled had graduation rates nearly eight percentage points higher than their control-group counterparts. Graduation rate gains were concentrated among male students, White students, and students in the midrange of prior achievement (i.e., students who scored in the middle of the 8th grade end-of-grade exam distribution).
- Students participating in AOIT enrolled in college within one year of graduation at rates roughly eight percentage points higher than their non-AOIT peers. These gains even larger for male students.

BACKGROUND

Apex High School's Academy of Information Technology (AOIT) is one of 20 career academies across 14 WCPSS high schools (Table 2). It was among the earliest career academies in the district, launching in 2001 along with Wake Forest High School's Construction Technology academy. AOIT remained one of only five career academies in WCPSS for nearly a decade after its launch. Since 2009, the rate of academy launch has grown rapidly.[2]

[1] The complete AOIT mission statement reads: "To prepare academy students for the many diverse career opportunities in today's fast paced digital work force. Students will be equipped with the personal, analytical, technical, teamwork and communication skills necessary to be successful in college and today's job market. Academy students will be given a unique learning experience that provides them access to industry-specific curricula, work-based learning experiences, and relationships with business professionals. All students will be supported to ensure academic success by having students in cohort classes that foster a sense of pride, community and personal worth."

[2] For more on WCPSS's career academies and evidence about wider career academy implementation, see "High School Career Academies: Status Report 2014-15" (February 2016), available by request.

Table 2
Timeline of WCPSS Career Academies

School	Program(s)	Launch Year
Athens Drive HS	Health Science Academy	1990
Sanderson HS	Academy of Finance	1995
Enloe HS	Medical Bioscience	1996
Apex HS	**Academy of Information Technology**	**2001**
Wake Forest HS	Construction Technology	2001
Knightdale HS	Academy of Environmental Studies	2009
Southeast Raleigh HS	Engineering Academy	2010
Middle Creek HS	Digital Media	2011
Enloe HS	Design & Merchandising Tech. Career Academy	2011
Broughton HS	Hospitality, Tourism and Sports Entertainment	2013
Cary HS	Culinary Arts	2013
Heritage HS	Game Art Design	2013
Southeast Raleigh HS	Biotechnology Research	2013
Middle Creek HS	Academy of Sustainable Energy Engineering	2013
Millbrook HS	Digital Media	2014
Southeast Raleigh HS	Academy of Information Technology	2014
Knightdale HS	Public Safety	2014
Apex Friendship HS	Academy of Engineering	2015
Garner HS	Fire and Safety	2015
Athens Drive HS	Energy and Sustainability	2015

Source: WCPSS Career and Technical Education administrative records.

AOIT is perhaps the best known of WCPSS's academies due to its frequent recognition by NAF (formerly the National Academy Foundation; now simply "NAF")[3], a network focused on the transition of high school students to college and career. NAF has named AOIT a "Distinguished Academy" on five occasions (only four academies nationally have received the distinction six times), which is awarded based on six "threshold" criteria and seven "characteristics" (NAF, 2016). AOIT also received NAF's first Sanford I. Weill Academy of Excellence Award in 2013, awarded to an academy that maintains exceptionally strong public-private partnerships (NAF, 2013).

Students interested in attending AOIT as freshmen must apply while in the 8th grade and must be assigned to Apex HS. AOIT restricted enrollment to 75 seats from its launch in 2001-02 until 2009-10, when it increased the number to 90 seats. Starting in 2007-08, applications began to exceed available seats and the following year, AOIT instituted a lottery admissions system. Through this system, applicant data were and continue to be collected online. Siblings of admitted students are also admitted, constituting the only exception to the random lottery. Table 3 summarizes cohort years, applicant counts, seat counts, and oversubscription ratios for each of the last seven cohorts.

[3] In 2015-16, nearly 90,000 students attended more than 700 NAF academies in 36 states (NAF, 2016).

Table 3

Application and Enrollment History at Apex High School Academy of Information Technology

2009-10 to 2015-16

Freshman Year	*Graduating Year*	*Seamless College Enrollment*	*Apps*	*Seats*	*Over-subscription Ratio*	*Apps minus Siblings*	*Seats minus Siblings*	*Sibling-Adjusted Ratio*
2009-10	2012-13	Fall 2013	139	75	1.9	109	46	2.4
2011-11	2013-14	Fall 2014	137	90	1.5	109	63	1.7
2011-12	2014-15	Fall 2015	208	90	2.3	169	51	3.3
2012-13	2015-16	Fall 2016	162	90	1.8	123	51	2.4
2013-14	2016-17	Fall 2017	115	90	1.3	91	66	1.4
2014-15	2017-18	Fall 2018	155	90	1.7	116	51	2.3
2015-16	2018-19	Fall 2019	112	90	1.2	76	54	1.4
		Totals:	**1,028**	**615**	**1.7**	**793**	**382**	**2.1**

Data Source: 2009-10 to 2015-16 student participation data provided by AOIT CA-CDCs.

Our ability to successfully leverage the randomized lottery rests on having more applicants than seats. Since siblings have a 100% chance of being admitted to AOIT, we removed them from the sample, which resulted in the oversubscription ratio increasing from 1.7 to 2.1.

Building on the mission of Apex HS, which aims to "provide all students with a foundation of academics and technology that will prepare them for a lifetime of learning as productive citizens," AOIT articulates its own skills-based mission with an eye toward the future. Specifically, the academy hopes students will be able to "solve problems we haven't identified yet, using technology and advancements that haven't been invented yet, in jobs that haven't been created yet." To achieve its mission, AOIT's approach utilizes a three-dimensional framework, in which the career academy's director (i.e., CA-CDC), teachers, and board of directors support students. AOIT participants take a sequence of courses that reflect one of two themes: programming or multimedia/web design. They are supported by Career and Technical Education (CTE) staff and academic course teachers who collaborate around AOIT's mission. Additionally, admitted students participate in various "cornerstone" activities and receive guidance from each of the three sources of support during their four years in the academy. Cornerstone activities include job shadowing and skills presentations as freshmen, resume writing as sophomores, mock interviews and pre-internship workshops as juniors, and internship presentations and banquet attendance as seniors. Table 4 summarizes some of the key features of AOIT.

According to interviews conducted with past CA-CDCs, the capstone internship is perhaps the most important feature of AOIT's program. In 2008, AOIT leadership set the goal that 100% of enrollees would complete a 135-hour internship as a prerequisite to graduate from AOIT with their cohort. Preparation for the internship begins freshman year and the internship itself starts during the junior year and continues until graduation. On average, more than 95% of AOIT enrollees successfully obtain an internship through the support of the CA-CDC.

AOIT is funded primarily through district CTE funds, which support CTE teachers, the CA-CDC, hardware and software, substitute teachers and transportation for field trips, and NAF membership. A parent-led

501(c)(3) supports additional equipment, professional development for teachers who attend the NAF Institute, and miscellaneous expenses.

Table 4

Select AOIT Program Components and Control Group Condition

Dimension	AOIT Enrollees ("Treatment")	Apex HS Non-AOIT Enrollees ("Control")
Work-based Learning; Workplace Engagement	Paid internship in 11th grade year; Job shadowing and career-development day-trips	Not available to non-AOIT students
Non-Academic Supports	Networking through local Chamber of Commerce, resume preparation, mock interviews, job shadowing, and pre-internship training	Not available to non-AOIT students
Curriculum	Cohort-based progression; project-based learning; teachers of CTE and academic courses collaborate during common, weekly planning time	No cohort-based structure to curriculum
IT Courses (required electives)	Sequence of courses that reflect one of two themes: programming or multimedia/web design (= 1/3 of content)	Limited availability to non-AOIT students (5% - 10% of course enrollees drawn from wider high school)
Bridge to Postsecondary Study	Students take college-level IT course (either AP or articulated) during 12th grade	No specific guidance or 12th grade course requirements

Sources: WCPSS Career and Technical Education Staff and former AOIT CA-CDCs.

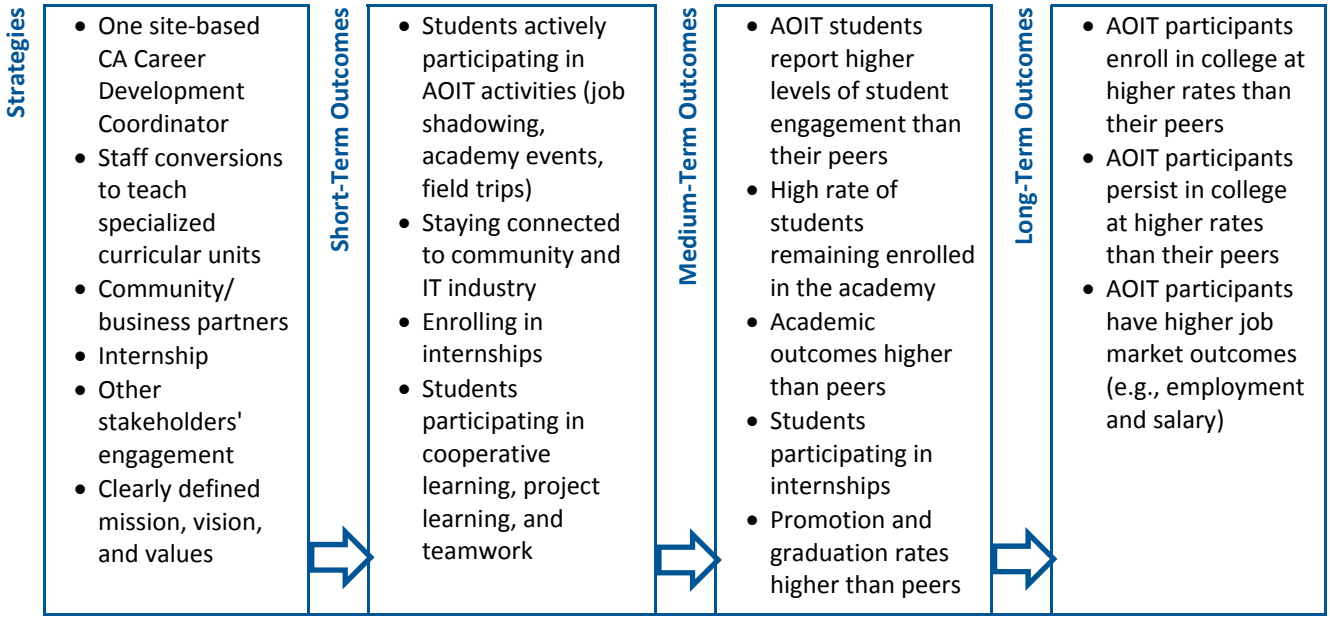
METHODS

Study Questions

The program's theory of action (Figure 1) suggests that, by providing a unique and consistent set of engaging program components, students who are admitted to, and enroll in, AOIT will have higher test scores, lower absenteeism, higher graduation rates, and higher college enrollment rates compared with their control-group counterparts.

Figure 1
Pathway of Change

- Effort: Apex High School's Academy of Information Technology (AOIT)
- Need: Provide students with a challenging, engaging, relevant, rigorous, and meaningful educational program that prepares them for postsecondary education and the workforce. AOIT was developed to accomplish this through a structured, multi-year program that integrates career and technical education (CTE) courses, project-based learning, internships, and other activities organized around IT specifically.



Data Sources

Our ability to measure the impact of AOIT on various student outcomes depends on whether we can compare AOIT enrollees to similar students while minimizing the presence of selection bias. Because AOIT admits students by random lottery, admitted applicants and applicants who did not win a seat are expected to be, on average, very similar. To determine membership of these two groups, we reviewed applicant and enrollee records for seven separate AOIT cohorts (see Table 3). Two former CA-CDCs provided us with applicant and enrollee lists for each cohort that was admitted by lottery. One critical question that applicants had to answer when applying is whether they had a sibling at Apex HS, since such applicants would receive priority and be automatically enrolled in AOIT. While the percentage of applicants with siblings varied from year to year, the overall rate was 23%. Since these applicants had a 100% chance of being admitted to AOIT, we removed them from our analyses. Also, since only four of seven cohorts have graduated from high school and had the opportunity to seamlessly enroll in college, we estimate these respective outcomes only for the first four cohorts (graduating classes of 2013-2016). Table 5 displays a summary of the types of data utilized in this evaluation.

Table 5

Key Evaluation Questions and Data Sources

Research Question	Data Source
Are the samples of students who are admitted (the "treatment" group) and not admitted (the "control" group) balanced?	AOIT lottery data and district administrative data through annual student locator files
Did AOIT lottery winners outperform their control-group counterparts on North Carolina End-of-Course (EOC) Tests and Advanced Placement exams?	Administrative test data
Were AOIT students absent less frequently than their control-group counterparts?	Administrative attendance data
Did AOIT lottery winners graduate at higher rates than their control-group counterparts?	Administrative graduate/dropout data; NC DPI graduate transfer database
Did AOIT lottery winners enroll in college at higher rates than their control-group counterparts?	National Student Clearinghouse

Note: We analyzed outcomes for entering ninth graders in 2009-10 through 2012-13.

Study Design

To examine the impacts of being offered a spot in AOIT (i.e., winning the lottery) we compared the outcomes of students randomly offered a seat to outcomes of students who were not. Since students are randomly given the chance to participate in AOIT, average differences in the outcomes of interest (such as high school graduation or college enrollment) between these two groups of students should be causal. The only remaining difference between students who won the lottery and those who did not is the opportunity to attend a career academy. In all other observable and unobservable ways, both groups of students should be statistically equivalent. To control for minor, known deviations from complete randomization and differences due to chance, analyses included pre-lottery controls (e.g., demographic characteristics such as gender, race/ethnicity, prior academic achievement, and sibling status). Any impacts we see from this analysis are called "intent-to-treat" (ITT) impacts. ITT impacts answer the question, What is the impact of being *offered* a seat in AOIT (i.e., drawing a successful lottery number). This question is important to ask because it helps to understand what the impact may look like if all students were offered a seat at AOIT, or any future IT career academy in a similar context.

To study the effects of actually participating in a career academy, known as "treatment-on-the-treated" (TOT) impacts, we used lottery assignment as an instrumental variable (IV) for enrollment in a career academy. The intuition behind this approach is that we can exploit random variation in the choice to participate in a career academy insofar as it is a consequence of being offered a spot via the lottery. TOT impacts answer the question, What is the impact of *enrolling* in AOIT (i.e., accepting the offer; see Appendix for technical details related to this analytic approach). This question is important because it helps us understand what the impact looks like for students who actually participated in AOIT after receiving an offer to attend (i.e., winning the random lottery).

RESULTS

Pre-Treatment Balance

A consistent challenge in program evaluation is ensuring that the treatment and control groups are similar or, better yet, equal in expectation. This means the two groups are theoretically equal because members of each group had roughly a 50-50 chance of winning the AOIT lottery. When students are randomly assigned to a treatment condition, like AOIT, we can be confident that the treatment and control groups are similar in observable characteristics (e.g., race/ethnicity, sex, LEP status) as well as unobservable characteristics that we cannot measure. That does not guarantee, however, that the treatment and control groups are *actually* equal after random assignment occurs. To test this, we measured the average difference between the treatment and control groups on a range of observable characteristics before they were assigned to AOIT or the control group. For the students in our sample who applied to AOIT and won or who did not win—and did not have siblings, since these students are guaranteed admission to AOIT—we saw consistent balance. The treatment and control groups had roughly the same proportion of students in each subgroup. Similarly, we did not detect meaningful differences between the treatment and control groups on baseline levels of academic achievement. AOIT applicants performed much higher than the average WCPSS student on the End-of-Grade (EOG) reading test (> 0.60 standard deviations) and math test (> 0.80 standard deviations), but between lottery winners and those who did not win—the groups we compared—there was no statistically significant difference.

Table 6
Balance between AOIT Treatment and Control Groups

Demographics	**Treatment Group**	**Control Group**	**Difference (T - C)**	**p-value**
Male	64%	64%	-1%	0.888
Female	36%	36%	1%	0.888
Black	6%	4%	2%	0.319
Hispanic/Latino	3%	2%	1%	0.330
White	77%	81%	-4%	0.270
Asian	11%	9%	2%	0.471
Students with Disabilities	7%	9%	-1%	0.579
Academically Gifted	55%	58%	0%	0.509
Limited English Proficient	0%	0%	0%	N/A
Prior Achievement (SD)				
8th Grade Math EOG	0.830	0.836	-0.006	0.932
8th Grade Reading EOG	0.640	0.634	0.006	0.931

Notes:

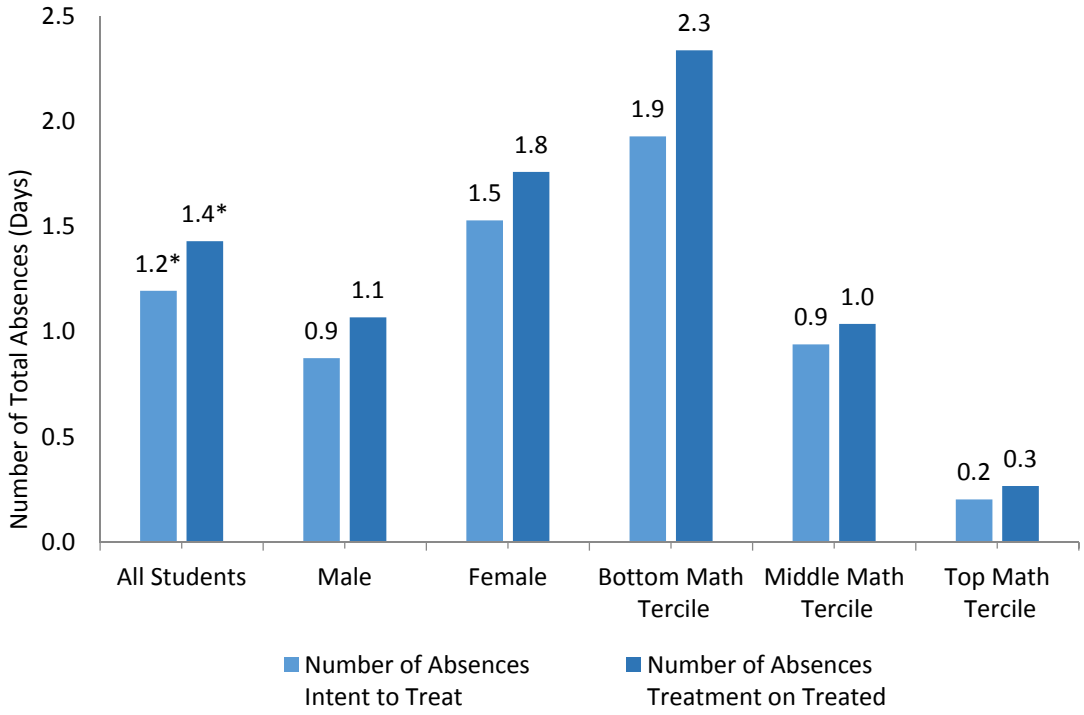
The sample includes students who applied to AOIT and either won or did not win the lottery. It includes 9th grade cohorts that entered Apex HS in fall 2009-10 through fall 2012-13 (i.e., graduating classes of 2013-2016) because we have lottery data for these years with oversubscription and can track these students through to high school graduation. Because siblings have a 100% chance of being admitted to AOIT, they are omitted from the sample. T-C: Treatment group mean minus control group mean, which may differ due to rounding. Means calculated using regression with robust standard errors. SD: standard deviation units. * $p < 0.05$.

Impacts on Absenteeism

One mechanism through which participation in a career academy is thought to contribute to higher graduation rates is student engagement. Given past work that highlights attendance in 9th grade as a powerful predictor of success in high school (Allensworth & Easton, 2007), we focused on this outcome as our measure of engagement. Figure 2 shows the results for attendance. We found that participation in AOIT significantly reduced the number of days the typical 9th grader was absent by about 1.2 days (or 38 percent of the control group's mean; $p < .05$). The magnitude of this impact was even greater for students who enrolled in AOIT (1.4 days; $p < .05$). Males and females who won the AOIT lottery and enrolled saw a reduction in days absent ranging from 0.9 to 1.8, though these impacts were not significantly different from zero, likely owing to the small sample size. The impact on absenteeism was particularly pronounced for students with lower levels of prior achievement in mathematics. Students in the bottom third of the mathematics achievement distribution prior to enrolling in AOIT were absent roughly two days fewer than their control group counterparts. The magnitude of this number stands in contrast to this reduction for students at the top of the math distribution (less than half a day). These results suggest that lower-achieving AOIT participants, compared to their peers who applied or gained admission to AOIT, had higher levels of relative engagement.

Figure 2

Impact of AOIT on the Reduction of 9th Grade Absences, Graduating Classes of 2013-2016



* $p < .05$

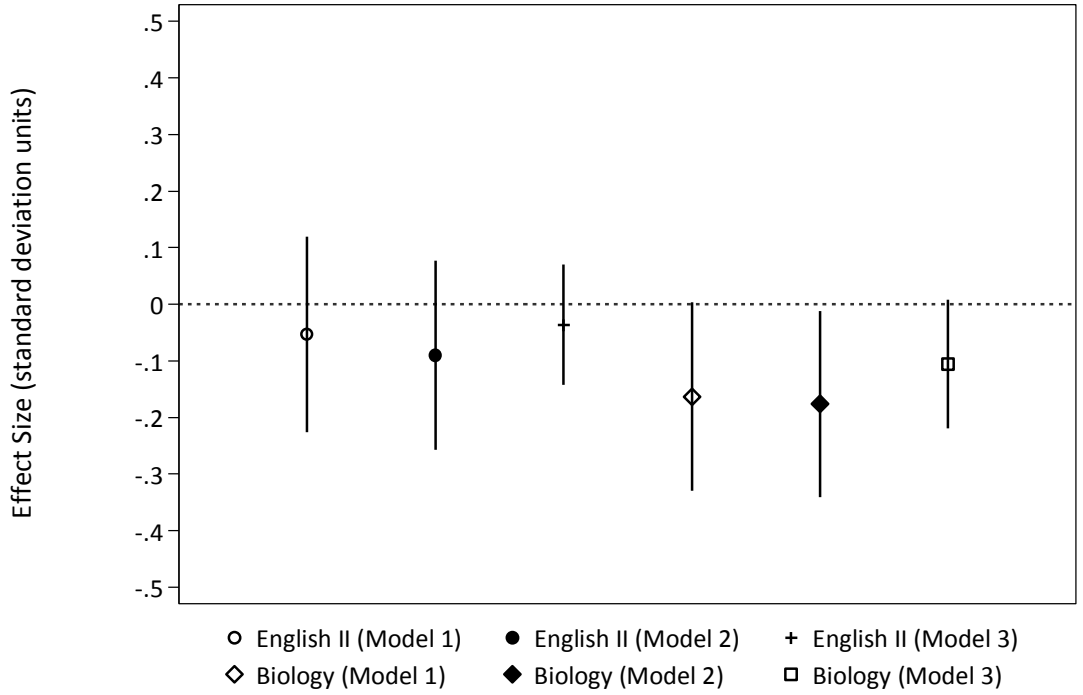
Impacts on Assessments

We estimated the impact of winning the AOIT lottery and enrolling in the academy on EOC tests and Advanced Placement (AP) exams. The EOC tests of interest were English II and Biology. Math I (formerly Algebra I) is omitted because a large proportion of AOIT students took the assessment in middle school. It is important to note that the mission of AOIT does not explicitly suggest that AOIT students should outperform their non-AOIT peers on any particular assessment. Still, we estimated test score impacts following past research that has asked similar questions about student performance impacts of career academies, especially for subgroups and students entering the academy at different baseline levels of achievement (Dayton, Hester, & Stern, 2011; Kemple & Snipes, 2000).

In order to compare test score impacts across different grade levels and different years, we standardized the outcomes for each test. Doing so produces a standardized score for each test which has a mean score of 0 and a standard deviation of 1. To put standardized deviations (*SD*) in context, in a review of hundreds of randomized controlled trials, the mean standardized impact of an intervention at the high school level was 0.09 *SD* and the median was 0.23 *SD* (Lipsey et al., 2012). For AOIT, we considered any standardized test score impact that fell within this range to be potentially meaningful.

We measured the impact of AOIT on EOC scores in three ways for each test. Figure 3 is a "coefficient plot" that shows the impact of AOIT on EOC test scores. The marker indicates the size and direction of the impact and the vertical bands represent 95% confidence intervals (CI). If the CI bands do not touch the dotted zero-line, the result is statistically significant. Figure 3 shows that for each EOC outcome, the first model controls for cohort since each AOIT cohort could have unique characteristics that vary from year to year. Model 2 adds controls for demographic characteristics, and model 3 adds further controls for prior achievement. The sample size for model 3 is slightly smaller than in the other models because some students did not have 8th grade EOG scores. TOT impacts are displayed here because they appeared nearly identical to ITT impacts. The results show that the impacts of AOIT on both English II and Biology were negative in direction but insignificant (-.07 > *SD* > -.03; ns). The impact on Biology was negative and significant in Model 2 (-.18 *SD*; $p < .05$), but it is important to keep in mind that this impact is less influential on a population that scores roughly one-half of a standard deviation higher than the average WCPSS student on this particular EOC. For additional context, the average achievement level for AOIT applicants was 3.6, with 95% of students scoring Level 3 or higher and 60% scoring at Level 4 or 5. Losing 0.18 *SD* is the equivalent of moving from a Level 4 to a "high" Level 3.

Figure 3
TOT Impacts of AOIT on End-of-Course English II and Biology
Graduating Classes of 2013-2016



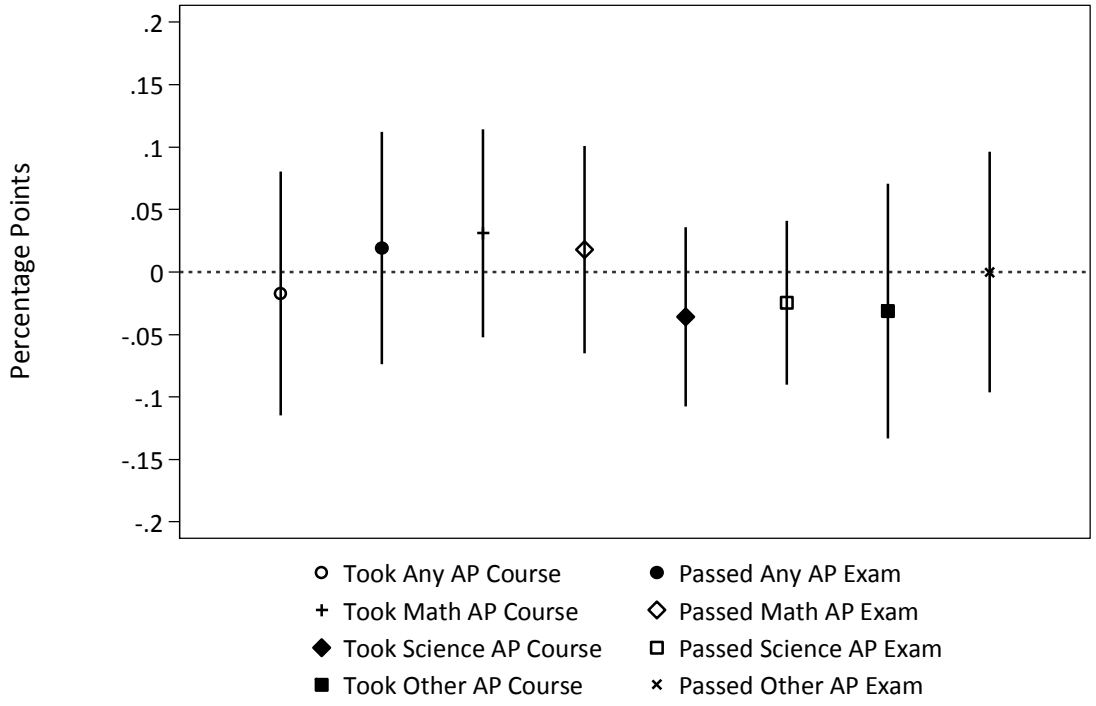
Note: This sample includes AOIT enrollees with End-of-Course (EOC) test scores. Model 1 includes cohort controls, Model 2 adds demographics, and Model 3 adds prior achievement. Markers in the graph indicate the size of the effect, where markers below the dotted 0-line show a negative impact and above it show a positive one. Vertical bars show 95% confidence intervals (CI). If the CI touches the 0-line, the effect is not significant ($p < .05$).

To measure the impact of AOIT on Advanced Placement (AP) coursetaking and performance on AP exams, we measured the percentage difference in the number of AP courses taken and the percentage difference in the number of students passing—earning a 3 or better—any AP exam. The results in Figure 4 show that for AOIT enrollees, the percentage of math AP courses taken, math AP courses passed, and overall AP courses passed is slightly higher than for non-AOIT enrollees. But since the vertical CI bands in Figure 4 for the positive impacts—and all impacts—touch the zero-line, these differences were not statistically different from zero. These results tell us that AOIT participants, compared with their counterparts, were neither helped nor hindered in their ability to take AP courses or perform well on AP exams. This is important because the specialized IT curriculum could potentially interfere with a student's ability to take Advanced Placement courses. Descriptively, this did not happen, as students in the treatment and control group each averaged 2.6 AP courses. The impact results in Figure 4 confirm that AOIT did not cause any differences in AP coursetaking patterns.

Figure 4

TOT Impacts of AOIT on Advanced Placement Coursetaking and Performance

Graduating Classes of 2013-2016



Note: This sample includes AOIT enrollees from the classes of 2013-2016 who took an AP course and/or exam. Markers in the graph indicate the size of the effect relative to the dotted 0-line. Vertical bars show 95% confidence intervals (CI). If the CI touches the 0-line, the effect is not significant ($p < .05$).

Impacts on High School Graduation

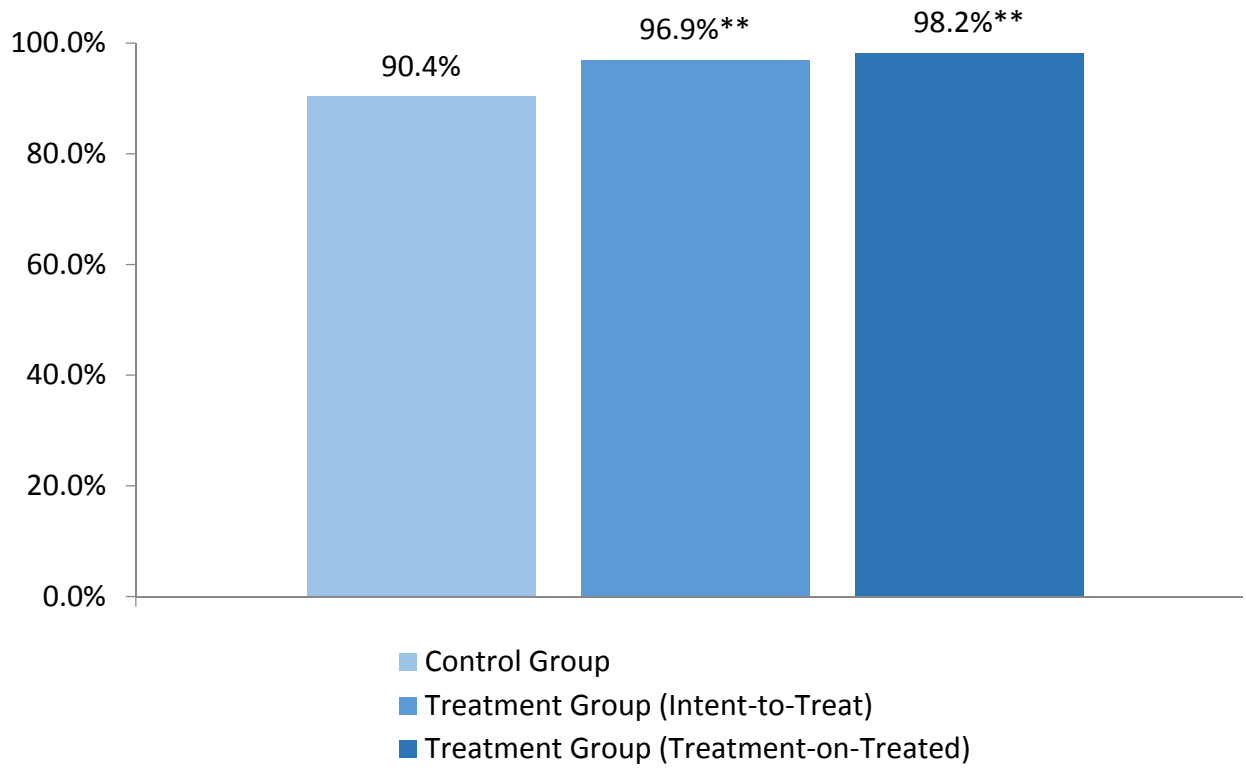
Does winning the AOIT lottery (ITT impacts) and enrolling in AOIT (TOT impacts) have an effect on high school graduation? We ask this question because career and technical education (CTE) is often credited with improving graduation rates. However, only one study has explored the causal effects of concentrated CTE coursework on educational outcomes in the modern era of high-stakes accountability and college- and career-ready standards (Dougherty, n.d.). This work examined whether CTE participation in Massachusetts impacted measures of academic performance and high school completion and found that it did in fact boost on-time high school graduation rates by between three and five percentage points for higher-income students and roughly seven percentages points for their economically disadvantaged peers. Regarding career academies, in particular, the classic MDRC studies did not find a significant impact on high school graduation rates (Kemple, 2001). Later work suggested that career academies may indeed have influenced high school graduation rates in Chicago (Cullen, Jacob, & Levitt, 2005). Thus, the evidence to date has been mixed.

We find that AOIT had fairly large and significant impacts on on-time graduation. In our sample of graduates from the classes of 2013-2016, students who won the lottery had an on-time graduation rate that was, on average, nearly seven percentage points higher than it was for students who did not win the lottery.

For students who won the lottery and ultimately *enrolled* in AOIT, the impact on graduation rates was even greater. Figure 5 shows that enrollees graduated at a rate nearly eight percentage points higher than students who did not win a seat or won a seat and did not enroll.

Figure 5

Impact of AOIT on High School Graduation, Graduating Classes of 2013-2016



Note: This sample includes 469 AOIT enrollees from the classes of 2013-2016 who graduated high school on time in WCPSS or the state of North Carolina if they transferred out and proceeded to graduate on time. The bars on the left represent graduation rates for the control group and the bars on the right represent the treatment group. The bars show that the intent-to-treat impact of gaining admission to AOIT was 6.5 percentage points higher than that control group while the treatment-on-treated impact of enrolling in AOIT was 7.8 percentage points higher. ** $p < .01$.

The overall graduation rate impacts were driven mainly by White students and male students. This is not entirely surprising since AOIT participants for the classes of 2013-2016 were 64% male and more than three-quarters White. Specifically, graduation rate impacts ranged from 5-6 percentage points (TOT: $p < .05$) for White students and 8-10 percentage points ($p < .05$) for male students. While nearly all AOIT

subgroups (except students with disabilities) had graduation rates that were higher than their control group counterparts, the impacts were statistically insignificant, likely owing to smaller sample sizes. Finally, we examined whether baseline academic achievement played a role in AOIT impacts on graduation. To do this, we first created two achievement groups based on baseline achievement for the top and bottom halves. Applicants from the top half of baseline achievement who won the lottery or enrolled in AOIT graduated at rates 9-11 percentage points ($p < .05$) higher than their control-group counterparts. Digging deeper, we found that these impacts were concentrated in the middle third of all applicants, suggesting that applicants who won a seat and/or enrolled realized graduation rate gains that were 10-12 percentage points higher than their control-group counterparts in the middle of the baseline achievement distribution of the applicant pool. Of course, AOIT applicants and participants are relatively high achieving compared to the WCPSS district average. The impact here suggests that participation in AOIT is particularly impactful for those students who are neither the lowest nor highest achieving among their peers.

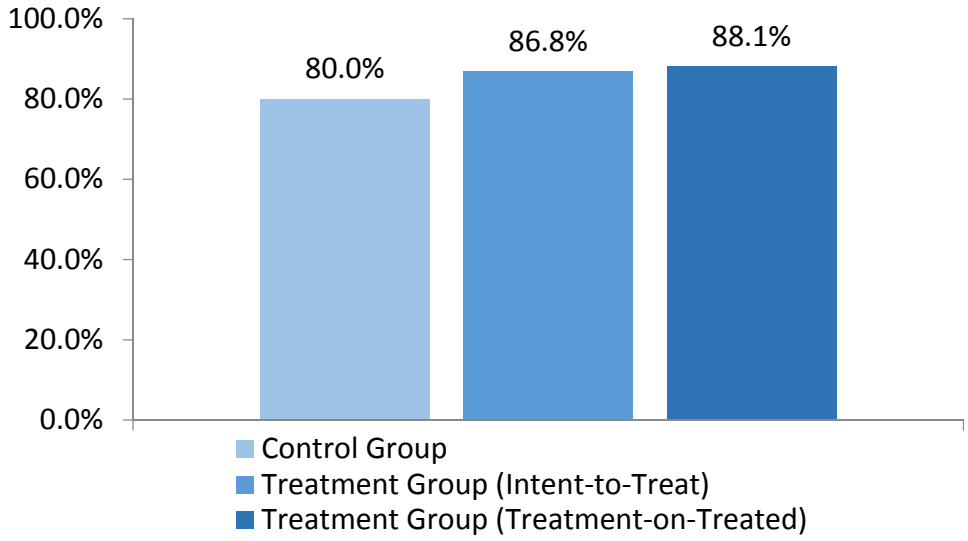
Impacts on College Enrollment

Did gaining admittance to and enrolling in AOIT impact college enrollment? We ask this because career academies are often promoted as opportunities that can prepare participants for college and career. The *National Standards of Practice for Career Academies* includes clear expectations around postsecondary readiness for contemporary academies. For example, the standards require that a career academy "meets or exceeds external standards and college entrance requirements" (NAF, 2013). However, we know very little about the actual impacts of career academies on post-secondary enrollment. While MDRC did not find effects on college enrollment in its important work, other studies provide correlational evidence that participation in older career academies may have enhanced postsecondary academic performance, encouraged persistence, and boosted rates of completion (Maxwell, 2001), especially for at-risk students (Maxwell & Rubin, 2002) and those who completed select occupational concentrations (Neumark & Rothstein, 2006).

AOIT appears to take post-secondary preparation seriously. Apex HS provides weekly planning time during which teachers of CTE courses who are a key part of the AOIT experience collaborate with teachers of the regular "academic" high school courses to weave common content and relevant applications through both sets of courses for AOIT students. In addition, AOIT aims to have its students take some sort of college-level IT course in their senior year of high school. These collective efforts appear to pay off in terms of college enrollment. Figure 6 shows that students who were admitted by lottery to AOIT enrolled in college at a rate seven percentage points higher than their counterparts who applied but were not admitted. The effect is even larger—eight percentage points—for students who ultimately enrolled in AOIT. This effect appears largely driven by male AOIT students, who enroll in college within one year of graduating high school at rates 12-14 percentage points higher than their non-AOIT counterparts (Figure 7).

Figure 6

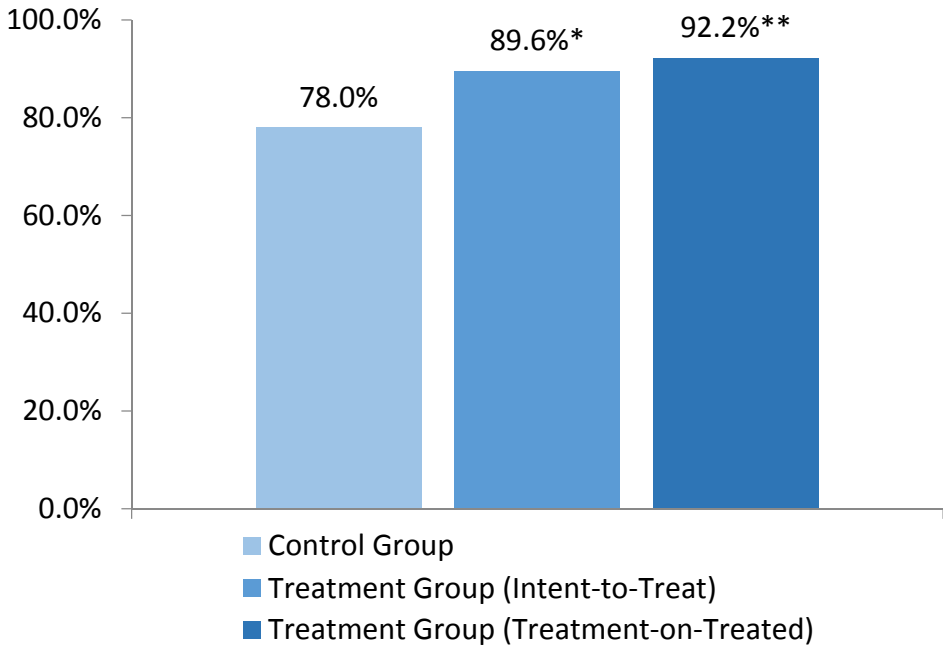
Impact of AOIT on College Enrollment within 1 Year, Graduating Classes of 2013-2016



Note: Treatment effects significant at $p < .10$.

Figure 7

Impact of AOIT on College Enrollment within 1 Year, Graduating Classes of 2013-2016, Males



* $p < .05$; ** $p < .01$

CONCLUSION

For nearly three decades, the Wake County Public School System has provided high school students with the opportunity to participate in career academies. These multi-year programs organized around specific career themes are designed to improve students' attachment to and performance in high school while exposing them to options for postsecondary study and work. This study focuses on outcomes for one such career academy—Apex High School's Academy of Information Technology (AOIT). Since its founding in 2001, AOIT has set a high bar for implementation and, as the results from this study show, engagement, high school graduation, and college enrollment.

For the graduating classes of 2013 through 2016, students who gained admittance to and ultimately attended AOIT benefited in three major ways. First, they experienced fewer days absent by the end of ninth-grade, a result that was concentrated among students who were absent more often. Second, they graduated from high school at rates higher than their non-AOIT counterparts, an outcome that was concentrated among male students. Finally, within one year of graduation, they enrolled in college at rates higher than their non-AOIT counterparts, an outcome that was also concentrated among male students. With respect to student achievement, participating in AOIT did not impact the number of Advanced Placement courses taken or performance on the exams. This finding tells us that AOIT's comprehensive IT curriculum did not interfere with access to or performance in advanced coursework.

These findings are important for two main reasons. First, few interventions have been shown to increase high school graduation rates (Murnane, 2013). We suspect this is particularly true for schools such as Apex HS where the graduation rate has, on average, exceeded the district rate. Second, the findings are noteworthy because the impacts were largely driven by male students. This contrasts with existing evidence that finds females much more responsive than males to programs and policies aimed at improving a wide range of educational outcomes (e.g., Anderson, 2008; Angrist, Lang, & Oreopoulos, 2009; Deming, Hastings, Kane, & Staiger, 2014). Our findings suggest that boys responded to the technology-rich, applied academic setting of AOIT in ways that girls did not. While there is much more we can learn about the longer-term impacts of AOIT, such as college attainment and labor market outcomes, these intermediate-term results suggest that AOIT has successfully engaged students and helped propel them through high school and into college.

RECOMMENDATIONS

Expand recruitment efforts to underrepresented student subgroups. Compared with ninth graders who enrolled in Apex High School during this period of study, a higher proportion of AOIT applicants were male (54% vs. 64%), Asian (6% vs. 10%), White (74% vs. 79%), and Academically or Intellectually Gifted in reading and/or math (26% vs. 57%). This overconcentration of select groups suggests that AOIT recruiters should expand outreach to underrepresented groups, such as Black, Hispanic/Latino, and female students, as well as students in the middle of the achievement distribution.

Across the district, adopt lottery-based admission at academies where application thresholds are met. While gaining admittance to AOIT and subsequently enrolling increased the likelihood of high school

graduation and improved college outcomes were encouraging findings, the research was limited to one school; thus, to determine the wider impact of career academies on WCPSS students participating across the district we recommend additional academies adopt a lottery-based admission process. A few additional academies are close to the threshold required to implement a lottery (at least twice the number of applicants as seats); therefore, program staff should transition to a lottery-based admission process when the 2:1 threshold is close to being met.

Strengthen adherence to the district's Career Academy Structure. We do not know exactly why AOIT has been successful at increasing high school graduation and postsecondary enrollment rates. While its success may be related to its information technology career theme, its adherence to the district's career academy pillars likely plays a role. These include strengthening the cohort-based coursework progression, cultivating a participatory advisory board, building the 4Cs (critical thinking, communication, collaboration, and creativity) into the learning experience, and consistently integrating the career theme into the core curriculum. We found that AOIT follows these pillars and suspect that many WCPSS academies can replicate its success by doing the same.

Exercise caution in attempts to replicate the IT model. Just because an IT academy produced large and significant impacts across a host of outcomes in one setting does not mean it will in any setting. The results here occurred for four cohorts of students that entered AOIT from fall 2009 to fall 2012, which excludes the previous eight cohorts. During that time, AOIT stakeholders established a strong foundation on which to ultimately realize positive results. Schools that implement a similar IT academy would presumably have to establish a similarly strong foundation.

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APPENDIX

Analytic Approach to Measuring Impacts

Our core analyses focused on estimating the effects of being offered a spot in AOIT (i.e., winning the lottery) as well as actually enrolling in the academy on a range of high school and college outcomes. Since students are randomly given the chance to participate in AOIT, the only difference between students who won the lottery and those who did not should be the opportunity to attend the academy. In all other observable and unobservable ways, both groups of students ought to be the same (in expectation). As shown in Table 6, we detected no statistically significant differences between these groups in terms of demographic characteristics or achievement at baseline, thereby substantiating a functional lottery that approximates a randomized experiment. A joint test of the statistical relationship between all baseline measures and winning the AOIT lottery produces a p-value of 0.76, indicating that we are unable to reject the null hypothesis that the means of these baseline characteristics are the same for lottery winners and losers.

To estimate intent-to-treat (ITT) effects of the offer to enroll in AOIT, we used the following model:

$$Y_{ic} = \alpha + \beta_1 CA_{ic} + \varphi X_{ic} + \sum_c \delta_c + \varepsilon_{ic} \quad (1)$$

Here, Y_{ic} is the outcome of interest (e.g., high school graduation) for student i in lottery cohort c; CA_{ic} is a variable equal to one if student i won admission via lottery to AOIT during lottery cohort c; X_{ic} is a vector of pre-lottery covariates (e.g., demographic characteristics such as sex, race and ethnicity, and prior academic achievement) included to increase statistical precision; δ_c is a set of lottery-cohort fixed effects; and ϵ_{ic} is a stochastic error term. Indicators for the lottery/cohort are necessary to ensure equivalent *ex-ante* probabilities of admission between lottery winners and losers given that winning a seat in the career academy varies from year to year. In equation 1, β_1 represents the causal effect of winning the lottery on students' outcomes.

To study the effects of participating in a career academy (i.e., treatment-on-the-treated [TOT] effects) we used lottery assignment as an instrumental variable (IV) for enrollment in a career academy. The intuition behind this approach is that we can exploit random variation in the choice to participate in a career academy insofar as it is a consequence of being offered a spot via the lottery. Thus, we used the following two-stage least squares (2SLS) setup, with enrollment (E_{ic}) as the endogenous variable in the first stage:

$$E_{ic} = \alpha + \theta_1 CA_{ic} + \gamma X_{ic} + \sum_c \delta_c + \omega_{ic} \quad (2)$$

$$Y_{ic} = \alpha + \beta_1 \hat{E}_{ic} + \phi X_{ic} + \sum_c \delta_c + \varepsilon_{ic} \quad (3)$$

Similarly named variables and vectors in equations 2 and 3 are the same as their counterparts described in equation 1. The additional variable of interest in this set of equations is E_{ic} – which is equal to one if

student i enrolls in the career academy as part of lottery cohort c. In equation 2, we used lottery assignment to isolate exogenous variation in whether a student enrolls in the career academy. In equation 3, we then used this remaining, exogenously determined variation in enrollment to identify the causal impact of participating in a career academy on our outcomes of interest. Specifically, β_1 represents the effect of enrolling in AOIT on an outcome of interest.