HOW CHANGES IN ENTRY REQUIREMENTS ALTER THE TEACHER WORKFORCE AND AFFECT STUDENT ACHIEVEMENT

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Abstract

We are in the midst of what amounts to a national experiment in how best to attract, prepare, and retain teachers, particularly for high-poverty urban schools. Using data on students and teachers in grades 3–8, this study assesses the effects of pathways into teaching in New York City on the teacher workforce and on student achievement. We ask whether teachers who enter through new routes, with reduced coursework prior to teaching, are more or less effective at improving student achievement. When compared to teachers who completed a university-based teacher education program, teachers with reduced coursework prior to entry often provide smaller initial gains in both mathematics and English language arts. Most differences disappear as the cohort matures, and many of the differences are not large in magnitude, typically 2 to 5 percent of a standard deviation. The variation in effectiveness within pathways is far greater than the average differences between pathways.

1. INTRODUCTION

Demographic changes and new policies, such as class size reduction, are increasing both the need for new teachers and the need for a greater understanding of how to prepare effective teachers. In New York City, for example, retirements and demand for teachers are straining the ability of existing teacher preparation programs to produce sufficient numbers of teachers. In addition, new standards for high achievement by all students require newly entering teachers to be more skilled than in the past. In low-performing schools with high proportions of poor and nonwhite students, the qualifications of teachers are already substantially worse than in better-performing urban and suburban schools (see, for example, Lankford, Loeb, and Wyckoff 2002). As the demand for high-quality teachers increases, these disparities are likely to worsen as schools with better working conditions and higher salaries bid away the better-qualified teachers from difficult-to-staff schools. In addition, there is evidence that a substantial majority of teachers take their first job very close to where they grew up and that urban areas hire more teachers than individuals who choose education as a profession from those areas, thus having to hire teachers from other areas, further disadvantaging urban schools (Boyd et al. 2005). Many urban districts have begun to rely on new teacher preparation programs that greatly reduce the requirements for coursework and experiences in schools prior to becoming a teacher but provide supports and additional coursework during the first years of teaching. Using data on students and teachers in grades 3–8 in New York City, this study assesses the effects of such programs on the teacher workforce and on student achievement. We ask whether teachers who enter through these new routes are more or less effective at improving student achievement than other teachers and whether the presence of these alternative pathways affects the composition of New York City's teaching workforce.

Recent research has documented the importance of teachers to student achievement (see, for example, Rivkin, Hanushek, and Kain 2005; Rockoff 2004; Sanders and Horn 1994; Sanders and Rivers 1996). Each of these studies documents the improvement of student achievement with increases in teacher experience during the first three to five years of experience, with virtually no additional gains for experience beyond five years. Many other factors, including teachers' verbal ability and subject matter preparation, contribute to teacher effectiveness (Ehrenberg and Brewer 1995; Monk 1994). Schools may also affect teacher effectiveness through, for example, resources, administrative leadership, and/or curriculum. There is some evidence that professional education can improve teachers' abilities in the classroom (National Research Council 2001; Brown and Borko 1992; Garet et al. 2001; Loucks-Horsley and Matsumoto 1999; Monk 1994). This study focuses specifically on pathways into teaching.

At the same time that schools face an increased need for new teachers, researchers and policy makers are engaged in debates over the best way to prepare teachers. While some argue that easing entry into teaching is the best way to attract strong candidates (U.S. Department of Education 2002; Finn and Madigan 2001), others argue that investing in high-quality teacher preparation will better serve schools and students (National Commission on Teaching and America's Future 1996). Most agree, however, that we lack a strong research basis for understanding how best to structure preparation requirements for teaching (see, for example, Wilson, Floden, and Ferrini-Mundy 2002). While there are many studies of how aspects of preparation affect teacher beliefs, knowledge, and practices,[1] much of the research is limited in scope, focuses on inputs rather than outcomes, or employs case study methodologies from which it is difficult to determine causal relationships or generalize to other populations. As a result, discussions about effective teacher preparation could benefit from more methodologically sophisticated research to inform the debates, especially as they pertain to preparing teachers for urban settings (see Cochran-Smith and Zeichner 2005).

Research on the effects of teacher preparation programs with reduced requirements prior to teaching is scarce—not surprisingly, given the relatively recent emergence of these programs. Some evidence, however, suggests that such programs increase the supply of teachers and change the composition of the teacher workforce (see McKibbon 1998; Shen 1999). However, to our knowledge, there is no work that assesses the effectiveness of teachers from *large-scale* programs at improving students' academic achievement.

The most relevant studies of student achievement effects come from three studies of Teach for America (TFA), a national program that recruits college seniors to teach in low-income communities for two years. Raymond, Fletcher, and Luque (2001) find that, in Houston, students of TFA teachers had higher test score gains in mathematics than did students of other teachers, many of whom were not certified. Darling-Hammond et al. (2005) use the same data and find mixed effects of TFA teachers on student test score gains, with students of TFA teachers performing relatively better in tests of mathematics than English language arts (ELA). Decker, Mayer, and Glazerman (2004) were able to compare teachers within the same grade and school in an experimental format that randomly assigned teachers to students. Using a sample of seventeen schools from Baltimore, Chicago, Los Angeles, Houston, New Orleans, and the Mississippi Delta, they find that TFA teachers were more effective at

1. For relevant work see Ball and Cohen 1999, Carnegie Forum on Education and the Economy 1986, Darling-Hammond 2000, Darling-Hammond and McLaughlin 1999, Feiman-Nemser 1983, 1990, Goodlad 1990, and Holmes Group 1986.

improving student math scores than were other teachers, though there were no statistically significant differences in reading scores.

The TFA results may or may not mirror the effects of other programs that have reduced preservice preparation aimed at increasing the supply of teachers to urban schools. TFA has brought a substantial number of teachers into schools, approximately 12,000 since 1990, and the applicant pool has been growing. Between 2000 and 2003 the applicant pool grew from 4,068 to 15,706, and the number of new TFA teachers increased from 868 to 1,656. However, it provides many fewer teachers to urban schools than do the new programs designed specifically to increase the supply of teachers (Decker, Mayer, and Glazerman 2004). For example, in 2004, the New York City Teaching Fellows program, an alternative route into teaching designed specifically to staff New York City schools, provided almost 2,500 new teachers to New York City, while TFA provided fewer than 350. Because they are so large, these new pathways may drastically change the composition of the teacher workforce in city schools. We are not aware of any studies that assess the effectiveness of these large-scale programs.

2. PATHWAYS INTO TEACHING IN NEW YORK CITY

Teachers in New York City can enter teaching through a number of different pathways. In the past, the majority of teachers have come through traditional university-based programs, at both the graduate and undergraduate levels. In these programs, students typically fulfill coursework requirements and engage in a variety of field experiences, including student teaching, before being recommended for certification by their colleges or universities. To be recommended for certification through this pathway, teachers must pass the general knowledge exam, the Liberal Arts and Science Test (LAST), a content specialty test (CST), and an assessment of teaching skills. They also must complete a university-based program that is registered with the State of New York.[2] In what follows, we refer to this pathway as "college recommended."

Teachers can also be certified through a process of individual evaluation. Such teachers fulfill similar requirements to those within a traditional program, including student teaching, but they can fulfill these requirements at different institutions, and even through distance learning. Once they have completed the requirements for certification, they submit their transcripts to

2. In 1998 the New York State Board of Regents revised the registration requirements of teacher education programs to be effective for graduates applying for certification beginning in February 2004. These new requirements reflect a substantial increase in preparation requirements. However, very few of the teachers employed in this analysis, all of whom were certified prior to September 2003, would have been affected by these new requirements. In subsequent analysis we will explore the effect of these new requirements.

the State Department of Education for review. The state then either issues a certificate or stipulates the requirements that must be met before a certificate can be awarded.

As the need for teachers to fill the city's classrooms intensified, an increasing number of teachers began to enter teaching without prior preparation. These teachers were hired under temporary licenses, which enabled them to serve as the teacher of record in the classroom, but without having fulfilled certification requirements. In the spring of 2002, New York City employed 12,400 teachers with temporary licenses (New York State Department of Education). The New York State Regents required that all teachers in New York City be certified by September 2003—in theory ending temporary certification. While the number of teachers holding temporary licenses has declined dramatically, New York State has allowed the limited use of modified temporary licenses to be issued for school districts that are experiencing shortages of certified teachers. However, teachers employed with these modified temporary licenses must have completed at least twenty-seven credit hours of a preparation program and must be actively moving toward certification. In addition, they cannot teach in low-performing schools, and their licenses are valid only for one year and are currently set to expire following the 2004–5 school year.

Not surprisingly, these new policies resulted in a shortage of certified teachers for New York City. Because of these and similar shortages in other school districts, the Regents approved a framework for alternative routes into teaching, "designed to attract highly competent people who possess a bachelor's degree with a major in the subject they plan to teach, but initially lack courses in teaching" (Office of Teaching Initiatives, New York State Department of Education). Participants in these alternative-route programs are expected to complete two hundred hours of preservice training and pass the LAST and the CST before entering the classroom. These teachers are issued "Transitional B" certificates, good for three years, following the introductory component. As teachers of record, they are expected to enroll in teacher education programs at partner colleges to fulfill certification requirements. The New York City Teaching Fellows, Teach for America, and the Teaching Opportunity Program (TOP) are all examples of alternative-route programs that provide teachers with Transitional B certificates. Participants enrolled in alternative-route programs must fulfill the same requirements as all other candidates for teaching certificates; thus, by the end of their programs, they have completed a similar set of courses to those taken by graduates of college-recommended programs. However, the costs of entering teaching through an alternative route are substantially less for the individual teacher than the costs of traditional university-based teacher preparation, both because alternative-route teachers earn a salary throughout their training and because, in the Teaching Fellows program and Teach for

America, they pay a reduced rate for the coursework taken. Conversely, the cost to the City is higher for these teachers because of the subsidized education.[3]

Teach for America recruits teachers for high-poverty schools in a number of areas around the country. They recruit teachers nationally, targeting recent graduates of elite colleges and universities; the recruitment process is extremely selective. Once corps members are selected, they must attend a summer training institute, run by Teach for America, prior to being placed in a classroom. The curriculum is designed by TFA and includes six components, in addition to a summer teaching experience in New York City. Once corps members begin teaching, they continue to take courses with a local partner university. TFA requires a two-year commitment; at the end of this period, corps members earn certification, and many also earn a master's degree.

The NYC Teaching Fellows (Fellows) began in the spring of 2000 to address shortages in NYC public schools. In its recruitment the program targets midcareer professionals as well as recent college graduates. The Teaching Fellows program has grown from 325 in its first year to more than 2,000 Fellows in 2004–5. The Fellows program is one of the largest alternative-route programs in the country. Currently, more than 6,000 Fellows are teaching in NYC schools (New York City Teaching Fellows 2005). Prior to entering the classroom as teachers of record, Fellows complete an introductory component, usually offered in the summer, which includes some time in local classrooms. The courses are taught by instructors at the partner universities. Once fellows begin teaching, they continue to take classes at their partner institution. Most Teaching Fellows complete their programs within two years. Teaching Fellows are generally older than TFA corps members, and approximately 20 percent of Fellows have completed graduate degrees. Teaching Fellows are typically placed in shortage subjects and schools and in the last few years are more likely to teach math, science, and special education than childhood education.

While TFA and the Teaching Fellows are the focus of this article, they are not the only alternative routes serving New York City. For example, the Teaching Opportunity Program (TOP) is a collaborative initiative between the City University of New York (CUNY) and the NYC Department of Education to produce middle and high school math, science, and Spanish teachers. Participants in TOP also take part in an intensive summer program run by a CUNY campus that includes experiences in local schools. Once they enter

3. The City covers the cost of the summer training program and stipend (about $2,500) for Teaching Fellows. In addition, New York City pays an additional $8,000 toward the cost of their master's degree over the next two years, while each of the Teaching Fellows pays $4,000 toward these degrees.

Table 1. Trends in the Numbers of First-Time New York City Teachers Entering through Different Pathways, 1996–2004

Path of Entry	1996	1997	1998	1999	2000	2001	2002	2003	2004	All
College recommended	1,260	2,192	2,901	2,840	2,618	2,375	2,018	2,434	2,192	20,830
Individual evaluation	433	740	766	736	657	534	517	712	682	5,777
Teaching Fellow	0	0	0	0	0	383	1,121	1,829	2,441	5,774
Teach for America*	0	0	0	0	0	118	115	189	360	782
Temporary license	1,617	2,561	2,927	3,495	3,886	4,017	4,230	2,671	607	26,011
Other	50	129	172	192	268	543	912	1,106	1,263	2,896
Prior New York State teaching	46	94	115	102	110	128	154	235	237	1,221
All	3,406	5,716	6,881	7,365	7,539	8,098	9,067	9,176	7,782	65,030

*Prior to 2001, Teach for America members were classified as temporary-license teachers.

the classroom, they continue to take courses at CUNY that count toward both their certification and master's degrees. TOP participants generally complete their requirements for certification and an master's degree in two to three years, after which they are committed to teaching in NYC public schools for an additional two years.

The distinction between alternative and traditional routes can be quite blurry. For example, many participants in traditional graduate programs in teacher education apply for an internship certificate when they have completed sufficient coursework. With this certificate they are able to become the teacher of record in the classroom, earning a salary while they complete the rest of their program and obtain a master's degree. Given this blurry nature of the distinction between alternative and traditional routes as well as the many pathways into teaching in New York City, there are many ways by which to distinguish pathways. For much of our analyses we divide teachers into six groups as defined by their pathway into their *first* job in New York City. These groups are (1) college-recommended; (2) individual-evaluation; (3) Teaching Fellows; (4) Teach for America; (5) temporary license; and (6) other. The "other" group includes all teachers not fitting in the other five categories, including internship certificates, Transitional B teachers, and those with certification through reciprocity agreements with other states.

Table 1 shows the trends in the number of first-year New York City teachers by pathway. The first trend to notice is the substantial increase in new teachers during the late 1990s and early 2000s. In 1996, 3,406 teachers began working in New York City for the first time. The size of this group peaked in 2003, when 9,176 new teachers entered the school system. This increase results from an abnormally small number of new hires in 1996, due to budget restrictions, combined with increasing enrollments, smaller class sizes, and increasing attrition over the period. The rise in the number of new teachers corresponded to an increase in the number of college-recommended new teachers from 1,260 in 1996 to 2,840 in 1999, but this contributed only a portion of the total number of new teachers. In addition, there was a large increase in the number of teachers with temporary licenses: from 1,617 in 1995–96 to over 4,000 in 2000–2001 and 2001–2. Prior to the 1999–2000 academic year there were no Teaching Fellows and only a few Teach for America teachers, but these groups grew rapidly over the next four years, providing 2,441 and 350 teachers in 2003 and 2004, respectively. The rapid increase in the size of these programs corresponds to a substantial decrease in the number of temporary-license teachers and a small decrease in the number of college-recommended teachers, indicating that the majority of the alternative route teachers are filling positions that previously had been filled by teachers with temporary licenses.

Table 2 describes the characteristics of teachers entering New York City public schools through different pathways. Differences are evident across pathways, with teachers entering through alternative routes demonstrating better performance on measures of academic preparation and/or general ability than those from other pathways. In the 2003–4 academic year, for example, none of the new TFA teachers and less than 2 percent of the Teaching Fellows had failed the general knowledge certification exam the first time they took it, compared with 16 percent of college-recommended and individual-evaluation teachers and 23 percent of temporary-license teachers. Similarly, 44 percent of Teaching Fellows and 70 percent of TFA members graduated from highly competitive colleges (as rated by *Barron's* as most competitive or highly competitive), compared with much lower rates from the other pathways.

A relevant question is whether the introduction of the Teaching Fellows and TFA programs altered the characteristics of teachers entering through other routes. Given the economic incentives, it would not be surprising if it had. The trends in table 2 show some indication of this, but the effects appear small. For example, the scores on the LAST for college-recommended teachers drops slightly after the introduction of the Teaching Fellows program in 2000–2001. However, the proportion of college-recommended and individual-evaluation teachers from more competitive colleges increases over this time, while the proportion from the least competitive colleges decreases.

In summary, the introduction of new pathways into teaching that reduced both the tuition and the time costs of preservice preparation attracted many new teachers. These new teachers primarily replaced temporary-license teachers, a group that had been growing in the years prior to the introduction of the new programs. The alternative-route teachers have stronger measures of qualifications than teachers entering through any other route, especially the

Table 2. Trends in the Characteristics of Teachers Entering New York City for the First Time by Pathway, 1996–2004

Path of Entry	1996	1997	1998	1999	2000	2001	2002	2003	2004	All
	Proportion who failed the general knowledge certification exam									
College recommended	0.136	0.144	0.143	0.132	0.117	0.126	0.134	0.145	0.162	0.137
Individual evaluation	0.149	0.14	0.172	0.169	0.173	0.15	0.165	0.172	0.161	0.162
Teaching Fellow						0.056	0.106	0.065	0.018	0.055
Teach for America						0.037	0.02	0.011	0	0.009
Temp license	0.369	0.358	0.362	0.332	0.364	0.385	0.389	0.329	0.227	0.357
	Score on liberal arts and science test — standard deviation =									
College recommended	252.08	250.01	249.97	250.06	250.4	248.39	247.54	247.17	246.07	248.86
Individual evaluation	262.37	254.59	252.37	250.68	249.84	249.03	249.02	246.38	247.23	249.75
Teaching Fellow						266.83	256.34	261.84	267.46	263.23
Teach for America						273.5	271.62	270.67	275.71	273.33
Temp license	233.71	233.56	234.8	236.51	232.59	229.39	229.41	234.4	241.69	232.97
	Proportion from most or highly competitive colleges									
College recommended	0.107	0.1	0.085	0.081	0.095	0.102	0.107	0.123	0.114	0.1
Individual evaluation	0.135	0.147	0.139	0.151	0.154	0.098	0.112	0.135	0.151	0.138
Teaching Fellow						0.361	0.279	0.401	0.442	0.391
Teach for America						0.677	0.462	0.778	0.695	0.694
Temp license	0.14	0.144	0.14	0.136	0.125	0.115	0.126	0.142	0.175	0.132
	Proportion from less or least competitive colleges									
College recommended	0.233	0.25	0.269	0.256	0.259	0.251	0.235	0.213	0.217	0.245
Individual evaluation	0.199	0.174	0.212	0.241	0.228	0.312	0.268	0.269	0.281	0.241
Teaching Fellow						0.18	0.15	0.114	0.104	0.121
Teach for America						0.04	0	0.024	0.033	0.03
Temp license	0.262	0.251	0.244	0.27	0.27	0.282	0.272	0.247	0.229	0.264

temporarily licensed teachers they largely replaced. While the presence of the alternative routes is likely to have drawn some teachers away from traditional preparation because they are less costly for the student to complete, the change has not led to a substantial drop in numbers or in the average measured educational achievement of new college-recommended teachers. In recent years, Teaching Fellows placements are largely targeted on difficult-to-staff subjects, such as middle and high school math and science, and special education, subjects that attract very few traditionally prepared applicants.

3. DATA

Estimating the effect of teachers on student achievement requires good student test score data. At present there are very few places that have data that would allow an examination of the effects of teacher pathways into teaching on the performance of the students they teach. New York City is one such place and, importantly, it provides an extraordinary range and quantity of teaching and learning environments to examine these relationships. New York State gives statewide student exams in mathematics and English language arts in fourth and eighth grades. In addition, the New York City Department of Education tests third, fifth, sixth, and seventh graders in these subjects. All the exams are aligned to the New York State learning standards; each set of tests is scaled to reflect item difficulty, and the tests are equated across grades and over time.[4] Tests are given to all registered students with limited accommodations and exclusions. Thus, for nearly all students the tests provide a consistent assessment of learning for a student from one grade to the next.

Recent articles by Ballou (2002) and Kane and Staiger (2001) raise concerns about how achievement tests are being used in accountability systems. Sanders (2003) and Rogosa (2002) argue that some of these concerns are overstated or mischaracterized or can be addressed through proper design of accountability systems. Because the score is the dependent variable, its measurement error reduces the precision of parameter estimates but does not create bias. Our large sample sizes help compensate for potential increases in the standard errors of the estimates. In addition, our goal is to accurately measure not the value added by individual teachers and schools but, rather, the relationship between scores and teacher *pathways*, groups that are substantially larger than individual teachers or small schools. Statistically, this requires far less precision in achievement measures than that required for an accountability system.

To conduct the analysis of the relationship between pathways into teaching and student achievement, we create a student database with student exam scores, lagged scores, and characteristics of students and their peers linked

4. There are some discrepancies and changes in the exams. The mathematics exams in all grades are developed by CTB-McGraw Hill. New York State employs CTB-McGraw Hill for its fourth- and eighth-grade ELA exams. In 2003 New York City switched from CTB to Harcourt Brace for its third-, fifth-, sixth-, and seventh-grade exams. At that time there was an equating study done to accommodate the switch in exams producers. The format and dimensions of the State and City exams differ in some ways, and there have been some changes in item pools over time. Finally, the State offers the fourth- and eighth-grade mathematics exams in the first two weeks of May, while the City offers the third, fifth-seventh mathematics exams the last week of April or the first week of May. The State offers the fourth- and eighth-grade ELA exams in the first week of February, while the City offers the third-, fifth-, sixth-, and seventh-grade ELA exams in the second week of April. Because of these discrepancies, we have normalized each exam by grade and year and included grade and year dummies.

to their schools, teachers, and characteristics of those teachers, including indicators of the pathway into teaching. The student data, provided by the New York City Department of Education (NYCDOE), consists of a demographic data file and an exam data file for each year from 1998–99 through 2003–4. The demographic files include measures of gender, ethnicity, language spoken at home, free lunch status, special education status, number of absences, and number of suspensions for each student who was active in any of grades 3–8 that year—approximately 450,000 to 500,000 students each year. They also include fall and spring codes for the student's school, official class (homeroom), and, for upper-grade students for whom the homeroom teacher often is not the subject matter teacher, the course and section number for the English language arts and mathematics classes.

The exam files include, among other things, the year in which an exam was given, the grade level of the exam (e.g., a grade between third and eighth), and the student's scaled score on the exam. For most years, the files contain scores for approximately 65,000 to 80,000 students in each grade. The only significant exception is that the files contain no scores for seventh-grade English language arts in 2002 because the New York City Department of Education is not confident that exam scores for that year and grade were measured in a manner that was comparable to the seventh-grade English language arts exam in other years.

Using these data, we construct a set of records with a student's current exam score and his or her lagged exam score. For this purpose, a student was considered to have value-added information in cases where we had a score in a given subject (ELA or math) for the current year and a score for the same subject in the immediately preceding year for the immediately preceding grade. We do not include cases in which a student took a test for the same grade two years in a row, or where a student skipped a grade.

While NYCDOE does not maintain an identifier linking students directly to their teachers, in most cases we were able to create our own links using school and course identifiers because the NYCDOE's data systems track the courses taken by each student and the courses taught by each teacher. Based on advice from NYCDOE staff, we matched students in grades 3–5 to teachers based on the homeroom identifier, and matched students in grades 6–8 based on the section of a course being taught. Unfortunately, some middle schools do not participate in NYCDOE's middle school performance assessment system (MSPA), and in those cases the course-section identifier is not linked centrally to teachers. Because of this, our matches are much lower for grades 6–8 than for grades 3–5. The matches for grade 6 in particular are lower than for other grades. On average, in grades 3–5 we have valid teacher identification for approximately 96 to 98 percent of students with exam scores; for grades 7 and 8 we have valid matches for about two-thirds of students with exam scores; and for grade 6 we have valid identifications for about half of the students. Overall, we had valid matches for approximately 80 percent of students with exam scores.[5]

To enrich our data on teachers, we match New York City teachers to data from New York State Education Department databases, using a crosswalk file provided by NYCDOE that links their teacher file reference numbers to unique identifiers compatible with both databases. We draw variables for NYC teachers from New York State data files as follows:

- Teacher Experience: For teacher experience, we use transaction-level data from the NYCDOE Division of Human Resources to identify when individuals joined the NYCDOE payroll system in a teaching position. When this information is missing or when the value is less than the value in the NYSED personnel master files, we use the NYSED data.
- Teacher Demographics: We draw gender, ethnicity, and age from a combined analysis of all available data files, to choose most-common values for individuals.
- Undergraduate: We identify the institutions from which individual teachers earned their undergraduate degrees from the NYS Teacher Certification Database (TCERT) and combine it with the *Barron's* ranking of college selectivity to construct variables measuring the selectivity of the college from which each teacher graduated.
- Test Performance: We draw information regarding the teacher certification exam scores of individual teachers and whether they passed on their first attempts from the NYS Teacher Certification Exam History File (EHF).
- Pathway: Initial pathway into teaching comes from an analysis of teacher certification applications plus separate data files for individuals who participated in Teach for America, the Teaching Fellows Program, and the New York City Teaching Opportunity Program.

5. The average attributes of sixth- through eighth-grade students who are matched to teachers compared to those who are not matched are substantially the same with a few exceptions. Matches in sixth and seventh grades had lower achievement gains than nonmatches (.019 vs. .105 and .055 vs. .061 respectively). Sixth-grade achievement scores for nonmatches also exceeded those for matches (.212 vs. .159). In addition, matches were more likely to include black and Asian students and less likely to include Hispanics than nonmatches. For the remaining student variables (seventh- and eighth-grade achievement scores, absences, suspensions, white students, home language, gender, free lunch status) differences were frequently statistically significant due to the very large number of students but did not differ by more than 5 percent. As one way of assessing the importance of these differences, we estimated pathway effects by grade and found only small differences across grades 6–8. We have no reason to believe that differences in achievement gains are correlated with pathways and thus believe our pathway estimates are unbiased.

- College-recommended: We obtain indicators for whether an individual had completed a college-recommended teacher preparation program, and, if so, the level of degree obtained (bachelor's or master's), from NYSED's program completers data files.

Using these data, we construct our indicator of the pathway into teaching as follows. Any individual who is separately identified as participating in Teach for America, Teaching Fellows, or the Teaching Opportunity Program is coded as entering teaching through that pathway, as appropriate. For other individuals, we examine certification application records to determine the *earliest* pathway for which they had approval from NYSED prior to their first teaching job in the New York State public schools, with those pathways defined as: (1) traditional college recommended; (2) individual evaluation; (3) temporary license (individuals who failed to complete one or more requirements for a teaching certificate but were allowed to teach under the temporary-license provisions, whereby a school district can request NYSED to allow a specific individual to teach in a specific school for a temporary period); (4) other certificates, including internship certificates, other Transitional B teachers, and those with certification through reciprocity agreements with other states.

There are 1,035,949 student observations for the assessment of mathematics achievement and 926,958 student observations for the assessment of ELA achievement. These observations include information on current and prior test performance as well as information on all other variables used in the models except free lunch program participation. There is substantial missing data on this variable, and we run our analysis both with the reduced sample and with this variable recoded so that those with missing information are assumed not to be eligible.

The percent of black and Hispanic student observations are about equal at 35 to 37 percent, while just over 11 percent of student observations are Asian.[6] Approximately three-quarters of the sample is eligible for free lunch, and approximately 40 percent speak a language other than English at home. As noted above, we have better student coverage in the elementary grades: for example, in math, 27 percent of the sample comes from the fourth grade, compared with 14 percent from the sixth grade and 16 percent from the eighth grade. As expected, the largest group of students is taught by college-recommended teachers (38 percent), though a large proportion is taught by temporary-license

6. A table that documents the following description of the attributes of students in our sample is available on the *Education Finance and Policy* Web site.

teachers (37 percent), with smaller shares for independent-evaluation teachers (14 percent), Teaching Fellows (4 percent), and TFA members (1 percent). The ELA sample has a higher percent of college-recommended teachers than does the math sample because these teachers are less likely to teach middle school math. They are replaced there largely by temporary-license teachers. Finally, because of issues with the tests discussed above, we standardized each test score for each grade and year to have a standard deviation of one and a mean of zero. The average gain in these standardized scores is zero, but the standard deviation is 0.66 for math and 0.71 for ELA.[7]

Teachers differ by pathway in the characteristics of their students.[8] When we examine only first-year teachers who began teaching in New York City between 1998–99 and 2003–4, we find that Teaching Fellows and TFA teachers work with students who are more likely to be nonwhite, poor, and low-performing than teachers from other pathways do. While, on average, 9 percent of students are white, less than 1 percent of students taught by TFA teachers are white, and only 3 percent of students taught by Fellows are white, compared with 16 percent of the students of college-recommended teachers. Similarly, approximately 82 percent of the students of first-year teachers are eligible for free lunch; the corresponding numbers are 76 percent for college-recommended teachers, 88 percent for Teaching Fellows, 92 percent for TFA members, and 83 percent for temporary-license teachers. Prior test scores show the same pattern. They are −0.26 on average for first-year teachers; −0.14 for college-recommended; −0.29 for temporary-license; −0.38 for Fellows; and −0.51 for TFA members.[9]

TFA teachers are the youngest; college-recommended teachers, the next youngest; and the other pathways include teachers of similar average ages. Most teachers are female, particularly college-recommended teachers. Fellows have the highest percent of male teachers, at 33 percent. Most teachers are white. Temporary-license teachers are the most racially diverse, with 19 percent black and 28 percent Hispanic. We find that college-recommended teachers are the least likely to have attended a highly competitive college, while TFA members are by far the most likely. The temporary-license teachers performed the least well on the general knowledge certification exam, with over 30 percent failing on the first try, while no TFA member in this sample failed.

7. The standard deviation of the gain is similar across grade levels.
8. A table showing the details of attributes of teachers and students by the pathways is available on the *Education Finance and Policy* Web site.
9. The greater proportion of Hispanic students relative to black students taught by TFA members is largely due to the placement of TFA teachers in Washington Heights and the South Bronx.

4. METHODS

How do the achievement gains of students differ by the teaching pathway of their teachers? Specifically, do students of teachers who enter the classroom with reduced coursework preparation and few prior field experiences achieve gains that are higher or lower than they would have if they were taught by traditionally certified or temporary-license teachers? Analyses considering whether teachers from one pathway are more effective than those from another pathway need to account for differences both in the students that teachers teach and in the work environments in which they teach. Different pathways into teaching lead teachers into schools with different characteristics and different students. Thus, we must account for these differences in the matching of teachers to schools and students if we are to accurately assess the effect of pathway. Because TFA members, for example, are assigned to schools that have traditionally been difficult to staff, the achievement of their students may be lower than the achievement of other students; but we would not want to attribute this difference to a negative causal relationship between TFA and student achievement. Importantly, students may be similar in many measured characteristics such as race/ethnicity or free lunch participation, but have different achievement trajectories due, for example, to the school they attend. If teachers from different pathways are differentially assigned to schools in which students are likely to learn more (or less), then we need to account for these differences.

While there is much agreement among researchers about the need to account for these assignment and selection issues, there is less agreement about which model specification is the most accurate for this accounting. Because of this, we choose to run a number of different specifications in order to test the robustness of the estimated effects. The base model that we used is summarized by equation 1.

$$\mathbf{A}_{isgty} = \boldsymbol{\gamma}_0 + \boldsymbol{\gamma}_1 \mathbf{A}_{is'g(g-1)t'(y-1)} + \gamma_2 \mathbf{S}_{iy} + \mathbf{C}_{jt}\gamma_3 + \mathbf{E}_{jt}\gamma_4 + \mathbf{P}_j\gamma_5 + \boldsymbol{\pi}_s + \boldsymbol{\pi}_g + \boldsymbol{\pi}_y + \boldsymbol{\epsilon}_{isgty} \quad (1)$$

Here the standardized achievement level (test score) A of student i in school s in grade g with teacher t in year y is a linear function of the student's test score in the prior year plus the square of this, characteristics of the student S, characteristics of the other students in the same grade with the same teacher in that year C, the teacher's teaching experience E, and the pathway the teacher took into teaching P. Student characteristics include gender, race/ethnicity, poverty status, days absent during the prior year, and suspensions in the prior year. The aggregate (teacher by grade by school by year) student characteristics include race/ethnicity, poverty status, average attendance in the prior year, average suspensions in the prior year, average student test scores in the prior year, and the standard deviation of student test scores in the prior year. Teaching experience is measured by dummy variables for each year of teaching from the first year through the twentieth and then an additional dummy variable for experience greater than twenty years. In addition, the model includes fixed effects for years, grades, and schools. The standard errors are clustered at the teacher level to account for the fact that teacher pathway is a teacher-level variable.

This model controls for all the attributes of students that typically remain constant from one year to the next, such as parental support and home environment. It also controls for all the characteristics of schools that do not change over the 2000–2004 period by including a school fixed effect. One implication of this approach is that the effectiveness of a teacher pathway is compared only to other pathways in the same school. In this way, we do not attribute to teachers or their pathways any effect that may differ from one school to another but that is not measured by the included school or class characteristics.[10] This is generally a conservative approach to the identification of the effects of pathway effectiveness. We find in our specification checks that the results are robust to an even more conservative approach of including school-by-year-by-grade fixed effects that effectively compare a teacher's pathway to other pathways in the same school, year, and grade. Finally, we assume that included student and class variables control for any within-school assignment of teacher pathways to classes that may be correlated with student achievement.

This model assumes that the returns to experience are similar across pathways. This may not be the case. Teachers from different pathways enter with very different experiences and strengths. We might imagine that teachers who have had few classroom experiences prior to teaching may gain differentially in their teaching effectiveness over the first few years. This may be especially true for teachers entering through alternative certification pathways. They may

10. School fixed effects account for unobservable differences across schools. We cannot use the same approach for classrooms because there is only one teacher in each classroom. Because of this, we use controls for classroom characteristics; however, there may still be omitted unobserved characteristics related to teacher pathways. In order to assess the likelihood of omitted variables bias, we examine whether *within schools* teachers entering from different pathways systematically teach students with different observed characteristics. If classrooms differ in observables by pathway, they probably are more likely to differ in unobservables as well. We find that there is no statistically significant difference in lagged student absences by pathway and that the only difference in lagged achievement scores are between temporary-license teachers and most other teachers. Teachers with temporary licenses teach students who enter the class with lower test scores. Thus, while it is possible that our estimates may be affected by omitted variable bias, we believe this is unlikely.

gain more because they are learning what many teachers learned prior to starting, either through on-the-job-training or through their ongoing education in master's programs, plus the typical things that teachers learn over the first couple of years. Alternatively, they may be so overwhelmed by figuring out how to get the class in order or they may have such little training in areas such as child development or the teaching of specific subject matters that they have less time and less of a framework to help them grow as teachers. In a second model, we add interactions between pathway and teacher experience in order to estimate these differences in returns to experience.

5. RESULTS

Tables 3a and 3b give the results for the base model for mathematics achievement and English language arts achievement, respectively. The base models aggregate the effects of students in grades 4 through 8. Two sets of estimates are presented: the total pathway effects that summarize the average results by pathway; and a set of results that indicate the differential effects of pathway by the level of teacher experience. First consider the student-level variables. As expected, there is a strong positive relationship between the current score and the lagged score. Black and Hispanic students, along with students receiving free lunch, demonstrate smaller gains over the year, in both mathematics and ELA, than white students and students from higher-income families. The estimate for black students is particularly large. The standard deviation in test score gain over the year for mathematics is approximately 0.66 points, indicating that black students gain approximately 16.5 percent of a standard deviation less than white students over the course of a year, holding all else constant. Female students gain less in math and more in ELA than do male students. Aggregate student measures also appear to affect test score gains. In particular, classes with a greater proportion of black or Hispanic students or a lower average starting test score gain substantially less on average than other classrooms.

Other studies have found (Rivkin, Hanushek, and Kain 2005; Rockoff 2004) that teacher experience is an important influence on student achievement. Tables 3a and 3b provide estimates of these effects for teachers by their level of experience. The experience estimates for this model include two components—the effect of additional years of teaching on the effectiveness of individual teachers and the differential selection of teachers across years of experience both as a result of quitting and through the change in the teacher labor market over time. For example, if many of the least able teachers left after their first year, then student achievement would increase for second-year teachers relative to first-year teachers even if the teachers who remained in the second year had not improved. Estimates that hold constant the selection of teachers provide insight on the extent to which average student achievement increases as teachers gain the knowledge that comes with experience. If, however, the question is taken from the student perspective—to what extent are students advantaged by having a second- or third-year teacher relative to a novice?—then it is important to include both the individual and selection effects of experience. Since our interest is in understanding the differences across pathways, which potentially include both differential gains in individual teacher effectiveness as well as differential retention, we focus primarily on the total effect.

Tables 3a and 3b show differences in the student achievement gains associated with teaching experience. For example, for math achievement, second-year teachers have average gains that are about 0.05 points (7.6 percent of a standard deviation) larger than those of first-year teachers. Third-year teachers have students that gain approximately .02 points more students of second-year teachers (.067 − .050 or about 3 percent of a standard deviation difference in test score gains). There are few gains to experience after the third year of teaching.

The variables listed under Teacher Pathway of tables 3a and 3b provide the estimates of the effects of pathways into teaching. These effects are relative to college-recommended teachers. For the total pathway results for mathematics, we see that the coefficient on Individual Evaluation is −.012, indicating that students with teachers who entered New York City through this pathway show a test score gain lower than 1.8 percent of a standard deviation (the standard deviation of the gain is 0.66) than that of students with college-recommended teachers. Students of TFA members have similar test scores to those of college-recommended teachers, while students of Teaching Fellows, temporary-license teachers, and teachers who entered through other pathways show the smallest gains, approximately 3.3 percent of standard deviation lower than college-recommended. The relationships for ELA are somewhat different. Individual-evaluation teachers have students with gains about equal to those of college-recommended teachers, while students of Teaching Fellows and TFA teachers show lower gains. Temporary-license teachers and other teachers demonstrate effects that are somewhat lower than college-recommended teachers and higher than Teaching Fellows.

The effect of experience by pathway is shown in the Experience by Pathway column and is summarized in table 4. When we examine the results for pathway by experience, teachers improve with experience over the first few years. However, there appears, in this specification, to be little difference in returns to experience across pathways. While the point estimates suggest that Fellows and TFA teachers gain relative to college-recommended teachers as

Table 3a. Base Model Student Achievement for Math with School Fixed Effects

STUDENT MEASURES			TEACHER EXPERIENCE			TEACHER PATHWAY		
	Total Pathway	**Experience by Path**		**Total Pathway**	**Experience by Path**		**Total Pathway**	**Experience by Path**
Lag score	0.659***	0.659***	2 years	0.048***	0.050***	IE	−0.012**	−0.014
	(0.002)	(0.002)		(0.005)	(0.008)		(0.005)	(0.017)
Lag score sqrd	0.001	0.001	3 years	0.067***	0.067***	Fellows	−0.023***	−0.020*
	(0.001)	(0.001)		(0.005)	(0.009)		(0.008)	(0.011)
Female	−0.009***	−0.009***	4 years	0.073***	0.079***	TFA	0.007	0.009
	(0.001)	(0.001)		(0.006)	(0.008)		(0.015)	(0.018)
Other ethnicity	−0.088***	−0.088***	5 years	0.077***	0.083***	Temporary	−0.021***	−0.011
	(0.011)	(0.011)		(0.006)	(0.009)		(0.004)	(0.009)
Asian	0.114***	0.114***	6 years	0.080***	0.085***	Other	−0.021***	−0.023*
	(0.003)	(0.003)		(0.007)	(0.009)		(0.008)	(0.013)
Hispanic	−0.083***	−0.083***	7 years	0.068***	0.073***	IE*Exp2		−0.014
	(0.003)	(0.003)		(0.007)	(0.009)			(0.023)
Black	−0.109***	−0.109***	8 years	0.075***	0.080***	IE* Exp3		−0.005
	(0.003)	(0.003)		(0.008)	(0.010)			(0.024)
English home	−0.047***	−0.047***	9 years	0.070***	0.075***	IE*Exp>3		0.002
	(0.002)	(0.002)		(0.008)	(0.010)			(0.018)
Free lunch	−0.046***	−0.046***	10 years	0.074***	0.079***	Fellows*Exp2		0.016
	(0.002)	(0.002)		(0.008)	(0.010)			(0.016)
Lagged absent	−0.004***	−0.004***	11 years	0.071***	0.076***	Fellow*Exp3		0.02
	(0.000)	(0.000)		(0.008)	(0.010)			(0.023)
Lag suspended	−0.052***	−0.052***	12 years	0.065***	0.070***	Fellows*Exp>3		−0.105***
	(0.004)	(0.004)		(0.009)	(0.011)			(0.025)

Class Average Measures		
Other ethnicity	−0.177	−0.18
	(0.115)	(0.115)
Hispanic	−0.182***	−0.183***
	(0.028)	(0.028)
Black	−0.230***	−0.231***
	(0.026)	(0.026)
Asian	−0.061*	−0.061*
	(0.033)	(0.033)
English home	0.042**	0.042**
	(0.019)	(0.019)
Free lunch	−0.057***	−0.057***
	(0.013)	(0.013)
Lagged absent	−0.010***	−0.010***
	(0.001)	(0.001)
Lag suspended	−0.078**	−0.077**
	(0.033)	(0.033)
Lag score	0.154***	0.153***
	(0.005)	(0.005)
Std. dev. score deviat.	0.006	0.006
	(0.008)	(0.008)
Other		
Constant	0.321***	0.324***
	(0.029)	(0.029)
Observations	960,970	960,970
Rt-squared	0.64	0.64

13 years	0.062***	0.067***
	(0.009)	(0.011)
14 years	0.080***	0.085***
	(0.010)	(0.011)
15 years	0.056***	0.061***
	(0.009)	(0.011)
16 years	0.054***	0.059***
	(0.009)	(0.011)
17 years	0.053***	0.058***
	(0.010)	(0.012)
18 years	0.059***	0.064***
	(0.011)	(0.013)
19 years	0.040***	0.045***
	(0.012)	(0.014)
20 years	0.049***	0.054***
	(0.012)	(0.014)
> 20 years	0.055***	0.059***
	(0.007)	(0.009)
Year		
2000	0.018***	0.018***
	(0.004)	(0.004)
2001	0.008*	0.008*
	(0.004)	(0.004)
2002	0.011***	0.012***
	(0.004)	(0.004)
2003	0.004	0.004
	(0.004)	(0.004)

TFA*Exp2		−0.004
		(0.025)
TFA*Exp3		0.028
		(0.045)
TFA*Exp>3		−0.012
		(0.045)
Temp*Exp2		−0.011
		(0.011)
Temp*Exp3		−0.005
		(0.012)
Temp*Exp>3		−0.012
		(0.010)
Other*Exp2		0.02
		(0.020)
Other*Exp3		0.021
		(0.022)
Other*Exp>3		−0.003
		(0.016)
Grade		
5	0.006	0.007
	(0.005)	(0.005)
6	0.158***	0.158***
	(0.011)	(0.011)
7	0.186***	0.185***
	(0.011)	(0.011)
8	0.198***	0.197***
	(0.011)	(0.011)

Notes: Robust standard errors in parentheses. *significant at 10%; **significant at 5%; *** significant at 1%. Results for TFA in the third year should be interpreted with caution due to small sample sizes.

Table 3b. Base Model Student Achievement for ELA with School Fixed Effects

STUDENT MEASURES			TEACHER EXPERIENCE			TEACHER PATHWAY		
	Total Pathway	**Experience by Path**		**Total Pathway**	**Experience by Path**		**Total Pathway**	**Experience by Path**
Lag score	0.606***	0.606***	2 years	0.030***	0.033***	IE	−0.005	0.012
	(0.002)	(0.002)		(0.005)	(0.008)		(0.005)	(0.014)
Lag score sqrd	−0.004***	−0.004***	3 years	0.042***	0.041***	Fellows	−0.030***	−0.026***
	(0.001)	(0.001)		(0.005)	(0.008)		(0.007)	(0.010)
Female	0.058***	0.058***	4 years	0.041***	0.047***	TFA	−0.031***	−0.032**
	(0.002)	(0.002)		(0.006)	(0.007)		(0.012)	(0.015)
Other ethnicity	−0.100***	−0.100***	5 years	0.052***	0.058***	Temporary	−0.012***	−0.004
	(0.012)	(0.012)		(0.006)	(0.008)		(0.004)	(0.009)
Asian	0.051***	0.051***	6 years	0.056***	0.062***	Other	−0.021***	−0.013
	(0.004)	(0.004)		(0.007)	(0.008)		(0.007)	(0.013)
Hispanic	−0.088***	−0.088***	7 years	0.056***	0.063***	IE*Exp2		−0.014
	(0.003)	(0.003)		(0.007)	(0.008)			(0.021)
Black	−0.115***	−0.115***	8 years	0.060***	0.067***	IE*Exp3		−0.004
	(0.003)	(0.003)		(0.008)	(0.009)			(0.024)
English home	−0.019***	−0.019***	9 years	0.060***	0.066***	IE*Exp>3		−0.02
	(0.002)	(0.002)		(0.008)	(0.010)			(0.015)
Free lunch	−0.069***	−0.069***	10 years	0.054***	0.060***	Fellow*Exp2		−0.011
	(0.002)	(0.002)		(0.009)	(0.010)			(0.014)
Lagged absent	−0.003***	−0.003***	11 years	0.058***	0.065***	Fellow*Exp3		0.051**
	(0.000)	(0.000)		(0.009)	(0.010)			(0.025)
Lag suspended	−0.057***	−0.057***	12 years	0.041***	0.048***	Fellows*Exp>3		−0.038*
	(0.005)	(0.005)		(0.009)	(0.010)			(0.021)

Class Average Measures		
Other ethnicity	−0.280***	−0.280***
	(0.102)	(0.102)
Hispanic	−0.182***	−0.182***
	(0.026)	(0.026)
Black	−0.236***	−0.237***
	(0.027)	(0.027)
Asian	0.047	0.047
	(0.031)	(0.031)
English home	0.023	0.023
	(0.016)	(0.016)
Free lunch	−0.075***	−0.075***
	(0.013)	(0.013)
Lagged absent	−0.008***	−0.008***
	(0.001)	(0.001)
Lag suspended	0.001	0.001
	(0.031)	(0.031)
Lag score	0.199***	0.199***
	(0.004)	(0.004)
Std. dev. score	0.020***	0.020***
	(0.007)	(0.007)
Other		
Constant	0.315***	0.310***
	(0.027)	(0.028)
Observations	861,698	861,698
R−squared	0.59	0.59

13 years	0.060***	0.067***
	(0.009)	(0.011)
14 years	0.051***	0.058***
	(0.009)	(0.011)
15 years	0.059***	0.065***
	(0.009)	(0.011)
16 years	0.073***	0.079***
	(0.012)	(0.013)
17 years	0.056***	0.062***
	(0.012)	(0.013)
18 years	0.054***	0.060***
	(0.012)	(0.013)
19 years	0.029**	0.035**
	(0.013)	(0.014)
20 years	0.031**	0.037***
	(0.012)	(0.013)
> 20 years	0.046***	0.052***
	(0.007)	(0.008)
Year		
2000	0.007*	0.008*
	(0.004)	(0.004)
2001	−0.004	−0.004
	(0.004)	(0.004)
2002	0.002	0.003
	(0.004)	(0.004)
2003	−0.003	−0.003
	(0.004)	(0.004)

TFA*Exp2		0.009
		(0.022)
TFA*Exp3		0.008
		(0.042)
TFA*Exp>3		0.032
		(0.044)
Temp*Exp2		−0.004
		(0.011)
Temp*Exp3		−0.002
		(0.012)
Temp*Exp>3		−0.011
		(0.010)
Other*Exp2		0.001
		(0.019)
Other*Exp3		−0.009
		(0.023)
Other*Exp>3		−0.011
		(0.017)
Grade		
5	0.003	0.003
	(0.004)	(0.004)
6	0.125***	0.124***
	(0.004)	(0.011)
7	0.146***	0.146***
	(0.010)	(0.010)
8	0.157***	0.156***
	(0.011)	(0.011)

Notes: Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. Results for TFA in the third year should be interpreted with caution due to small sample sizes.

Table 4. Effects of Teacher's Pathway and Years of Experience on Student Achievement by Grade

Pathway	1 Year	2 Years	3 Years
	Math grades 4–8		
College recommended		.048	.067
Individual evaluation	−.014	.020	.048
NYC Teaching Fellows	−.020*	.044	.067
TFA	.009	.053	.104
Temporary license	−.011	.026	.051
Other	−.023*	.045	.065
	ELA grades 4–8		
College recommended		.030	.042
Individual evaluation	.012	.028	.050
NYC Teaching Fellows	−.026*	−.007	.067*
TFA	−.032*	.007	.018
Temporary license	−.004	.022	.036
Other	−.013	.018	.020

Notes: Based on estimates in table 3. Results for TFA in the third year should be interpreted with caution due to small sample sizes.

experience increases, in general these gains are not statistically significant in this specification.[11]

The first six columns of tables 5a and 5b report the results of the specification checks described above.[12] The consistency of the estimates across models is striking. For example, for math, the effect of Teaching Fellows relative to college-recommended teachers is −.023 in the base model and −.025 in both the model with only teachers with three or fewer years of experience and the two-stage full model; the magnitude of the coefficient increases to .031 in the

11. The estimates of the differential return to experience in the third year and beyond for TFA members and beyond the third year for Fellows may not be accurate due to small sample sizes for these groups. Because of this we restrict our discussion of results to groups with at least twenty-five teachers. We also omit from the summary tables to be discussed below the estimates of differential returns to experience for the teachers with greater than three years of experience, though the variables are included in the models.
12. In addition to the general models presented in tables 5a and 5b, estimates that show the pathway-experience interactions across each of these specification is available on the *Education Finance and Policy* Web site. And in addition to the specification checks in tables 5a and 5b, we have estimated models that attempt to control for the differential timing of the student exams between grades and across years. For example, the fourth-grade math exam is often given at the beginning of February. Thus the fifth-grade math exam, often given at the beginning of April, includes several months of learning partly attributable to the fourth-grade teacher. We have estimated models that allocate each student's fifth-grade scores proportionately to the fourth- and fifth-grade teachers. The resulting estimates are very similar to those presented in this article. Positive and negative effects are slightly larger, and in some cases the precision of the estimates improves slightly.

Table 5a. Specification Checks on the Base Model for Math Achievement

	Base Model	<= 3 Years Experience	Student Fixed Effect on Gains	School/ Year/Grade Fixed Effects	Two Stage	2 Stage Exp <=3	No Class Controls	No School Fixed Effect	No School or Class
IE	−0.012** (0.005)	−0.028** (0.011)	−0.009 (0.006)	−0.011** (0.005)	−0.015** (0.006)	−0.032** (0.013)	−0.014** (0.006)	−0.013** (0.006)	−0.018*** (0.007)
Fellows	−0.023*** (0.008)	−0.025*** (0.009)	−0.014 (0.009)	−0.030*** (0.007)	−0.025*** (0.009)	−0.031*** (0.010)	−0.025*** (0.008)	−0.015* (0.008)	−0.048*** (0.009)
TFA	0.007 (0.015)	−0.001 (0.016)	0.015 (0.017)	−0.005 (0.015)	−0.004 (0.016)	−0.011 (0.018)	0.006 (0.017)	0.002 (0.016)	−0.036** (0.018)
Temp	−0.021*** (0.004)	−0.026*** (0.006)	−0.010** (0.004)	−0.017*** (0.004)	−0.023*** (0.005)	−0.034*** (0.007)	−0.034*** (0.005)	−0.022*** (0.004)	−0.049*** (0.005)
Other	−0.021*** (0.008)	−0.025*** (0.010)	−0.018** (0.008)	−0.015** (0.007)	−0.026*** (0.009)	−0.039*** (0.012)	−0.027*** (0.008)	−0.021*** (0.008)	−0.036*** (0.009)
N	960,970	320,503	960,970	960,970	960,970	320,503	960,970	960,970	960,970

Notes: Models include all variables in Table 3. Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. Results for TFA in the third year should be interpreted with caution due to small sample sizes.

Table 5b. Specification Checks on the Base Model for ELA Achievement

	Gain as Outcome	<= 3 Years Experience	Student Fixed Effect on Gains	School/ Year/Grade Fixed Effects	Two Stage	2 Stage Exp <=3	No Class Controls	No School Fixed Effect	No School or Class
IE	−0.005 (0.005)	0.00 (0.010)	0.002 (0.005)	−0.003 (0.004)	−0.003 (0.005)	−0.004 (0.010)	−0.010* (0.006)	−0.010* (0.005)	−0.023*** (0.006)
Fellows	−0.030*** (0.007)	−0.022*** (0.008)	−0.016** (0.007)	−0.031*** (0.006)	−0.032*** (0.007)	−0.028*** (0.009)	−0.036*** (0.008)	−0.01 (0.008)	−0.061*** (0.010)
TFA	−0.031*** (0.012)	−0.030** (0.013)	−0.031** (0.014)	−0.022* (0.012)	−0.033** (0.013)	−0.035** (0.014)	−0.033** (0.014)	−0.021* (0.012)	−0.081*** (0.015)
Temp	−0.012*** (0.004)	−0.011** (0.006)	−0.002 (0.004)	−0.009*** (0.003)	−0.012*** (0.004)	−0.014** (0.006)	−0.025*** (0.004)	−0.006* (0.004)	−0.041*** (0.004)
Other	−0.021*** (0.007)	−0.016* (0.009)	−0.008 (0.008)	−0.21*** (0.006)	−0.023*** (0.008)	−0.25** (0.011)	−0.030*** (0.008)	−0.014* (0.008)	−0.035*** (0.010)
N	861,698	300,156	861,698	861,698	861,698	300,156	861,698	861,698	861,698

Notes: Models include all variables in Table 3. Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. Results for TFA in the third year should be interpreted with caution due to small sample sizes.

two-stage model with three or fewer years of experience and decreases to .014 in the model with student fixed effects. None of these estimates differ statistically from the estimates in table 3a. As in the base model, the estimated effects of temporary-license teachers are very similar to those of Teaching Fellows, and the effects of TFA members are very similar to those of college-recommended teachers.

The specification tests for ELA also give estimates that are similar to base model estimates. The Teaching Fellows and TFA members both appear to perform worse than college-recommended teachers. Temporary-license teachers fall between college-recommended and alternative route teachers. The difference between temporary and college-recommended and the difference between temporary and Teaching Fellows teachers are both statistically significant ($p = .001$ and $p = .015$, respectively).

The results in tables 5a and 5b also allow us to assess the importance of controlling for aggregate student characteristics and including school fixed effects. Excluding either school fixed effects or student aggregates, but not both, gives results similar to the full model. However, the estimates are quite different when both aggregate student characteristics and school fixed effects are omitted, even after controlling for detailed student-level characteristics. In particular, both Teaching Fellows and TFA members appear to do much worse when these are omitted. This result is not surprising. These teachers often teach in the most difficult schools. Students in these schools are likely to perform more poorly than other students, even accounting for their prior scores and other individual characteristics. Without these controls, the estimates would attribute to the skills of these teachers' school characteristics that differentially disadvantage students in the places where Fellows and TFA members teach.

In addition to the base model and specification checks presented in tables 5a and 5b, we estimated several other models. First, the prior models have assumed that pathways do not change in their characteristics over time, but this is not the case. Both Teaching Fellows and Teach for America, for example, continue to change both their selection criteria and their preservice training. Is there evidence that these programmatic changes affect student performance? To examine this, we estimated models by cohort. Unfortunately, the smaller sample sizes result in large standard errors when the sample is divided in this way. The strongest trend is an improvement in the math performance of Fellows over time. Second, teachers and students are mobile among classrooms, even within a school year. While we cannot fully account for this mobility in our estimates, we can estimate models that address this issue. When we limit our sample to teachers who taught in the same school from October through the date of the student achievement exam, we lose some observations, but the results are unaffected. Unfortunately, we do not have equivalent information for students. We can eliminate students who were not in the same school in the previous year. This removes all students who switched schools between the two academic years, including those who transitioned to middle school. The sample size for this analysis drops substantially, and we cannot identify the effects of Teaching Fellows or TFA in the middle school; however, the results for fourth and fifth graders are very consistent with previous estimates. Third, some teachers may be more effective than others teaching students with certain characteristics. We explored this hypothesis for teacher pathways by estimating models that include interactions between pathway and classroom characteristics. However, except for evidence that college-recommended teachers do not do as well with classes that have students with a large range of prior test scores, there are few interactions worth noting.[13]

We find that the effects of pathways differ by grade and thus estimate models that group students into two groups, a fourth- and fifth-grade group and one composed of sixth, seventh, and eighth graders. The models are specified the same as the Pathway by Experience models in tables 3a and 5b. Table 6 summarizes the Pathway by Experience estimates. For elementary math, Teaching Fellows start out performing worse, but gain more over the first year than do other teachers. By their second year, their students are doing as well as students of college-recommended teachers. TFA members also appear to make substantial gains during their first year, but this coefficient is never statistically different from that of a college-recommended teacher. For elementary ELA results, Teaching Fellows and TFA members initially have more trouble improving their students' reading achievement than do temporary-license teachers or college-recommended teachers, and, unlike the situation for math, these teachers do not make differentially large gains in student achievement by their second year. By their third year, differences are not statistically significant.

The middle school estimates, especially for math, are quite different. While temporary-license teachers continue to see smaller gains than college-recommended teachers, Teaching Fellows do not perform significantly worse than college-recommended teachers, on average, and TFA members initially perform better. In addition, Teaching Fellows make significantly greater improvements between their second and third year of teaching than do other teachers and appear to outperform both college-recommended and temporary-license teachers. Of the specification checks, the one model with school-by-year-by-grade fixed effects finds somewhat different results, with Fellows

13. All of these estimates are available from the authors on request.

Table 6. Effects of Teacher's Pathway and Years of Experience on Student Achievement by Grade

Pathway	1 Year	2 Years	3 Years
	Math grades 4, 5		
College recommended	0	0.048	0.08
Individual evaluation	−0.009	0.045	0.061
NYC Teaching Fellows	−0.040***	0.055	0.053
TFA	−0.034	0.042	0.106
Temporary license	−0.021	0.034	0.052**
Other	−0.049**	0.066	0.059
	ELA grades 4, 5		
College recommended	0	0.035	0.054
Individual evaluation	0.005	0.031	0.074
NYC Teaching Fellows	−0.035***	0.006*	0.039
TFA	−0.055*	−0.015*	−0.025
Temporary license	−0.015	0.041	0.047
Other	−0.007	0.014	0.008*
	Math grades 6, 7, 8		
College recommended	0	0.049	0.035
Individual evaluation	−0.02	−0.017**	0.028
NYC Teaching Fellows	−0.012	0.03	0.091*
TFA	0.046**	0.057	0.113
Temporary license	−0.018	0.016**	0.04
Other	−0.018	0.021	0.056
	ELA grades 6, 7, 8		
College recommended	0	0.032	0.025
Individual evaluation	0.013	0.032	0.017
NYC Teaching Fellows	−0.025*	−0.016**	0.114**
TFA	−0.030*	0.033	0.051
Temporary license	−0.005	0.004	0.017
Other	−0.021	0.017	0.02

Notes: Models include all variables in table 3 and include the sample identified in the table. All significance tests are relative to college-recommended teachers with the same years of experience. *significant at 10%; **significant at 5%; ***significant at 1%. Results for TFA in the third year should be interpreted with caution due to small sample sizes.

having a negative and significant effect and TFA members having no average effect relative to college-recommended teachers. The results for sixth- through eighth-grade reading show negative point estimates for both Fellows and TFA teachers, but only the results for Fellows are statistically different from zero.

However, Fellows show a differential gain to the third year of experience and at that point outperform both college-recommended and temporary-license teachers.

Table 6 allows an easy comparison of Teaching Fellows with college-recommended teachers; however, it is also interesting to see how Fellows perform relative to all other teachers in New York City. Because of the lower performance of teachers with temporary licenses or individual evaluation, the comparison of Fellows with all other teachers provides a more positive view of the gains of Fellows' students. On average, there is no significant difference between the gains of Fellows' students and all others in grades 6–8, though elementary students do perform somewhat worse with first-year Fellows than with all other first-year teachers. However, in math second-year Fellows show a disproportionate gain and perform at least as well as all other second-year teachers. There is no evidence of such a gain for second- or third-year Fellows in ELA.

How Important are the Pathway Effects?

There are several ways of gaining perspective on the magnitude of the estimated effects of pathways. The first is statistical significance: do the estimates of alternative pathways and pathway interactions with experience differ from each other enough that we can be confident that the differences represent more than random fluctuations? The estimates presented in tables 3 and 5 identify the pathway coefficients that are statistically different from a first-year college-recommended teacher; table 6 indicates the statistically different effects when comparing a college-recommended teacher to teachers from other pathways with similar experience.

A second means of gauging importance is to assess whether the estimated effects are big from a policy perspective. One way of assessing this is to examine the pathway effects relative to other effects. For example, a first-year Teaching Fellow is estimated to show gains that are .02 lower in math than a first-year college-recommended teacher (table 4). This effect is about 40 percent of the average difference in the improvement of students taught by second-year teachers relative to first-year teachers (.02 compared to .05), which several other researchers have identified as important. Similarly, a Fellow on average has students who gain .03 points less in ELA than students of college-recommended teachers; this is approximately equivalent to 43 percent of the difference in gains between a student who is eligible for free lunch and one who is not. We estimate that a third-year Fellow teaching seventh-grade math improves student performance by 5.6 percent of a standard deviation more than a third-year college-recommended teacher, which is a bit closer but still less than the effect of free lunch eligibility. Thus, relative to other estimated effects, pathway differences are not large.

Alternatively, we could examine the relative increase in scale scores implied by the estimated pathway effects. For example, the average scale score of students on the 2002 seventh-grade math exam is about 670, with a standard deviation of 48. Our model estimates that the difference between a third-year Teaching Fellow and a third-year college-recommended teacher in seventh-grade math is .056 (.091 − .035). This translates into 2.7 scale points. At the median student score (671), an increase of 2.7 scale points moves a student in the middle of the test score distribution ahead of about 2.5 percent of the other students. Most would not judge this to be a large effect, but when this difference is accumulated over a few teachers over time, it could have a moderate impact.

Teacher Improvement with Experience

The estimated coefficient of the interaction of pathway and experience combines several mechanisms. It includes the gains that individual teachers make over time, but it also includes differential attrition. If the best (worst) teachers leave during the first year, the second-year estimates will look worse (better). To see whether selection or learning is driving these results, we estimate models that include fixed effects for teachers. With teacher fixed effects, we cannot identify the effects of pathways because an individual's pathway does not change over time. However, we can include pathway by experience interactions. We find no statistically significant difference in the returns to experience across pathways. The few differences in pathway returns to experience shown in table 6 are likely due to differences in attrition.

In addition to estimating the previous models, we examine whether the effectiveness of pathways differs by the attributes of students and whether successive cohorts of teachers yield different gains in student achievement. We hypothesized that different pathways may be relatively more effective with students with differing characteristics, such as prior academic achievement or race. We estimate models that include interactions between pathway and classroom characteristics and found little evidence of this by pathway. Likewise, we hypothesized that as the attributes of pathways change over time, they may have differing effects on student achievement. Both Teaching Fellows and TFA, for example, continue to change both their selection criteria and their preservice training. Is there evidence that these programmatic changes affect student performance? Unfortunately, the sample sizes get small, and the standard errors large, when the sample is divided in this way.

The strongest trend is an improvement in the math performance of Fellows over time.[14]

Differential Turnover and the Overall Effect of Pathways

The analyses do not present a simple story, but a few important relationships emerge. First, it is clear from the numbers in table 1 that the composition and overall supply of teachers changes as a result of changes to certification requirements; in opening up new certified pathways having lower preservice requirements and subsidized education, uncertified teachers were largely eliminated. Many teachers entering through these new pathways have strong academic training and perform well on tests of general knowledge. However, there is some evidence that teachers that enter New York City elementary schools through these pathways do not teach mathematics or ELA as well as teachers from the college-recommended path during their first year. Their mathematics teaching does improve differentially between their first and second year, and they are approximately equivalent to college-recommended teachers during their second year. Teachers who enter New York City middle schools through these pathways do better than those who teach in elementary schools. Teach for America members do a better job of teaching mathematics to middle school students than either temporary-license or college-recommended teachers during their first year, while Fellows perform at least as well as these teachers. By their third year of experience, Fellows appear to outperform college-recommended and temporary-license teachers. The results for ELA in middle school are not as strong. The students of both Fellows and TFA teachers in their first year have somewhat lower achievement gains than college-recommended or temporary-license teachers. Teaching Fellows show differentially strong improvement in teaching between their second and third years. Fellows with three years of experience perform about as well as college-recommended teachers with three years of experience and exceed the performance of temporary-license teachers.

These estimates tell us something about the relative effectiveness of the pathways for first-year, second-year, and third-year teachers, but they do not incorporate the differential retention of these teachers and thus do not reflect the average quality of teachers that we might expect to get if we filled teaching positions with teachers from certain pathways relative to other pathways. *How would the academic gains of students differ if school officials systematically filled job openings by hiring teachers entering through one pathway versus another?* The answer in part depends upon the relatively effectiveness of the first-year,

14. Estimates for these models can be found in "How changes in entry requirements alter the teacher workforce and affect student achievement" at www.teacherpolicyresearch.org.

Table 7. Cumulative Teacher Attrition Rates by Pathway for Elementary, Middle, and Junior High School Teachers in New York City, 2000–2004

Experience	College recommended	Individual evaluation	Teaching Fellows	Teach for America	Temporary license	Other
			Actual			
1	0.115	0.139	0.105	0.107	0.184	0.264
2	0.212	0.256	0.278	0.477	0.300	0.402
3	0.290	0.322	0.434	0.727	0.413	0.500
4	0.368	0.391	0.544	0.850	0.501	0.573
	Adjusting for differences between school environments					
1	0.143	0.147	0.096	0.088	0.167	0.252
2	0.261	0.276	0.265	0.426	0.327	0.396
3	0.354	0.355	0.433	0.667	0.435	0.510
4	0.446	0.438	0.547	0.813	0.519	0.592

second-year, and third-year teachers differentiated by pathway discussed above. However, it is also necessary to account for differences in retention rates across pathways. This follows from the meaningful gains in teacher value-added measures associated with increased experience over the first few years of teaching. If one pathway consistently has higher turnover, even if its teachers do well relative to those in other pathways *with the same experience*, the pathway may not, on average, be providing the most effective teachers.

Descriptive statistics characterizing the attrition rates for teachers by pathway in elementary, middle, and junior high schools are shown in table 7. The statistics reflect the experiences of the cohorts of teachers who began teaching in New York City from 1999–2000 to 2003–4. The table shows that 11.5 percent of college-recommended teachers leave teaching after the first year and that after four years 37 percent have left. The turnover rates are higher for the temporary-license group and the other groups in the first year and are substantially higher for TFA members in the following years.[15]

Interpreting the meaningful differences in attrition rates shown is complicated by several factors. With the more recent cohorts of entering teachers not having been observed for the full five years, the attrition rates for greater levels of experience only reflect the pattern for the earlier entering cohorts. This is problematic in that a closer look at the underlying data reveals that attrition rates generally are higher in some years than others. A related issue is that teachers entering through alternative pathways disproportionately entered in recent years. As a result, experience effects could mistakenly be attributed

15. Note that teachers who transfer to positions in public charters and nonteaching positions are counted as leaving.

to experience, pathways, or a combination of the two. Interpretation is also complicated by the fact that the attrition rates of teachers from various pathways may in part reflect differences in the kinds of schools they are assigned. To account for these and other issues, we estimate a conditional logit model predicting whether or not a teacher leaves teaching in New York City the following year accounting for pathway, experience dummies, the interaction of experience and pathway, year fixed effects, and school fixed effects. Thus, these estimates are based upon within-school differences in teacher attrition rates and hold constant any effects that vary between schools.

The results indicate that the differences in attrition rates across pathways are statistically significant and meaningful in magnitude. For example, 9.6 percent of Teaching Fellows are predicted to leave teaching after the first year, substantially less than the attrition of college-recommended teachers. The difference between the alternative routes and college-recommended teachers is significant but not as great as prior to controlling for school fixed effects. Over time the relative attrition of Teaching Fellows grows so that it is roughly comparable to college-recommended teachers after two years and exceeds them after three and four years. Those entering through TFA also are relatively more likely to return in the second year. The retention of TFA teachers beyond the second year falls off dramatically, relative both to the traditional routes and to the Fellows pathway. After four years, fewer than 20 percent of TFA teachers are predicted to remain teaching in New York City public schools.

How does the average-value-added measure of teachers vary across pathways once differences in teacher retention rates are taken into account? We address this question using the following simulation. Suppose that school officials hired an arbitrary number of new teachers (e.g., one thousand) from each of the pathways. For subsequent years, the teachers hired from each pathway are allowed to age through the experience distribution, applying the pathway-dependent retention rates implied by the conditional logit model. Teachers who quit are replaced by new teachers from the same pathway. These new hires in turn age through the system. In this way, it is possible to simulate how the experience distribution of teachers from each pathway would evolve over time and differ across pathways and, in turn, simulate how such differences would affect the average-value-added measures of the teachers from each pathway.[16]

Simulation results are shown in table 8 for the value-added ELA and Math models estimated separately for grades 4 and 5 and 6–8. For comparison

16. Given the small number of TFA members and Fellows with greater than three years of experience, we assume that after three years of experience, student achievement gains remain equal and constant across pathways and the retention differences remain constant and reduce at the overall quit rate for years four and higher.

Table 8. Predicted Average Value Added by Pathway, Grade Groupings, and Years

ELA 4&5: AVERAGE VA BY PATHWAY AND EXPERIENCE SINCE IMPLEMENTATION							MATH 4&5: AVERAGE VA BY PATHWAY AND EXPERIENCE SINCE IMPLEMENTATION						
Simulation year	**CR**	**IE**	**TF**	**TFA**	**TL**	**Other**	**Simulation year**	**CR**	**IE**	**TF**	**TFA**	**TL**	**Other**
1	0.000	0.005	−0.035	−0.055	−0.015	−0.007	1	0.000	−0.009	−0.040	−0.034	−0.021	−0.049
2	0.030	0.027	0.002	−0.019	0.032	0.009	2	0.041	0.037	0.046	0.035	0.025	0.037
3	0.044	0.058	0.023	−0.035	0.035	0.006	3	0.065	0.048	0.037	0.052	0.036	0.038
4	0.054	0.069	0.027	−0.026	0.044	0.013	4	0.071	0.056	0.039	0.046	0.042	0.042
5	0.059	0.076	0.029	−0.027	0.048	0.017	5	0.073	0.058	0.041	0.048	0.043	0.044
VA BY PATHWAY AND EXPERIENCE							VA BY PATHWAY AND EXPERIENCE						
Experience	**CR**	**IE**	**TF**	**TFA**	**TL**	**Other**		**CR**	**IE**	**TF**	**TFA**	**TL**	**Other**
1st year	0	0.005	−0.035	−0.055	−0.015	−0.007	1st year	0.000	−0.009	−0.040	−0.034	−0.021	−0.049
2nd year	0.035	0.031	0.006	−0.015	0.041	0.014	2nd year	0.048	0.045	0.055	0.042	0.034	0.066
3rd year	0.054	0.074	0.039	−0.025	0.047	0.008	3rd year	0.080	0.061	0.053	0.106	0.052	0.059
4th year	0.068	0.088	0.053	−0.011	0.061	0.022	4th year	0.088	0.069	0.061	0.114	0.060	0.067
5th Year	0.077	0.097	0.062	−0.002	0.07	0.031	5th Year	0.091	0.072	0.064	0.117	0.063	0.070

Table 8. Continued.

ELA 6-8: AVERAGE VA BY PATHWAY AND EXPERIENCE SINCE IMPLEMENTATION						
	CR	**IE**	**TF**	**TFA**	**TL**	**Other**
1	0	0.013	−0.025	−0.03	−0.005	−0.021
2	0.027	0.029	−0.017	0.027	0.002	0.007
3	0.022	0.018	0.078	0.021	0.011	0.011
4	0.017	0.013	0.061	0.018	0.007	0.007
5	0.025	0.020	0.065	0.022	0.013	0.012
VA BY PATHWAY AND EXPERIENCE						
	CR	**IE**	**TF**	**TFA**	**TL**	**Other**
1st year	0.000	0.013	−0.025	−0.030	−0.005	−0.021
2nd year	0.032	0.032	−0.016	0.033	0.004	0.017
3rd year	0.025	0.017	0.114	0.051	0.017	0.020
4th year	0.017	0.009	0.106	0.043	0.009	0.012
5th Year	0.030	0.022	0.119	0.056	0.022	0.025

MATH 6-8: AVERAGE VA BY PATHWAY AND EXPERIENCE SINCE IMPLEMENTATION						
	CR	**IE**	**TF**	**TFA**	**TL**	**Other**
1	0.000	−0.020	−0.012	0.046	−0.018	−0.018
2	0.042	−0.017	0.026	0.056	0.010	0.011
3	0.032	0.015	0.067	0.085	0.026	0.034
4	0.044	0.029	0.071	0.081	0.037	0.045
5	0.047	0.033	0.071	0.082	0.040	0.048
VA BY PATHWAY AND EXPERIENCE						
	CR	**IE**	**TF**	**TFA**	**TL**	**Other**
1st year	0.000	−0.020	−0.012	0.046	−0.018	−0.018
2nd year	0.049	−0.017	0.030	0.057	0.016	0.021
3rd year	0.035	0.028	0.091	0.113	0.040	0.056
4th year	0.054	0.047	0.110	0.132	0.059	0.075
5th Year	0.059	0.052	0.115	0.137	0.064	0.080

purposes, the value-added estimates by pathway and experience level are also shown below each of the simulations by grade level. As an example, consider teachers entering via TFA and teaching fourth- or fifth-grade math. Their average value added in the first year of the simulation (relative to first-year college-recommended teachers) is estimated to be −0.034, merely reflecting the estimated value added for a first-year TFA teacher and the fact that all the teachers are in their first year. In the second year of the simulation, 91.2 percent of the teachers would be in their second year, with the remainder newly hired, implying an average value added of 0.035, a figure lower than the 0.042 for a second-year TFA math teacher in fourth or fifth grade but higher than the −0.034 estimated for such a teacher in the first year. Rolling the simulation forward, it is possible to see how the average-value-added measure for a particular pathway would change over time as well as how the average-value-added estimates would differ across pathways after any given number of years. In general, pathways with high teacher attrition will have their overall student achievement gains reduced as inexperienced teachers with lower student achievement gains are substituted for teachers who would have produced stronger gains in student achievement.

Again, the average-value-added results do not tell a simple story. It is still the case that the Teaching Fellows and TFA perform well relative to other pathways in middle school math. In elementary math, after a somewhat weaker first year, they do approximately as well as teachers from all other routes except for college-recommended. For middle school ELA, the Fellows start out somewhat worse but outperform other routes in later years. TFA teachers also start somewhat worse but roughly catch up in later years. In fourth- and fifth-grade ELA, the Fellows perform somewhat worse than other routes, with the exception of TFA teachers, who perform worse than Fellows.

6. CONCLUSIONS

We find that there are relatively small differences in student achievement improvement attributable to preparation pathways, and these effects typically exist only when comparing first-year teachers. What might be the story behind these results? One possibility is that the differential effectiveness of teachers from different pathways comes from differences in experiences working with students prior to beginning as the teacher of record. College-recommended teachers can spend hundreds of hours in the classroom before taking control of their own class, while alternative-route teachers may spend comparatively little time in classrooms due to the short duration of their preservice preparation. A second possible cause for the differences in effectiveness may be differences in coursework prior to entry. This coursework may cover topics from child development and classroom management to how to teach reading and mathematics. In general, Teaching Fellows and TFA teachers have stronger math backgrounds than teachers from other pathways. Some would suggest that teaching middle school math draws on this stronger background more directly, yielding these teachers a relative advantage in these subjects. In addition, Teaching Fellows and Teach for America members, as well as other Transitional B teachers, enroll in coursework during their first two years of teaching. Our teacher fixed effects estimates indicate that the differential effects of experience across pathways is probably due to the differential attrition of weaker teachers across pathways, not to improvements in performance of individual teachers. The administrative data employed here is not well suited to understanding the variety of selection and preparation differences that exist across and within paths.

We are in the midst of what amounts to a national experiment in how best to attract, prepare, and retain teachers, particularly for high-poverty urban schools. New York City offers a valuable setting in which to study the effects of different pathways into teaching, as a number of pathways coexist in the same labor market. In many respects, alternative routes are designed as a recruitment strategy. By targeting elite colleges and universities or recruiting career-changers, both TFA and Teaching Fellows succeed in attracting, and selecting, teachers with stronger academic backgrounds, at least as measured by selectivity of undergraduate institution and test scores. In large measure alternative-route teachers are replacing teachers who previously had been uncertified and thus had not necessarily had any prior or concurrent preparation for teaching. Alternate-route teachers are typically placed in schools with more students of poverty, schools that generally have the hardest time attracting and retaining teachers. Both the Fellows and TFA programs are designed specifically to place teachers in underserved or difficult-to-staff schools.

Our analysis of alternative-route teachers suggests that in some instances Fellows and TFA members provide higher student achievement gains than the temporary-license teachers they replace. For example, Fellows in their third year of teaching in middle schools outperform temporary-license teachers in both math and ELA. More typically, alternative-route teachers are no better or worse than the temporary-license teachers they replace. When compared to college-recommended teachers, alternative-route teachers often provide smaller gains in student achievement, at least initially, and for ELA it takes longer to catch up. As noted above, many of these differences are not large in magnitude, typically about 2 to 5 percent of a standard deviation, and the variation in effectiveness within pathways is far greater than the average differences between pathways.

In the end, this is not likely to be a story about which pathway is best, nor should it be. For example, without alternative routes to teaching it is unlikely New York City could meet New York State and federal requirements to have a qualified teacher in every classroom. Based on this analysis we believe that different pathways bring different strengths to teaching. These differences in pathways provide a means to discuss potential improvements in how all pathways prepare teachers. They also suggest that the assignment of teachers to grades and subjects may be influenced by pathway.

The current analysis does not address a number of important policy questions. For example, what attributes of preparation are most important in increasing student achievement. One can imagine that the gross aggregations by pathways mask the potential strong effects of specific preparation attributes. We are in the process of collecting additional data toward this goal, as well as hoping to shed light on which *characteristics* of pathways and preservice education (not simply which pathways) affect teachers' ability to enhance student learning. As part of this data collection effort, we surveyed program participants as they completed their teacher education programs in the spring of 2004 at seventeen institutions that provide many of the new college-recommended teachers to New York City. In addition, we surveyed all Teaching Fellows and Teach for America members who in 2004 were completing their summer training to prepare them to take jobs in New York City schools. On this survey we asked questions about the participants' family background, education, selection of pathway into teaching, and many facets of their preparation. In addition, we have completed a survey of all six thousand first-year teachers in New York City public schools inquiring about their background, preparation, and induction and the environment in which they work. Finally, we are just completing a detailed analysis of the preparation programs at seventeen schools of education and alternative route programs to understand the structure, requirements, and content of preparation that teachers receive. This information will be used to identify the attributes of teacher preparation that are most influential in the achievement of students and the retention of teachers.

Another interesting question is how the size and composition of the college-recommended pool of teachers would change if these teachers received the financial incentive of reduced tuition toward a master's degree, as is currently offered by the alternative-route programs. Would they be able to attract a stronger pool of applicants, and would that result in higher student achievement gains for that path? This is more difficult to assess. Given the demand for new teachers, debates over entrance requirements, recruitment strategies, and teacher preparation are likely to continue for some time. However, the quality of such debates should improve as data from large-scale investigations such as this one begin to inform policy decisions about entry into teaching.

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