
# Does Teaching Experience Increase Teacher Effectiveness?

## *A Review of the Research*

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LEARNING POLICY INSTITUTE

JUNE 2016

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## External Reviewers

This report benefited from the insights and expertise of two external reviewers: Gene Glass, Regents' Professor Emeritus from Arizona State University and Senior Researcher at the National Education Policy Center at the University of Colorado Boulder; and Helen Ladd, Susan B. King Professor of Public Policy Studies and Professor of Economics at Duke University's Sanford School of Public Policy. We thank them for the care and attention they gave the report. Any remaining shortcomings are our own.

## Acknowledgments

The authors would like to thank Linda Darling-Hammond, President and CEO of the Learning Policy Institute, for her invaluable assistance providing feedback on early drafts of this paper, and Erin Fahle, doctoral candidate in the Education Policy program at the Stanford Graduate School of Education, for her valuable assistance in reviewing the research and analysis in the appendix. We also thank the following LPI colleagues for their contributions to the research process: Dion Burns, Desiree Carver-Thomas, Patrick M. Shields, and Leib Sutcher. In addition, we appreciate the insights and feedback offered by our colleagues Joseph Bishop, Roberta Furger, and Maria Hyler. We would like to thank Naomi Spinrad and Penelope Malish for their editing and design contributions to this project, and Lisa Gonzales for overseeing the editorial process. Without the generosity of time and spirit of all of the aforementioned, this work would not have been possible.

Research in this area of work is funded in part by the S. D. Bechtel, Jr. Foundation. Core operating support for the Learning Policy Institute is provided by the Ford Foundation, the William and Flora Hewlett Foundation, and the Sandler Foundation.

The appropriate citation for this report is: Kini, T., & Podolsky, A. *Does Teaching Experience Increase Teacher Effectiveness? A Review of the Research* (Palo Alto: Learning Policy Institute, 2016). This report can be found at https://learningpolicyinstitute.org/our-work/publications-resources/does-teaching-experience-increase-teacher-effectiveness-review-research.

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# Executive Summary

Do teachers continue to improve in their effectiveness as they gain experience in the teaching profession? This paper aims to answer that question by critically reviewing recent literature that analyzes the effect of teaching experience on student outcomes in K-12 public schools in the United States. The goal of this paper is to provide researchers and policymakers with a comprehensive and timely review of this body of work. A renewed look at this research is warranted due to advances in research methods (including the use of teacher and student fixed effects) and data systems that have allowed researchers to more accurately answer this question. Specifically, by including teacher fixed effects in their analyses, researchers have been able to compare a teacher with multiple years of experience to that same teacher when he or she had fewer years of experience. In contrast, older studies often used less precise methods, such as cross-sectional analyses, which compare distinct cohorts of teachers with different experience levels during a single school year.

Based on our review of 30 studies published within the last 15 years that analyze the effect of teaching experience on student outcomes in the United States and met our methodological criteria, we find that:

1. Teaching experience is positively associated with student achievement gains throughout a teacher's career. Gains in teacher effectiveness associated with experience are most steep in teachers' initial years, but continue to be significant as teachers reach the second, and often third, decades of their careers.
2. As teachers gain experience, their students not only learn more, as measured by standardized tests, they are also more likely to do better on other measures of success, such as school attendance.
3. Teachers' effectiveness increases at a greater rate when they teach in a supportive and collegial working environment, and when they accumulate experience in the same grade level, subject, or district.
4. More experienced teachers support greater student learning for their colleagues and the school as a whole, as well as for their own students.

Of course, there is variation in teacher effectiveness at every stage of the teaching career, so not every inexperienced teacher is less effective, and not every experienced teacher is more effective. Nonetheless, policymakers generally craft policy for the norm, and therefore, it is important to recognize that, on average, the most effective 20-year teachers are significantly more effective than the most effective first-year teachers—and these positive effects reach beyond the experienced teacher's individual classroom to benefit the school as a whole.

Our research does not indicate that the passage of time will make all teachers better or incompetent teachers effective. However, it does indicate that, for most teachers, experience increases effectiveness. The benefits of teaching experience will be best realized when teachers are carefully selected and well-prepared at the point of entry into the teaching workforce, as well as intensively mentored and rigorously evaluated prior to receiving tenure. This will ensure that those who enter the professional tier of teaching have met a competency standard from which they can continue to expand their expertise throughout their careers.

Policymakers' first task is to develop policies to attract high quality individuals into the teaching profession. From there, given what the research says about the benefits of teaching experience, policies aimed at reducing teacher turnover and accelerating teachers' professional learning should be pursued. This research suggests that administrators and policymakers might seek to:

1. Increase stability in teacher job assignments so that teachers can refine their instruction at a given grade level and subject, as research shows that teachers who have repeated experience teaching the same grade level or subject area improve more rapidly than those whose experience is in another grade level or subject area.
2. Create conditions for strong collegial relationships among school staff and a positive and professional working environment, as these contexts are associated with the greatest gains in teacher effectiveness.
3. Strengthen policies to promote the equitable distribution of more experienced teachers and to discourage the concentration of novice teachers in high-need schools, so that students are not subjected to a revolving door of novice teachers, who are on average less effective than their more experienced peers.

Other strategies for developing an experienced teaching workforce and reducing teacher turnover have been well documented elsewhere, such as providing clinically-based preparation and high-quality mentoring for beginners as well as career advancement opportunities for expert, experienced teachers.[1]

# Does Teaching Experience Increase Teacher Effectiveness?

## A Review of the Research

## Introduction

A central value of our public education system in the 21st century is the notion that all children can learn. Yet this perspective has not necessarily carried over to social attitudes about teachers. While there is consensus in the research and policy communities that teachers improve quickly early in their careers,[2] there is debate about whether or not teachers continue to learn after they gain significant experience in the classroom. That is, do teachers continue to improve in their effectiveness as they gain experience in the teaching profession? One study summarizing the benefits of teaching experience noted that "[t]eachers show the greatest productivity gains during their first few years on the job, after which their performance tends to level off."[3]

This finding seems counter-intuitive, given the evidence that professionals in a wide range of contexts improve their performance with experience. For example, a surgeon's improved performance is associated with increased experience gained at a given hospital.[4] An increase in a software developer's experience working on the same system is associated with increased productivity.[5] What is common sense in the business world—that employees improve in their productivity, innovation, and ability to satisfy their clients as they gain experience in a specific task, organization, and industry—is not the commonly accepted wisdom in public education.

The answer to the question "For how long do teachers continue to improve with experience?" has significant policy implications. For example, is it an equity problem that low-income students and students of color are more likely to be taught by the least experienced teachers and to attend schools with high rates of teacher turnover? Should we invest in professional development and learning opportunities for more experienced teachers, or focus these resources on novice teachers only? Should experience be rewarded through salary schedules that tie pay to experience in an effort to recognize greater competence and retain veteran teachers? Should policy be focused on building teaching as a long-term profession, or on recruiting and training a short-term teaching workforce? How policymakers will answer these questions depends in large part on the arc of teachers' learning trajectories and its translation into greater effectiveness.

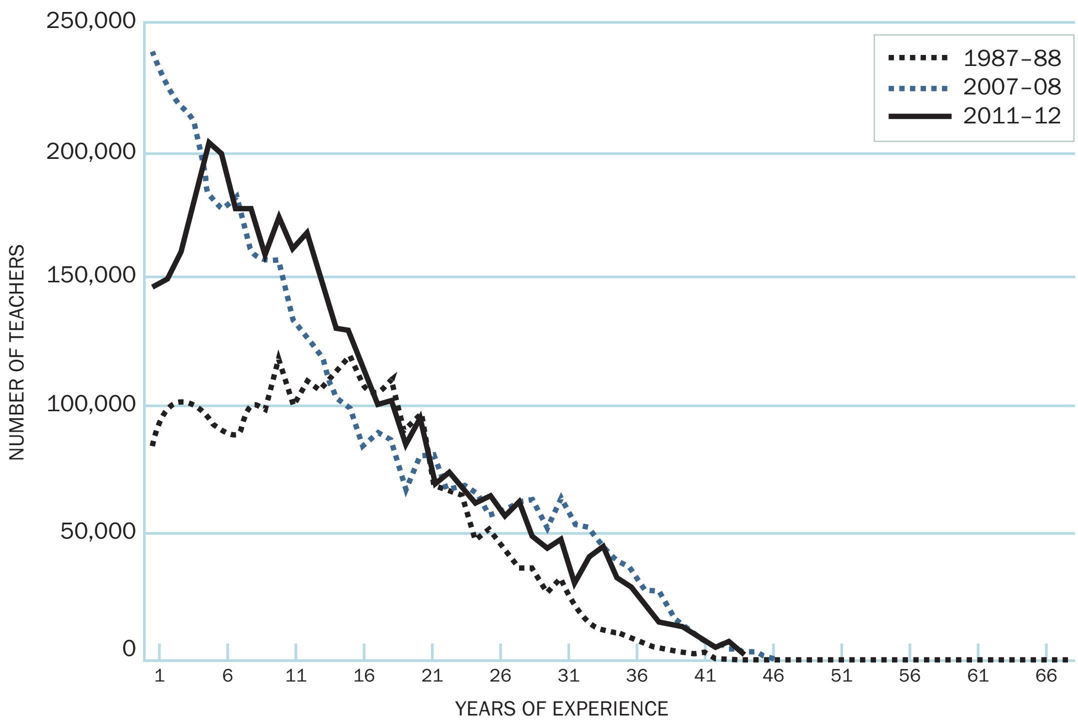
This report documents a review of research finding that, indeed, teachers do continue to improve in their effectiveness as they gain experience in the teaching profession. We find that teaching experience is, on average, positively associated with student achievement gains throughout a teacher's career. Of course, variation in teacher effectiveness exists at every stage of the teaching career; not every inexperienced teacher is, on average, less effective, and not every experienced teacher is more effective.

The policy importance of this finding is heightened as the teaching workforce becomes less experienced. The most recent national data suggest that compared to prior decades, a greater proportion of the teaching workforce has less than five years of experience.[6] In 1988, the most common teacher was a veteran with 15 years of teaching experience; by 2008, the most common teacher was a beginner in the first year of teaching (see Figure 1).

Though this "greening" of the teacher workforce slowed during the layoffs and hiring freezes of the Great Recession, by 2012—the most current national Schools and Staffing Survey data—the most common teacher was still an early-career teacher in his or her fifth year. Should the public care that more students are being taught by teachers new to the job rather than by veterans with significant experience?

At the same time, there is little debate that the least experienced teachers are disproportionately concentrated in low-income, high-minority schools and schools serving large numbers of English learners.[7] Based on a nationwide sample of 7,000 school districts, the U.S. Department of Education's 2009–10 Civil Rights Data Collection (CRDC) found that schools serving mostly African-American students are twice as likely to have teachers with one or two years of experience than are schools within the same district that serve mostly white students.[8] The 2012-13 CRDC, which includes data from every public school in the nation, found that Black, Latino, American Indian and Native-Alaskan students are three to four times more likely to attend schools with higher concentrations of first-year teachers than white students. English learners also attend

Figure 1: **Teaching Experience of School Teachers, 1987–88, 2007–08, and 2011–12**




Note: In their analysis, the authors used data from the U.S. Department of Education, Institute of Education Sciences, Schools and Staffing Survey for 1987–88, 2007–08, and 2011–12.

*Source: Richard M. Ingersoll, Lisa Merrill, and Daniel Stuckey, "Seven Trends: The Transformation of the Teaching Force" (Philadelphia, PA: Consortium for Policy Research in Education, 2014)* these schools at higher rates than native English speakers.[9] The nationally-representative 2011-12 Schools and Staffing Survey found that students in the highest-poverty schools were 50 percent more likely to have a teacher with fewer than four years of experience when compared to students in the lowest-poverty schools.[10] A recent study by the U.S. Department of Education found students in high-poverty districts were twice as likely to be taught by novice teachers enrolled in alternative certification programs (who have not yet earned their full teaching credential) than students in low-poverty districts.[11]

With significant additions in recent years to the literature on the effects of teaching experience, a renewed look at the research is warranted given the growth of inexperienced teachers in the profession combined with their disproportionate concentration in schools with high proportions of low-income students, students of color, and English learners. More sophisticated state and district data systems, which allow for matching student data with individual teachers, have led to more accurate research findings on the effects of teaching experience. Such data systems have allowed researchers to look more closely at the effect of teaching experience on student outcomes for the same teachers over time as they gain more experience. To do this, researchers compare the test scores of students with a teacher in a given year to the test scores for the same students from the prior year to isolate the teacher's contribution during the given year. This method, referred to as "value-added modeling," when applied to large data sets of teachers and students, is intended to provide insight into the effect of teaching experience on student outcomes.

In this paper, we explore what the recent research says about the impact of teaching experience on student outcomes throughout a teacher's career. Specifically, we will:

- Provide an overview of the various methods used to measure the impact of teaching experience on student outcomes and explain our approach to this review.
- Discuss four key findings.
- Discuss the limitations of this review and present suggestions for further research.
- Conclude with policy recommendations that flow from these findings.

# Methods

In this review, we examined 30 studies that analyzed the effect of teaching experience on student outcomes in K-12 public schools, as measured by student standardized test scores and non-test metrics when available. We reviewed studies that examined teaching experience published in peer-reviewed journals and by organizations with established peer-review processes since 2003, when the use of teacher fixed effects methods—which allows researchers to compare a teacher with multiple years of experience to that same teacher when he or she had fewer years of experience—became more prevalent. (The importance of this methodological advance is described below.)

Our review expands on Harris and Sass's comprehensive 2011 review of recent research into teaching training and productivity.[12] We include the studies that were designed specifically to focus on teaching experience, and we add more recent studies. A summary of our review is in the appendix, including identification of the methods used by each study, as well as the range of years of experience studied.[13] In addition, the appendix contains studies released since 2003 that included measures of teaching experience but did not meet the criteria for this study, either because the study was not published in a peer-reviewed journal or by an organization with established peer-review processes, or the study did not specifically focus on returns to teaching experience (i.e., teaching experience was an incidental variable in a study that focused on another issue). Despite these limitations, we found that these studies generally supported the same findings as those we report here.

## Methodological Issues in Studying Teaching Experience

Research examining the effects of teaching experience generally addresses two questions. The first question: Is the typical experienced teacher more effective at raising student test scores than the typical inexperienced teacher? The second question: Do teachers continue to improve in their effectiveness as they gain experience in the teaching profession?

Earlier studies generally only answered the first question. These studies usually used cross-sectional analyses, which compare distinct cohorts of teachers with different experience levels during a single school year.[14] Some of these studies found that on average, teaching quality did not differ across experience levels, meaning that the effectiveness of a novice teacher was similar to the effectiveness of a veteran.[15] However, because these studies often do not account for other factors that may contribute to student outcomes, their findings may be less precise.[16]

Advances in research methods and data systems have allowed researchers to more accurately answer the first and second questions, which has led to a shift in the findings in this body of work. We primarily focus on the second question: Do teachers continue to improve in their effectiveness as they gain experience in the teaching profession?

## Challenges with Early Empirical Analyses

Most early empirical studies that analyzed the relationship between teachers' years of experience and their students' outcomes could not distinguish between two effects. The first effect is the extent to which teachers grow on the job, which is sometimes called "returns to teacher experience." The second effect is the possibility that the teachers with more experience are simply more or less able as a group than those with less experience.

The second effect could arise if the teachers who leave the profession after only a few years of teaching differ in their basic ability from those who choose to remain in the profession. For example, if more effective teachers are more likely to leave the teaching workforce under certain circumstances—as some research shows[17]—then estimates of the effects of teaching experience using a cross-sectional analysis would likely underestimate the returns to experience, and show a negative relationship between teaching experience and student outcomes.[18] This trend of the lower quality of teachers remaining in the teaching workforce is countered by the trend of individual returns to experience, which may make teaching quality appear flat across experience levels in a cross-sectional analysis.[19] Accordingly, earlier studies using cross-sectional methods often resulted in downwardly biased estimates of the effects of teaching experience on student outcomes.[20]

Alternatively, the second effect could arise when social processes and norms that influence the quality of individuals entering the profession change (e.g., the adoption of more stringent certification requirements or changed economic conditions that make teaching a more attractive job). For example, if the teacher certification standards became more rigorous, then younger teachers might be more competent and capable, on average, than more experienced teachers. One study of New York State teachers found that the academic ability of teachers (as measured by standardized test scores and the selectivity of undergraduate institutions) has increased since 1999. The authors suggest that changes in the state's accountability policies beginning in 1998, which imposed more stringent regulations for teacher preparation and certification, contributed to incoming teachers' improved academic ability.[21] As a result, New York State teachers who started teaching after 1998 may, as a cohort, be more effective than the cohort of teachers who entered prior to 1998 because of the more selective certification requirements, with the result that the pre-1998 cohort might not show returns to their experience in a cross-sectional analysis.

These two illustrations of the second effect—the possibility that the teachers with more experience are simply more or less able as a group than those with less experience—demonstrate the complex dynamics of the public education system that researchers try to account for to ensure their estimates are accurate and minimally biased. Different researchers employ different strategies to control for student, teacher, and school dynamics that influence teacher effectiveness and student outcomes. The researchers in this field most frequently use the strategies described below to reduce the bias in their estimates of returns to teaching experience. While we privilege teacher fixed effects for the reasons explained below, each method has advantages and limitations that must be considered when interpreting a study's findings, and the findings of the literature as a whole.

## Fixed Effects

### Teacher Fixed Effects

When researchers want to most accurately estimate the extent to which teachers improve as they gain more years of teaching experience, the standard solution for reducing bias is to include teacher fixed effects in the model. The addition of teacher fixed effects allows researchers to compare a teacher with multiple years of experience to that same teacher when he or she had fewer years of experience. This approach, sometimes referred to as a "within-teacher comparison," controls statistically for teacher ability.[22] In other words, teacher fixed effects analyses account for each teacher's characteristics that do not vary with time, such as basic ability or motivation. As a result, this method improves the estimate of the relationship between the gains teachers make in their ability to improve student outcomes and their experience, often referred to as "within-teacher returns to experience."[23] Consequently, this method eliminates the limitations created by selective attrition and/or differences in cohort quality. This method has become more feasible, and thus common, in part because of the increasing availability of large longitudinal data sets in which students can be matched to their specific teachers over time.

A recent study using data from North Carolina fifth-grade public school teachers from 1996 to 2005 explored how excluding teacher fixed effects data can negatively bias estimates of the returns to teacher experience. This study found that teachers who leave the teaching workforce earlier in their careers have higher "innate teaching quality" than those who remain in teaching for a longer period of time.[24] The author applied multiple empirical models from prior literature to replicate the lower returns to experience found in earlier studies. This study suggests that many of the empirical specifications in previous models measuring returns to experience that did not include teacher fixed effects mask the trend of selective teacher exits, and therefore, may be downwardly biased.[25]

### School and Student Fixed Effects

Another challenge that researchers encounter when estimating returns to teaching experience is that teachers are generally not randomly assigned to students. More experienced teachers tend to teach students with higher ability.[26] As such, the estimated effects of teacher experience on student achievement will be biased upward if more experienced teachers typically teach in schools serving more high-performing students. The standard solution for addressing this potential bias is to add school fixed effects, which allows researchers to compare teachers within, not across, schools. In other words, school fixed effects analyses compare a teacher only to other teachers in the same school. Thus, these analyses account for the variation of school-level factors that cannot be observed but may contribute to a teacher's returns to experience, such as the effectiveness of a school's administration.[27]

However, school fixed effects analyses can be limited. First, this approach assumes there are no meaningful differences in teacher quality across schools, which we know to be an unrealistic assumption. For example, because inexperienced teachers are disproportionately concentrated at the highest-need schools and also show the steepest returns to experience, this method may limit the teacher comparison group and bias estimates of returns to teaching experience. Another downside to this approach in estimates of returns to teaching experience is that it may not address the possibility that even within schools, more experienced teachers might be given the classrooms with the stronger students. One solution researchers employ for this possibility is to control for student characteristics, or to add student fixed effects.

Similarly, student fixed effects analyses compare a teacher only to other teachers who have taught the same student. In the teacher experience literature, this means that models with student fixed effects look at whether a given student's performance is better (or worse) when the student is taught by a teacher with more (or fewer) years of experience. The application of student fixed effects analyses seeks to address the issue that teachers are not randomly assigned to students or randomly distributed across classrooms, possibly as a result of teacher assignment or preference, parent pressure, or student tracking. Evidence suggests that teachers with better training and more experience tend to teach not only at schools serving more affluent, higher-achieving, and whiter students, but also in classrooms serving these more advantaged students within a given school.[28] While student fixed effects analyses can be beneficial for investigating some relationships, this method can bias estimates of returns to teaching experience because it restricts the comparison group.

## Analysis of the Range of Teaching Experience

Researchers adopt different methods for specifying teaching experience in their analyses, including focusing on the early years only, with the later years capped; using indicator variables to group teachers into ranges of experience; and applying individual indicators by years of experience. An indicator variable is an artificial variable researchers create to represent an attribute with two or more distinct categories. In this case, an indicator variable is often used to represent the different categories of experience (e.g., a variable for each year of experience, or a variable for teachers with more than 4 years of experience, etc.). Including indicator variables for each year of experience for a teacher in a similar grade over time introduces challenges for researchers. Specifically, the year variable (which controls for broad changes within the year, such as changes in testing or standards that might influence student achievement) and the teaching experience variable move together over time. As a result, these variables are perfectly correlated, which makes it difficult for researchers to separate the experience effect from the year effect.[29] To address this issue, researchers use a variety of methods for including experience variables in their estimates. We describe the commonly used indicator variables for teaching experience analyses below, including the potential bias the different methods can introduce.

### Cut-Off Year

One way that researchers analyze experience is by only looking at returns to experience during the first few years of a teacher's career, using an indicator variable that includes all experience above a specific threshold together.[30] This method assumes that teachers do not improve their effectiveness after the cut-off year of experience.[31] Thus, this limits the inferences that can be drawn about experience past the cut-off year because it may conflate the effects of teacher experience throughout this wide period of time.

One recent study of elementary and middle schools in a large urban school district in a southern U.S. state from 2000 to 2009 highlights how conflating many years of experience creates significant downward bias to estimates of returns to experience. This study found that the main assumption of this method—that teachers do not improve in their effectiveness in later years or past the cut-off year—was violated across multiple specifications that showed teachers continuing to make gains in their productivity later in their careers, past the cut-off year.[32] In addition, this study found that this method created "substantial downward bias that understates the estimated returns to experience" when teachers continue to make gains in their effectiveness after the cut-off year.[33]

### Indicator Variables for Wide Ranges of Experience

Another way that researchers analyze returns to experience is by using indicator variables that combine wide ranges of experience. For example, a researcher may look at the gains a teacher's students make during the first through fifth years of the teacher's career, the sixth through tenth, and then from the eleventh year through the end of the teacher's career.[34] This approach is limited because it assumes that teacher productivity does not change within each of the ranges of experience.[35] As such, estimates may represent an average return to experience within each range, and could therefore underestimate returns, especially during periods of teachers' careers when they are rapidly improving in their effectiveness.[36]

The recent study mentioned above, of a large urban school district in a southern U.S. state, demonstrated how this method creates significant downward bias to estimates of returns to experience. The authors found that using indicator variables to represent broad ranges of years of experience "substantially understates the estimated returns to experience … by as much as 68%."[37] Moreover, this study found that "as the [intervals for experience] get narrower, the estimated returns to experience grow steeper and the extent of later-career improvement increases … suggest[ing] a violation of the key assumption" of the model, by suggesting that teachers continue to improve throughout the ranges of experience.[38]

In addition, a study of North Carolina fifth-grade public school teachers found that this method also influenced the calculation of teacher fixed effects in models of teacher experience.[39] More specifically, in the North Carolina data, the author applied restricted intervals for experience that were used in prior literature, and found that this method used one-third of the total sample of teachers to estimate teacher fixed effects and tended to exclude more experienced teachers. To illustrate, assume a sample covered a five-year period, and the range of the intervals of experience was 0–4, 5–12, and 13–20 years. If a teacher entered the sample with five years of experience and then gained experience for each year through the five-year sample period, it would appear as if the teacher had not gained experience because 5–10 years of experience is in the same interval. Consequently, the growth this teacher made would be excluded from the fixed effect calculation. The study's author concluded that the fixed effect estimator in this case would be biased because it "does not reflect at all the sample of more experienced teachers."[40]

## Interpretation of Findings

Because teacher effectiveness is often measured by looking at student test score gains, the measures of teacher effectiveness in this paper are generally explained in terms of standard deviations of student test scores. There are no universal guidelines for determining the practical, real-world importance of a standard deviation estimate.

Researchers have adopted empirical benchmarks to compare the magnitude of their effects. Empirical benchmarks generally take one of the following approaches: (1) normative expectations for growth over time, (2) policy-relevant gaps in student achievement by demographic group, and (3) effect size results from past research for similar interventions and target populations.[41] In order to put the results in context, we summarize a few approaches that others have taken to ground standard deviation estimates in practical terms. For all of these approaches, we advise caution with their interpretation, as there is wide variation in these estimates.

One commonly used benchmark is a translation of standard deviation effect sizes to "days of learning." In other words, this approach looks at how "the effect of an intervention compare[s] to a typical year of growth for a given target population of students."[42] One variation of this approach, popularized by the Center for Research on Education Outcomes (CREDO) at Stanford University is summarized in Table 1.[43] To create this benchmark, CREDO adopted the assumption put forth by Hanushek, Peterson, and Woessman (2012) that "[o]n most measures of student performance, student growth is typically about 1 full standard deviation on standardized tests between 4th and 8th grade, or about 25 percent of a standard deviation from one grade to the next."[44] Therefore, assuming an average school year includes 180 days of schooling, each day of schooling represents approximately 0.0013 standard deviations of student growth. CREDO also notes that, using their conversion, a school week consists of five days, a school month is 20 days, and a quarter or nine-week term is typically 45 days.

Table 1: **Translation of Standard Deviations to Days of Learning**

| Growth (in Standard Deviations) | Days of Learning |
|---|---|
| 0.00 | 0 |
| 0.005 | 4 |
| 0.01 | 7 |
| 0.02 | 14 |
| 0.04 | 29 |
| 0.05 | 36 |
| 0.10 | 72 |
| 0.15 | 108 |
| 0.20 | 144 |
| 0.25 | 180 |
| 0.30 | 216 |
| 0.35 | 252 |
| 0.40 | 288 |

*Source: E. Cremata, D. Davis, K. Dickey, D. Lawyer, Y. Negassi, M.E. Raymond, and J.L. Woodworth, National Charter School Study 2013, (Stanford, CA: Stanford University, 2013).*



In contrast, Levin, Glass, and Meister (1987) found that "each standard deviation is approximately equal to gains of an academic year of about 10 months, so each tenth of a standard deviation can be viewed as about one month of achievement gain."[45] Between these two methods of translating standard deviations into days of learning, each tenth of a standard deviation translates to 72 days (or about 3.6 months) of learning in the CREDO estimate as compared to one month in the Levin, Glass and Meister estimate.

Hill et al. (2008) similarly estimated the average annual gain in effect size using cross-sectional estimates from nationally normed standardized tests (e.g., California Achievement Test, Stanford Achievement Test, and TerraNova-Comprehensive Test of Basic Skills).[46] A summary of their results is listed in Table 2. Overall, the average effect sizes for the transition from grades 1 to 10 were larger in math (ranging from 1.03 in grades 1–2 to 0.25 in grades 9–10) than in reading (0.97 in grades 1–2 and 0.19 in grades 9–10). This suggests that a given change in a fraction of a standard deviation translates into more days of learning in reading than in math, and that students make greater annual gains on standardized tests in the elementary grades than in high school.

While these translations offer a starting point for understanding the practical importance of a standard deviation, they suffer from several limitations. Scholars note the "significant controversies

Table 2: **Average Annual Gain in Effect Size From Nationally Normed Tests**

| Grade Transition | Reading Tests | | Math Tests | |
|---|---|---|---|---|
| | Mean | Margin of Error | Mean | Margin of Error |
| Grade K–1 | 1.52 | ±0.21 | 1.14 | ±0.49 |
| Grade 1–2 | 0.97 | ±0.10 | 1.03 | ±0.14 |
| Grade 2–3 | 0.60 | ±0.10 | 0.89 | ±0.16 |
| Grade 3–4 | 0.36 | ±0.12 | 0.52 | ±0.14 |
| Grade 4–5 | 0.40 | ±0.06 | 0.56 | ±0.11 |
| Grade 5–6 | 0.32 | ±0.11 | 0.41 | ±0.08 |
| Grade 6–7 | 0.23 | ±0.11 | 0.30 | ±0.06 |
| Grade 7–8 | 0.26 | ±0.03 | 0.32 | ±0.05 |
| Grade 8–9 | 0.24 | ±0.10 | 0.22 | ±0.10 |
| Grade 9–10 | 0.19 | ±0.08 | 0.25 | ±0.07 |
| Grade 10–11 | 0.19 | ±0.17 | 0.14 | ±0.16 |
| Grade 11–12 | 0. 06 | ±0.11 | 0.01 | ±0.14 |

Note: The authors calculated the annual gain for reading from seven nationally normed tests: California Achievement Test (CAT) 5th edition, Stanford Achievement Test (SAT)-9th edition, TerraNova-Comprehensive Test of Basic Skills (CTBS), Metropolitan Achievement Test (MAT8), TerraNova-CAT, SAT10, and Gates-MacGinitie. Annual gain for math calculated from six nationally normed tests: CAT5, SAT9, TerraNova-CTBS, MAT8, TerraNova-CAT, and SAT10.

*Source: Carolyn J. Hill et al., "Empirical Benchmarks for Interpreting Effect Sizes in Research," Child Development Perspectives 2, no. 3 (2008): 173.*



in the psychometric literature regarding the relationship between learning and test scores."[47] Moreover, as noted by the Hill et al. (2008) results, the gains in student achievement vary by grade and subject.[48] Further, gains in student achievement may vary by geography (i.e., district, state). As a result, translations of effect sizes should ideally be made with a similar target population, grade level and subject.

A second approach that researchers adopt for translating standard deviations is to look at "how the effects of an intervention compare with existing differences among subgroups of students or schools."[49] Hill et al. (2008) use data from the 2000 and 2002 National Assessment of Educational Progress (NAEP) in mathematics and reading to calculate the gaps (in standardized effect sizes) listed in Table 3. NAEP includes a nationally representative sample of students.[50]

Staiger and Rockoff (2010) similarly find that the gap in the United States between non-poor students and students from poor families (those who receive free or reduced-priced lunch), as well as between white and black students, was approximately 0.8 to 0.9 standard deviations on the 2009 NAEP.[51]

Table 3: **Demographic Performance Gap In Mean NAEP Scores, by Grade (in Effect Size)**

| Subject and Grade | Black-White | Hispanic-White | Eligible-Ineligible for Free/Reduced-Priced Lunch | Male-Female |
|---|---|---|---|---|
| Reading | | | | |
| Grade 4 | -0.83 | -0.77 | -0.74 | -0.18 |
| Grade 8 | -0.80 | -0.76 | -0.66 | -0.28 |
| Grade 12 | -0.67 | -0.53 | -0.45 | -0.44 |
| Math | | | | |
| Grade 4 | -0.99 | -0.85 | -0.85 | 0.08 |
| Grade 8 | -1.04 | -0.82 | -0.80 | 0.04 |
| Grade 12 | -0.94 | -0.68 | -0.72 | 0.09 |

Note: In their analysis, the authors used data from the U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2002 Reading Assessment, and 2000 Mathematics Assessment.

*Source: Carolyn J. Hill et al., "Empirical Benchmarks for Interpreting Effect Sizes in Research," Child Development Perspectives 2, no. 3 (2008): 174.*



While an understanding of demographic gaps can help in evaluating a policy's effect by comparing the effect to the size of the gap it is intended to ameliorate, such translations nonetheless present challenges. For example, a gap between different demographic subgroups may vary for different outcomes (e.g., math and reading) and for different grade levels.

A third approach researchers adopt to benchmark standard deviations is looking at how "the effects of an intervention compare to those from previous studies for similar grade levels, interventions, and outcomes."[52] This translation or comparison may help answer questions raised by policymakers, school leaders, and teachers on how best to allocate limited resources amidst competing policies and interventions, because it provides a comparison of effects between realistic alternatives.

John Hattie synthesized over 800 meta-analyses on the key influences on K-12 student learning, and calculated standardized effect sizes for many popular educational interventions.[53] The average effect size for the various educational interventions in Hattie's study was 0.40 standard deviations, and the effect that the average teacher had on student achievement was between 0.15 and 0.40 standard deviations. For example, Hattie found that providing formative evaluations to teachers was associated with an effect of 0.90 standard deviations in improved student performance. In contrast, having multiple grades and ages of students in one classroom together was associated with a smaller effect on students' achievement, of 0.04 standard deviations.

Like the other benchmarks for understanding the practical significance of a standard deviation, this approach has its limits. First, the effects represented in Hattie's meta-analysis represent average results, which may not be generalizable to a specific grade, subject area, or school or community context. In addition, while Hattie notes that the effect size of 0.40 "summarizes the typical effect of all possible influences in education and should be used as the benchmark to judge effects in education," he warns that this is "not a magic number … but a guideline to begin discussions about what we can aim for if we want to see students change."[54]

To aid in the interpretation of the practical significance of the findings discussed below, we summarized a range of the approaches for interpreting standardized effects/standard deviations in Table 4.

Table 4: **Interpreting Standardized Effects/Standard Deviations**

| Author | Interpretation of 0.10 Standard Deviation |
|---|---|
| CREDO (2013) | 3.6 months of learning |
| Levin et al. (1987) | 1 month of learning |
| Hill et al. (2008) | Between 1.5 weeks to 1 month of learning in Grades 1 to 9 |
| Staiger and Rockoff (2010) | Almost 1/10 of the gap in performance between Black and White students and students eligible and ineligible for free/reduced-price lunch |

# Findings

## Teaching experience is positively associated with student achievement gains throughout a teacher's career. The gains from experience are highest in teachers' initial years, but continue for teachers in the second and often third decades of their careers.

There is now a broad base of literature demonstrating that teachers continue to develop their effectiveness throughout their careers. The finer-grained analysis in these studies has generally found that while teachers improve at greater rates during the first few years of their career, teachers continue to improve, albeit at lesser rates, throughout their career. As Table 5 shows (details in the appendix), we reviewed 30 studies examining the effects of teaching experience on student achievement, as measured by standardized test scores. Of these 30 studies, 28 found that teaching experience is positively and significantly associated with teacher effectiveness. Approximately two-thirds of the studies analyze longitudinal datasets with teacher fixed effects, the method preferred because it allows for the examination of "within-teacher" returns to experience. Of these studies, 18 out of 18 found that teaching experience is positively associated with teacher effectiveness.

Table 5: **Summary of Analyses of Teaching Experience and Student Achievement**

| Included Studies | No. of studies | No. of studies with positive findings | No. of studies with mixed, non-significant, or negative findings | % of studies with positive findings |
|---|---|---|---|---|
| Teacher fixed effects & measuring 7+ years of experience | 15 | 15 | 0 | 100% |
| Teacher fixed effects (including the 15 studies above plus three studies that analyzed <7 years of experience) | 18 | 18 | 0 | 100% |
| All studies looking at 7+ years of experience, with and without teacher fixed effects (including the 15 studies in the top row plus seven other studies) | 22 | 21 | 1 | 95% |
| All studies total (including studies that analyzed <7 years of experience) | 30 | 28 | 2 | 93% |

Note: Positive studies include those where, of all the findings about experience that are statistically significant, the majority show a positive relationship between teaching experience and student achievement. Mixed studies include those with a relatively equal mix of positive and negative statistically significant results. Nonsignificant studies include those where the majority of findings are insignificant. Negative studies include those where, of all the findings about experience that are statistically significant, the majority show a negative relationship between experience and student achievement.

Among the studies applying teacher fixed effects analyses and examining the effects of teaching experience on student achievement later in a teacher's career after a teacher accumulates seven or more years of experience, all 15 found that teachers continue to improve in their effectiveness in fostering student achievement beyond the first decade of a teacher's career. In sum, these studies consistently find a positive and significant relationship between teaching experience and student performance on standardized tests.

### All of the studies applying teacher fixed effects analyses have found that teaching experience is positively associated with gains in student achievement.

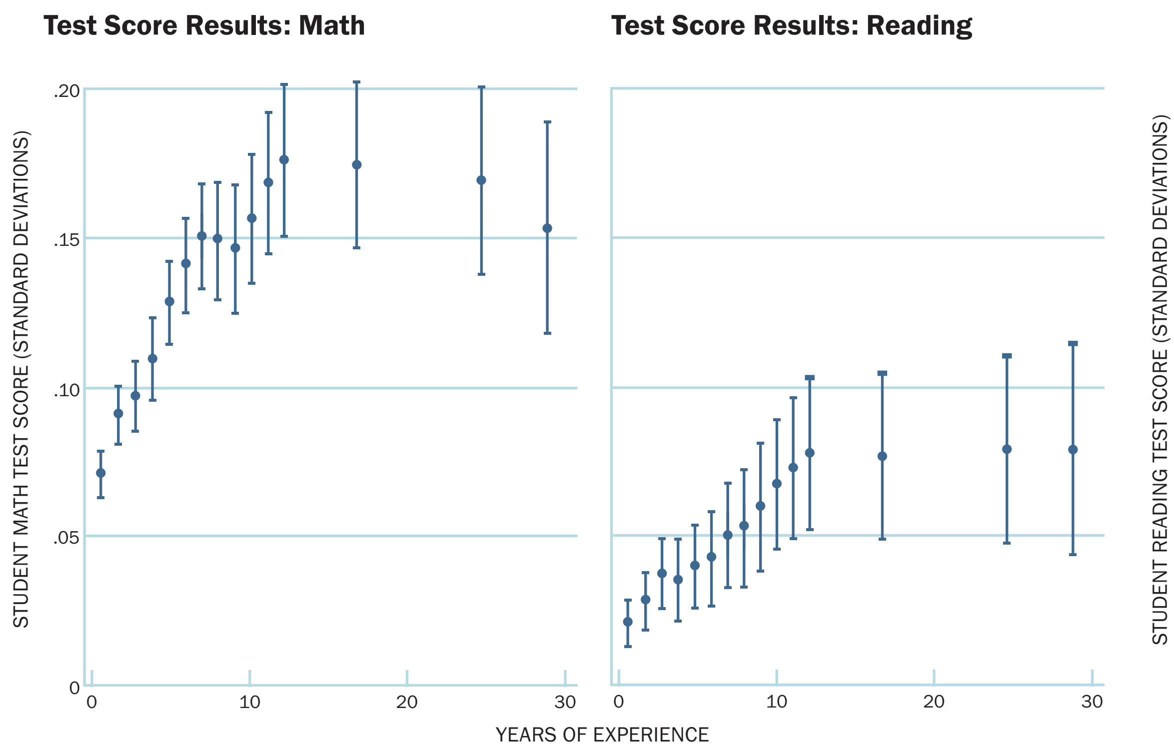
Teachers make the steepest gains in effectiveness during their first few years in the classroom, when they are "greenest." Numerous studies confirm the unremarkable finding that, on average, brand new teachers are less effective than those with some experience.[55] Most of these studies also find that teachers show the greatest gains from experience during their initial years in the classroom, but continue to make meaningful improvement in their effectiveness past these initial gains.[56] Teachers who received little hands-on training prior to entering the classroom—such as those who come through alternative routes to certification without completing student teaching or a residency under the guidance of an accomplished teacher—may experience the steepest gains in their initial years in the classroom as they are starting from zero.[57]

The overwhelming majority of studies that examined teachers' improvement trajectory over the course of their careers have found that teachers continue to improve well into their careers. The most recent studies that analyze a wider range of teaching experience and apply teacher fixed effects analyses—in both math and reading at the elementary, middle, and high school levels—have found significant returns to experience into the second, and often third decade of a teacher's career. More specifically, **all 15 of the recent teacher experience studies examining the effects of experience after seven or more years in the classroom and applying teacher fixed-effects analyses found a positive and statistically significant relationship between teachers' experience and their students' outcomes.** The summary below highlights five recently published studies that use teacher fixed effects analyses over ten or more years of teaching experience.

- One study of 250,000 middle school students in North Carolina over a five year period that used teacher fixed effects analyses (comparing teachers to themselves over time) found clear returns to teaching experience, at least through 12 years of experience in both math and English language arts (ELA) (see Figure 2).[58] A teacher with 12 years of experience raised test scores from 0.08 standard deviations in ELA to 0.18 standard deviations in math as compared to a teacher with no prior experience.[59] Placed into context, this means that a teacher with 12 years of experience provided about three weeks of additional learning in ELA and seven weeks in math (based on Levin et al.'s conversion), or three months of additional learning in ELA and 6.5 months in math (based on CREDO's conversion), as compared to a teacher with no experience. Although the returns level off after 12 years for math and ELA teachers, the study found that math and ELA teachers with 21–27 years were still 0.04 standard deviations more effective than when they had five years of experience.

- Another statewide study of high school students in North Carolina over four years found that the effects of teacher experience on student learning increase up to 20 years.[60] The authors note that in their initial analyses they found gains in achievement associated with teacher experience to occur largely in the first two years of teaching. However, in order to

Figure 2: **The Relationship of Teaching Experience to Math and Reading Test Score Gains**




Note: In their analysis, the authors used administrative data on teachers and students in North Carolina from the North Carolina Education Research Data Center for grades 6, 7, and 8 in 2006–2011.

*Source: Helen F. Ladd and Lucy C. Sorensen, "Returns to Teacher Experience: Student Achievement and Motivation in Middle School," Forthcoming in Education Finance and Policy, 2016.*



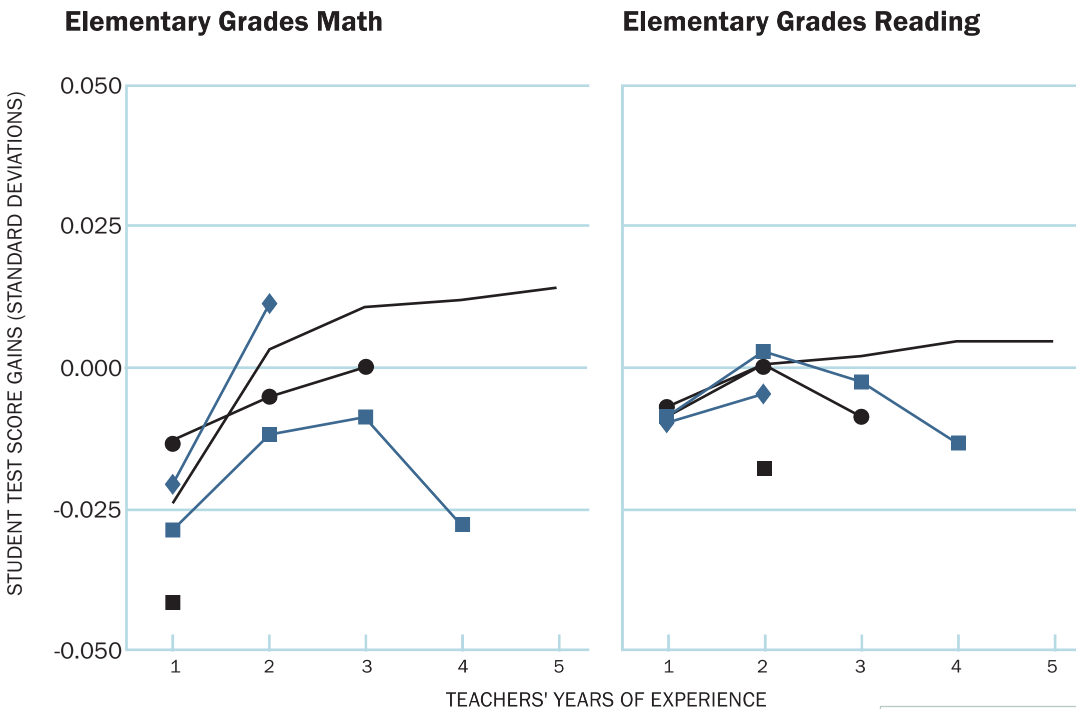
control for the likely possibility that more effective teachers stop teaching the basic ninth and tenth grade courses that were the focus of the study, they conducted an additional analysis with teacher fixed effects models, comparing each teacher to him or herself over time. With this more accurate method, they found teachers dramatically improve with experience and returns to experience rise considerably over the course of a teacher's career. Indeed, the results of the study indicated that a teacher with 1-2 years of experience raises student achievement by about 0.06 standard deviations, while a teacher with more than 27 years of experience raises student achievement by about 0.27 standard deviations.[61] Placed into context, this means that a teacher with more than 27 years of experience provides between 2.5 months (applying Levin et al.'s conversion) and 9 months (applying CREDO's conversion) of additional learning compared to a teacher with no experience. The same research team also studied elementary school students in North Carolina, finding significant returns to experience for teachers with 21-27 years of experience. This study did not use teacher fixed effects analyses; however, the authors note that the gains to experience were similar in unpublished models that included teacher fixed effects.[62]

- A recent study of students' achievement across 11,460 fifth grade classrooms in North Carolina over a nine-year period found that "teaching experience has a substantial and statistically significant impact on mathematics achievement, even beyond the first few years of teaching."[63] A teacher with 30 years of experience has over 1 standard deviation higher measured quality than new, inexperienced teachers, and about 0.75 standard deviations higher measured mathematics effectiveness than a teacher with five years of experience. (In reading, returns to experience were smaller and focused in the early years.) Placed into context, the average child studying math under a teacher with 30 years of experience would be expected to gain a whole school year's worth of learning over the student of a new teacher as a consequence of that teacher's greater experience (according to Levin et al.'s translation) or four school year's worth of learning (according to CREDO's translation).

- Another study of all students in Florida in grades 4–10 over a six-year period found that students' achievement rises as a consequence of teachers' experience in both elementary and middle school in both math and reading.[64] The study found that "the bulk of the experience effects are indeed in the early years," but there are still effects even after more than 25 years of experience. "Overall, the results indicate that experience effects in elementary and middle school are quantitatively substantial, ranging from 1.1 to 2.4 scale score points for the first 1-2 years of experience to as much as 2.3–3.7 scale score points for 15–24 years of experience. This translates to 0.04 to 0.09 of a standard deviation in achievement gains or 0.03 to 0.06 of a standard deviation in the achievement level for the first couple of years of experience and as much as 0.16 of a standard deviation in achievement gains for a teacher with 15–24 years of experience (relative to a first-year teacher)." Placed in context, a teacher with 15–24 years of experience produces about 1.5 additional months of learning relative to a first year teacher according to Levin et al.'s translation, or about 5.5 months according to CREDO's translation. (The study did not find returns to experience for high school teachers.)

- A study of a large urban school district using longitudinal data over nine years for more than 3,500 teachers and their students in grades 4–8 (more than 200,000 student-year records) found that, consistent with prior research, teachers experience rapid improvement early in their careers, but continue to improve well into their careers.[65] Importantly, this study, unlike others, ran the data through four different models to eliminate different types of potential bias in the data. The study found large and statistically significant early-career (years 1–5) returns to experience across models in both students' mathematics and reading achievement. The study also found consistent evidence of growth in later stages of the teaching career, particularly in mathematics. From year 5 to year 15 of teacher experience, in mathematics, the study found statistically significant improvements in teacher effectiveness between 0.033 and 0.051 standard deviations. Placed in context, this translates to about one to two weeks of additional learning (according to Levin et al.'s translation) or one to two months of additional learning (according to CREDO's estimate). The authors note that teachers' gain in effectiveness during this later 10-year period is meaningfully large, representing 45 percent to 60 percent of the gains teachers make in their first five years of experience.

Figure 3: **Differential Teacher Effectiveness Based on Year of Teacher Attrition**




Note: In their analysis, the authors used administrative data on teachers and students in North Carolina public schools for grades 3–5 in 2005–2009, and 2004–2009 for grades 6–12.

*Source: Gary T. Henry, Kevin C. Bastian, and C. Kevin Fortner, "Stayers and Leavers: Early-Career Teacher Effectiveness and Attrition," Educational Researcher 40, no. 6 (2011): 271–80.*



### A small minority of studies that have not applied teacher fixed effects analyses have had more mixed findings about the relationship between teaching experience and gains in student achievement.

Twelve of the 30 recent teacher experience studies have not applied teacher fixed effects analyses. Nonetheless, of these 12 studies, 10 find a positive relationship between teaching experience and gains in a teacher's effectiveness in improving student outcomes. Two of the 12 studies find a mixed or insignificant relationship between teachers' experience and their students' outcomes. A summary of the two studies with more mixed findings appears below.

- A recent study of North Carolina public school teachers compared the effectiveness of teachers during the first five years of their teaching career to early career teachers who left the profession.[66] The data for the study linked student test scores to their teachers for the 2004–05 to 2008–09 school years for middle and high school students, and the 2005–06 to 2008–09 school years for elementary students, though the study did not apply teacher fixed effects to examine within-teacher returns to experience. To analyze returns to early career teaching experience, the authors dropped cohorts from their analysis each year, so that during the first school year of analysis, the authors included teachers with one to five years of experience, and then during their second school year of analysis, the authors included teachers with two to five years of experience. The authors found that teachers' effectiveness at raising student test scores significantly increased during their second year of teaching; however, the authors also found that teachers who taught for at least five years did not make any statistically significant gains in their effectiveness after three years. In addition, the authors found that teachers who remained in teaching for more than five years were significantly more effective during their third and fourth years of experience than teachers who left the profession after their third or fourth year (see Figure 3). Importantly, though this study found that teachers who stay for at least five years were "the group that displays the highest upward developmental trajectory," the study failed to look at teachers' growth beyond their fifth year of experience, so did not examine whether this high developmental trajectory continues.[67] This study is one of two studies relied on by the U.S. Department of Education in its recent guidance to states suggesting that teachers do not make significant improvements after their first year in the classroom and defining the term "inexperienced teacher" as only those teachers in their first year of teaching.[68]

- Another study of San Diego public school teachers between 1997 and 2000 in elementary, middle, and high school found a statistically insignificant relationship between teaching experience and gains in student achievement in math and reading.[69] More specifically, the authors did not find a statistically significant difference between the effectiveness of a fully credentialed elementary teacher with more than 10 years of experience and teachers with fewer years of experience. Unfortunately, the authors did not isolate the returns to experience because they only reported the gains related to the interaction of teachers' credentials (i.e., full, emergency, intern) and their experience. In addition, the authors grouped teachers with 10 or more years of experience together, which limits the inferences that can be drawn about experience past 10 years because the effects of teachers throughout this wide period of time are conflated.

### A minority of those studies that limit their analysis to teachers with fewer than seven years of experience found that teachers plateau in their improvement early in their careers.

Eight of the 30 teacher experience studies we reviewed limited their analysis to teachers with fewer than seven years of experience. Among these studies, three found that teachers improve rapidly early in their careers but then reach a plateau relatively quickly. These studies are Henry (2011) discussed above, as well as two Texas studies using data from the 1990s, summarized below.

- One study of students and teachers in grades 4 through 8 in a large urban district in Texas between the 1995–96 and 2000–01 school years found that teachers in their fourth year of teaching performed "systematically better" than teachers in their first, second, third, and fifth (or later) year of teaching.[70] The authors also found that first-year teachers performed significantly worse than experienced teachers. However, the method applied in this study, conflating all teachers with more than five years of experience, poses concerns. This grouping of teachers with very different levels of experience often leads to significant underestimates of returns to experience.[71] The authors explain their decision to conflate experience beyond five years by noting that "preliminary analysis, not shown, found no experience effects beyond five years of experience," but they do not provide supporting data and analysis. Without this, we cannot determine the extent to which their method of combining all experience of five or more years together downwardly biased the estimates of returns to experience, as other studies suggest is likely.[72]

- Another study of Texas elementary and middle school students and teachers using three cohorts of students, each with more than 200,000 individuals, between 1993 and 1998 found that the proportion of teachers in a school with one to two years of experience was associated with the greatest gains in student achievement and concluded that "experience is not significantly related to achievement following the initial years in the profession."[73] To reach this conclusion, the study performed a school-level analysis by looking at experience levels throughout a school, comparing the proportion of teachers at a given experience level in a school (i.e., the proportion of teachers with 0, 1, 2, and 3–5 years of experience compared to the proportion of teachers with more than 5 years of experience). This methodology is problematic for identifying any type of causal inference between gains in teachers' effectiveness and experience, as it only represents the relationship between the average student achievement in a school and the proportion of teachers in the school with a given experience level. The study also only examines within-school differences in teacher quality, a method that is likely to bias results as, the authors note, "schools able to offer higher salaries or better working conditions … likely enjoy higher average teacher quality."[74] As discussed above, research is clear that schools serving low-income students and students of color are more likely to be staffed by inexperienced and underprepared teachers. Finally, the study did not use teacher fixed effects, and therefore could not compare within-teacher returns to experience and eliminate any bias from attrition.

### Conclusion

Taken as a whole, the large and growing body of research applying the teacher fixed effects method provides strong support for the conclusion that teachers become better able to support student learning as they gain experience, and that gains from experience continue well into the second and, often third decades of their career. The myth alluded to earlier that teachers reach a plateau after their initial years in the classroom, after which additional experience has no benefit for student achievement, finds little support in the research, particularly among those studies that examine teaching experience beyond seven years and apply methods to examine "within-teacher" returns to experience.

## As teachers gain experience, their students are more likely to do better on other measures of success beyond test scores, such as school attendance.

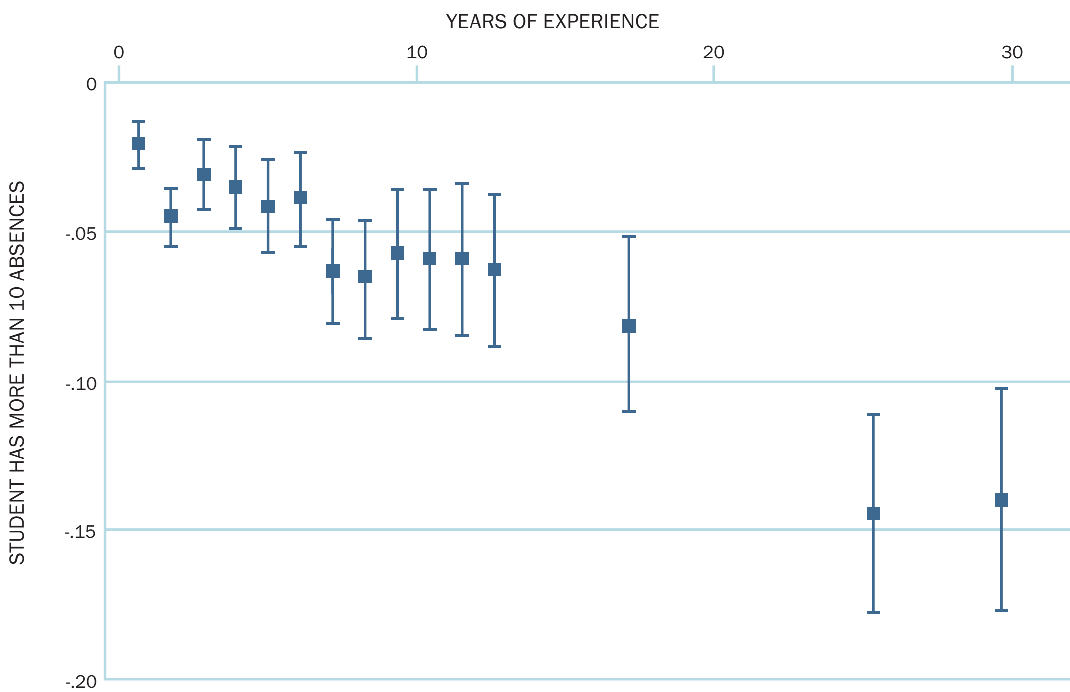
Measuring teachers' growing effectiveness over time solely by their students' test scores is, by definition, a limited measure: there is more to educating students than simply boosting students' standardized test scores.[75] To date, studies of returns to teacher experience have not examined whether the students of more experienced teachers are more likely to achieve academic success in non-tested areas. Are the students of more experienced teachers more likely to graduate? Are they more likely to reclassify as proficient in English, or enroll in and complete college? Are they more likely to write a coherent argument? Are more experienced teachers more likely to provide leadership and support to other teachers at their school—a positive return to experience that would not necessarily appear in their own students' test scores but rather be hidden as a "spillover effect" in their fellow teachers' test scores?

Researchers have only recently begun to study whether more experienced teachers produce academic benefits for students that go beyond test scores. One study of 1.2 million middle school students in North Carolina from 2007–2011 analyzed student data on test scores as well as other non-cognitive outcomes: absences and disciplinary offenses (as reported by the school) and amount of time spent reading for pleasure and amount of time spent completing homework (as reported by the student). Using statistical methods that compare a teacher to herself over time and that control for student characteristics (e.g., poverty level and parent education), the study found that as teachers gain experience, their students are less likely to miss school (see Figure 4). The study found:

- "One year of experience enables an English Language Arts teacher to reduce the proportion of students with high absenteeism by 2.0 percentage points, and these reductions increase as she continues to gain experience. **A teacher, of given quality, who obtains over 21 years of experience on average reduces the incidence of high student absenteeism by 14.5 percentage points.**"[76]
- Two years of experience allows a math teacher to reduce "the proportion of students with high absenteeism by 3.8 percentage points, an effect that rises to an 11.5 percentage point reduction for teachers with extensive experience."[77]

Figure 4: **Non-Test Student Outcome Results: Absences, ELA Sample**

***Probability of having more than 10 absences***




Note: In their analysis, the authors used administrative data on teachers and students in North Carolina from the North Carolina Education Research Data Center for grades 6, 7, and 8 in 2006–2011.

*Source: Helen F. Ladd and Lucy C. Sorensen, "Returns to Teacher Experience: Student Achievement and Motivation in Middle School," Forthcoming in Education Finance and Policy, 2016.*

These findings are striking and highly policy relevant, given the strong evidence base linking high rates of absenteeism with negative long-term educational outcomes.[78] Importantly, the study found that more experienced teachers provided the greatest benefit to higher-risk, chronically absent students. For example, "ELA and math teachers with 21–27 years of experience reduce the number of students with over three absences by 5.6 and 4.4 percent respectively," but reduced "the number of students with over 17 absences by 18.8 and 12.2 percent."[79]

While the study found that non-test returns to teacher experience were greatest for absences, results also indicated that experience increased the ability of ELA teachers to encourage students to spend more time reading for pleasure, and math teachers to promote positive classroom behavior. Given the surprisingly large effects for student absences, the authors suggest that as teachers gain experience, they improve their skills in classroom management and motivating students.

As discussed above, the study also found clear returns to experience, at least through 12 years, for middle school teachers of both math and ELA, as measured by their students' test scores. Interestingly, the non-test outcomes were stronger for ELA teachers than for math teachers, in contrast to test-based outcomes, which were stronger for math teachers.

## Teachers make greater gains in their effectiveness when they teach in a supportive and collegial working environment, or accumulate experience in the same grade level, subject, or district.

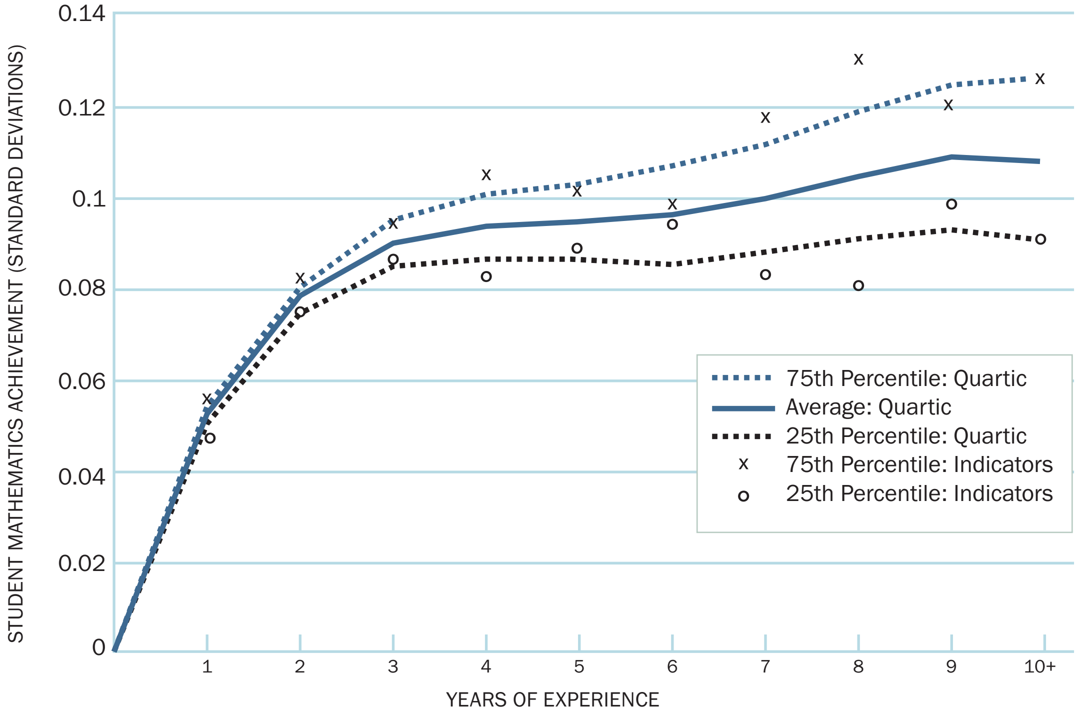
There is a growing body of research analyzing whether different types of teaching experience accelerate teachers' rates of improvement over time. With the wider availability of matched student-teacher data, this body of research will continue to grow and shed light on how districts can accelerate professional learning on the job and further increase the benefits that students receive from more experienced teachers. Two types of experience have been addressed in the research so far: prior experience in a supportive professional working environment and prior experience at the same grade level/subject area or in the same district.

### Experience in a more collegial and supportive working environment

Research is clear that significant school improvement is most likely to occur in schools led by a strong principal, providing extensive opportunities for collaboration and common planning among teachers, and focused around a shared vision for student achievement.[80] The research is also clear that these elements of a school are essential to a teacher's decision whether to stay in or leave that school or the profession altogether.[81] For example, research demonstrates that a variety of supports throughout teachers' careers are associated with their commitment to teaching (e.g., novice teachers' need for support with behavioral management of students; midcareer teachers' need for autonomy and empowerment with instruction).[82] Most recently, research has begun to show that teachers' rate of improvement over time also depends on the supportiveness of their professional working environment.

A recent longitudinal study of 3,145 teachers and 280,000 elementary math students over 10 years in the Charlotte-Mecklenberg School District examined how teachers' improvement over time was related to the type of school they worked in.[83] The study used data from the North Carolina Teacher Working Conditions Survey to create a measure of the professional environment for each school, including data elements related to order and discipline, peer collaboration, principal leadership, professional development, school culture, and fair and meaningful teacher evaluation. The study

Figure 5: **Returns to Teaching Experience for Prototypical Teachers, Across School Professional Environments**




Note: In their analysis, the authors used administrative data on teachers and students in a large, urban school district in the southern United States in 2000–2009.

*Source: Matthew A. Kraft and John P. Papay, "Can Professional Environments in Schools Promote Teacher Development? Explaining Heterogeneity in Returns to Teaching Experience," Educational Evaluation and Policy Analysis 36, no. 4 (2014): 476–500.*



focused on teachers early in their careers (years 1–10) and compared teachers to themselves over time, using teacher fixed effects analyses. The study then compared the within-teacher returns to experience of teachers in schools with more supportive professional environments to those of their peers in schools with less supportive professional environments. As with many other studies, the study found positive returns to experience generally (see Figure 5).

Of particular interest, however, the study also showed that teachers who work in schools with strong professional environments improve in their effectiveness in teaching mathematics at much faster rates than their peers working in schools with weaker professional environments. The study found that third year teachers working in schools at the 75th percentile—characterized by a trusting, respectful, safe and orderly environment, with collaboration amongst teachers, school leaders who support teachers, time and resources for teachers to improve their instructional abilities, and teacher evaluation that provides meaningful feedback—improved by 0.010 standard deviations more than third year teachers working in schools at the 25th percentile (schools that are weaker in the above characteristics), which represents a gap in improvement of 12 percent. This gap in improvement between teachers working at schools with working environments at the 75th and 25th percentiles increases to 20 percent after five years (or by 0.017 standard deviations), and to 38 percent after 10 years, (or by 0.035 standard deviations).

In other words, after 10 years, teachers who work in schools with stronger (75th percentile) working environments will have become more effective, by approximately one-fifth of a standard deviation, as compared to teachers who work at schools with weaker (25th percentile) working environments.[84] The authors note that "a difference of 0.035 test-score [standard deviation] is approximately 20 percent of a SD in the distribution of overall teacher effectiveness and represents over 30 percent of the average total improvement teachers make in their first 10 years on the job."[85]

Consistent with the research on school improvement overall, the study shows that a teacher's improvement over time is greatest when working in a school that has a strong professional working environment offering opportunities for peer collaboration, professional learning, and meaningful feedback from a strong principal. **Translated into days of learning, a 10th-year teacher working in a strong professional working environment will produce about an additional week (according to Levin et al.'s translation) to an additional month (according to CREDO's translation) of learning more than that same teacher working in a weak professional environment.** A similar study of over 9,000 teachers in 336 Miami-Dade County public schools also found that teacher collaboration led to greater rates of improvement and improved student outcomes in math and reading.[86]

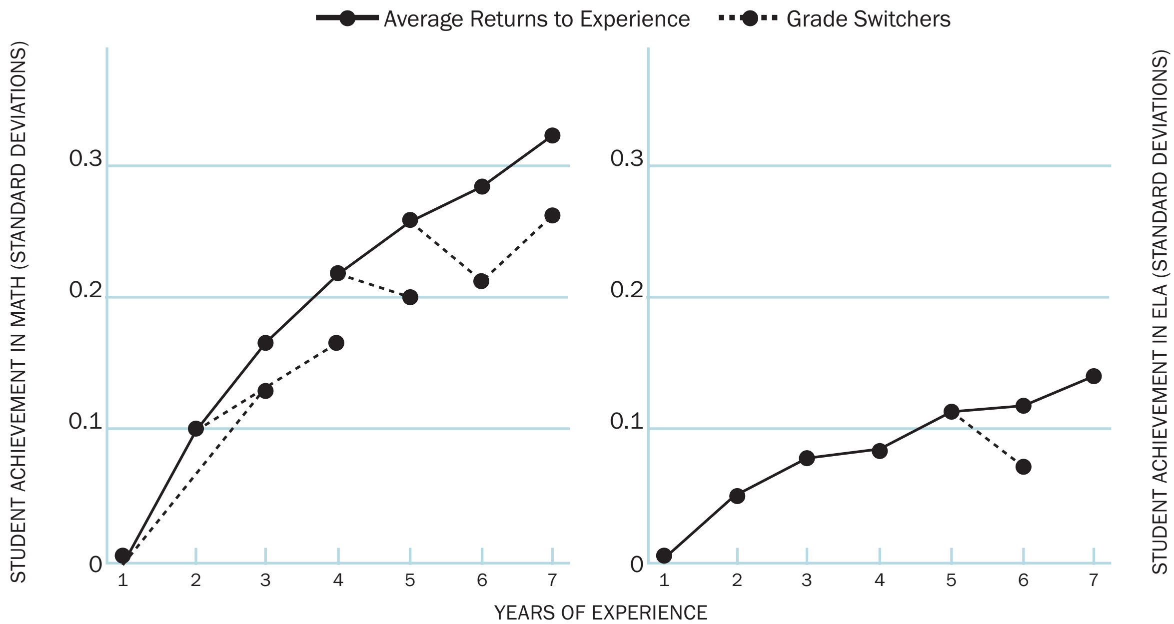
### Experience in same grade level, subject area, or district

A few studies have examined the relationship between the type of experience and its effects on student achievement. They show that teachers with prior experience in the same grade level, subject area, or district show greater returns to experience than those with less relevant prior experience.

One recent study, using the same large North Carolina data set relied on by numerous other researchers, examined the impact of prior experience at grade level.[87] Looking at elementary teachers in grades 3–5 over an 18-year period, the author found returns to experience, with larger returns to experience teaching at the same grade level. In math, students of teachers with more grade-specific experience made greater progress than students who had a similarly experienced teacher with less grade-specific experience, with the grade-specific experience effect half as large as the general experience effect.[88] In reading, the study showed returns to general teaching experience but did not find greater returns for grade-specific experience as compared to general teaching experience. Perhaps this is because reading objectives in North Carolina are constant across grades whereas the math objectives vary dramatically for each grade.[89]

The study also found that the teachers who had recently taught their current grade showed a greater benefit from specific experience than those who had not. In other words, teachers who had taught in their current grade within the last few years showed the greatest benefit from specific experience. Finally, the study found that teachers switch grade assignments frequently: 18 percent of teachers switch to a new grade in their second year of teaching, and fewer than half teach the same grade over the course of their first five years of teaching. A similar study using 10-year data from a large urban school district in California reached a similar conclusion: elementary teachers frequently switch grades, particularly in low-achieving, high-minority schools, and grade switching is associated with smaller returns from experience and higher rates of turnover among teachers[90] (see Figure 6). These studies suggest that reducing the frequent reassignment of teachers, especially for less experienced teachers, would help to improve the substantial returns to specific teaching experience.

Figure 6: **Returns to Experience in Math and ELA on Average and for Teachers Who Switch to Any Grade**




Note: In their analysis, the authors used administrative records from a large urban school district in California for elementary school teachers and students in 2002–2012.

*Source: David Blazar, "Grade Assignments and the Teacher Pipeline: A Low-Cost Lever to Improve Student Achievement?" Educational Researcher 44, no. 4 (2015): 213–27.*



A smaller study examining benefits of experience for teachers of elementary reading at 53 Title I schools in a mid-Atlantic state also found large and significant benefits where teachers had prior experience at the same grade level covered in the study.[91] Importantly, the study found that

> [t]he effect size for seasoned grade level teachers [effect size = .27] is three times larger than the effect size of economic status (effect size=−.09) and nearly as large as the effect of minority status (effect size=−.33). This suggests that experienced teachers teaching at a specific grade level could have a large effect in countering the effects of the widening achievement gaps.[92]

The study also found that teachers constantly improved teaching effectiveness until the 21st year. The most effective teachers had 19–24 years of experience at grade level and were associated, holding all other variables constant, with increased student reading achievement (effect size=.40). These highly experienced teachers were twice as effective as teachers with at least more than five years of experience (effect size=.20). The study did not find significant returns to experience when prior experience did not occur at the same grade level.

## More experienced teachers confer benefits to their colleagues and to the school as a whole, as well as to their own students.

Research indicates that teachers whose colleagues are more experienced are more effective than those whose colleagues are less experienced, suggesting that more experienced teachers provide important additional benefits to their school community beyond increased learning for the students they teach. A study using data from third through fifth grade students and their teachers in North Carolina over an 11-year period found that teachers whose peer teachers had more experience tended to have improved student outcomes.[93] For example, the study found that teachers improve in their ability to raise their students' test scores by over 0.02 standard deviations in math and over 0.01 standard deviations in reading when their peer teachers (those teaching at the same grade level) have at least four years of experience. Put in context, this translates into about one additional week of learning, according to Levin et al.'s translation, or three additional weeks of learning, according to CREDO's translation. The study also found that novice teachers benefit most from having more experienced teachers as peers, and that the quality of a teacher's peers has ripple effects for that teacher's students' achievement beyond the current school year. That is, the quality of a teacher's peers the year before, and even two years before, affects her current students' achievement.

Another study, while focused on a different question, also suggests that returns to experience differ depending on the experience level of a teacher's colleagues. A study of Florida and North Carolina elementary schools from the 2000-01 to 2004-05 school years found that the returns to experience for teachers in the lowest-poverty schools tended to be greater than for teachers in the highest-poverty schools.[94] In addition, the authors tracked teachers who left their school, and found that the mobility of teachers at low- and high-poverty schools did not drive their different rates of returns to experience. Instead, the authors asserted that differences in effectiveness were likely the result of the quality and experience of peer teachers and the challenging environment of many high-poverty schools that leads to "burn out." Schools with large proportions of inexperienced teachers (often the highest-poverty schools) have limited numbers of experienced mentor teachers to support the development of new teachers.[95] In these types of settings where "the blind are leading the blind," returns to experience may be lessened because there simply are not enough expert, experienced teachers to mentor and support novices, and the few who could serve as mentors are stretched thin and feel overburdened by the needs of their colleagues as well as their students.[96]

These studies uncover the broader school-wide benefits of retaining an experienced and stable workforce. Namely, schools with lower attrition rates, and often more experienced teachers, tend to have a collegial culture rooted in teachers' shared knowledge and practice.[97] In contrast, schools with higher attrition rates, and often fewer experienced teachers, tend to have a disjointed knowledge base within the school and a lack of coherence of instructional practice. High rates of teacher turnover have been found to have a significant negative effect on student achievement that extends well beyond the classrooms of students whose teachers have left, particularly in schools serving large populations of low-performing and Black students.[98] Relatedly, a high level of collaboration among teachers within a school is associated with increased gains in student achievement and faster rates of improvement for teachers.[99] Taken as a whole, these findings suggest that policies to increase opportunities for inexperienced teachers to collaborate with and learn from more experienced colleagues—and to ensure the least experienced teachers are not concentrated in certain schools, subjects, or grade levels—may result in better outcomes for students.

# Limitations of This Review and Suggestions for Future Research

While this study highlights the growing body of research finding that teaching experience contributes to improved student outcomes, our findings include several caveats and limitations. First, the majority of the studies in our review drew their samples from a limited number of states and districts (e.g., Florida, New York, North Carolina, and Texas) because of their advanced data systems that match student and teacher data. While the conclusions drawn from these studies may not be generalizable to all other states, these states nonetheless represent diverse populations from different parts of the country.

Second, all but one of the studies measured gains in student achievement in terms of standardized test scores. To the extent that standardized tests are not well matched to the content of the instruction that students receive (i.e., that standardized tests focus on a narrow range of ability but more effective teachers' instruction occurs beyond that narrow range), then our findings on the benefits of experience may under- or overestimate the value of teachers' experience to students' learning. If, as would be expected, teachers expand their repertoire as they teach, returns to experience may be underestimated to the extent that experience allows teachers to more effectively teach a wider range of skills, content, and dispositions.

Third, none of the studies measured the optimal mix of experience for a grade level or subject team, school, or district. Based on the organizational and business literature, student achievement may best be supported with a blend of inexperienced and experienced teachers with a distributed set of expertise and experiences.[100] For example, younger teachers may bring knowledge about technology to more experienced teachers, while experienced teachers might bring contextual knowledge about the students, parents, and community the school serves to their novice colleagues.

Based on our analysis and the limitations of the study, we recommend further research in the following areas: (1) the association between teaching experience and the development of skills students need to succeed in the 21st century, such as students' collaboration skills, critical thinking and problem-solving, oral and written communication, and an academic mindset; (2) the optimal blend of teaching experience levels within a school or a grade-level team; and (3) the circumstances of a teacher's working conditions (e.g., team, school, and district characteristics) associated with the greatest returns to teaching experience.

# Policy Implications and Recommendations

These research findings showing the benefits of more experienced teachers for both students and schools suggest a number of implications for policymakers and educators at the federal, state, district, and school levels. Policymakers' primary goal should be to build an experienced teaching workforce of high-quality individuals focused on learning. To accomplish this goal will require the conscious pursuit of policies to increase teacher retention and reduce turnover in schools. At the same time, the benefits of teaching experience will be best realized when teachers are carefully selected and well-prepared at the point of entry into the teaching workforce, as well as intensively mentored and rigorously evaluated prior to receiving tenure. This will ensure that those who enter the professional tier of teaching have met a competency standard from which they can continue to build and grow throughout their careers.

As teachers gain experience—both within their first few years in the classroom as well as later in their careers—they are better able to foster student learning. This is particularly true when teachers are working in supportive and collegial school environments where teachers engage in common planning and share in decision-making, school staff are focused on a shared vision for student achievement, and principals are supportive. A more stable and experienced teaching staff benefits students across the entire school, as more experienced teachers are better able to support their less experienced colleagues in producing student achievement. Importantly, retention is also higher in this type of school environment, creating a virtuous cycle in which supportive and collegial schools are able to attract and retain excellent, experienced teachers, who are the ones best positioned to contribute to school-wide learning and greater student achievement.

The pursuit of policies to simultaneously build an experienced, continually-learning teaching workforce while reducing teacher turnover also makes economic sense. A study published in 2007 found that, at that time, the costs to school districts of replacing a teacher who leaves in the early part of her career ranged from $4,366 in a small rural district to nearly $18,000 in a large urban district, at an estimated national cost of more than $7 billion annually.[101] With these costs likely even higher today, this is not a wise use of scarce resources that could instead be used to create conditions which would retain teachers and improve their effectiveness. Given the research demonstrating that teacher effectiveness improves, on average, with experience, policies to keep experienced teachers in the classroom and reduce teacher turnover can increase student achievement and reduce student absenteeism. In turn, this can contribute to long-term economic benefits to students and to taxpayers in terms of reduced grade retention, special education costs, and drop out rates.[102] Such policies are especially critical for schools serving large concentrations of low-income students and students of color, who are more likely to be taught by inexperienced teachers churning through their schools.

To support the development of an experienced teaching workforce that is continually learning while reducing teacher turnover, we offer the following recommendations:

1. **Increase stability in teacher job assignments.** Research shows that teachers who have repeated experience teaching the same grade level or subject area improve more rapidly than those whose experience is in another grade level or subject.[103] Of course, many factors influence job assignment decisions, including teachers' desires for professional growth and new challenges as well as principals' needs for flexibility in management.[104] School leaders, however, should be educated about the increased benefits of specific teaching experience and consider this in their decisions about teaching assignments.

2. **Create conditions for strong collegial relationships among school staff and a positive and professional working environment.** Among the most common reasons teachers give for leaving the classroom is an unsupportive principal or a lack of collegial support among the staff. In contrast, teachers who have chosen to stay in the profession cite the quality of relationships among staff, a supportive principal, and opportunities to collaborate as among their most important reasons for continuing to teach.[105] Collegiality is hard to legislate, but there are nonetheless concrete steps that policymakers can take. District and school leaders can facilitate **scheduling changes** to allow for regular blocks of time for teachers who teach the same subject or who share groups of students to collaborate and plan curriculum together.[106] Federal and state policymakers can promote **principal career pathways**, in which talented teachers are proactively recruited and intensively trained by an expert principal.[107] Increasing opportunities for collaboration and a more productive working environment is smart policy both because of the promise this holds for increased teacher retention and because the benefits of experience are greater for teachers in strong professional working environments.[108]

3. **Strengthen policies to encourage the equitable distribution of more experienced teachers and discourage the concentration of novice teachers in high-need schools.** The new Every Student Succeeds Act maintains a federal focus on closing the equity gap with respect to students' access to expert, experienced teachers. The No Child Left Behind Act highlighted the problem of teacher inequities, requiring states and districts to, for the first time, develop plans "to ensure that low-income and minority students are not taught at higher rates than other children by inexperienced, unqualified, or out-of-field teachers," and to evaluate and publicly report on their progress.[109] Enforcement was weak and sporadic, however. Throughout the 14 years of NCLB, states were required to submit educator equity plans only twice, and no states were ever sanctioned for failure to deliver on the promise of equitable access to excellent teaching. The new ESSA requires states to develop plans describing how low-income students and students of color "are not served at disproportionate rates by ineffective, out-of-field, or inexperienced teachers" and to evaluate and publicly report on their progress in this area.[110] Further, districts are required to "identify and address" teacher equity gaps.[111] As the U.S. Department of Education works to implement these provisions, much will depend on how the term "inexperienced teacher" is defined. The Department of Education should strengthen its enforcement of these provisions and define the term "inexperienced" teacher to include teachers who, at a minimum, are in their first or second year of teaching. Such a definition would be consistent with the definition used by the Department in its Civil Rights Data Collection, which provides important data on the concentration of first-year and second-year teachers in every school in the nation.[112]

Other strategies for developing an experienced teaching workforce that is continually learning have been well documented elsewhere:

4. **Provide expert teachers with career development opportunities so that they will be incentivized to stay in the classroom.** Another situation driving teachers from the classroom is the relatively flat career trajectory of the teaching profession, which offers little opportunity for shared learning, career advancement, or enhanced compensation for individuals who are not interested in becoming administrators.[113] To retain excellent, experienced teachers, districts can create **hybrid teacher leader roles**, which provide such teachers with new challenges and opportunities for career advancement. Such roles can keep expert teachers in the classroom and at the same time meet pressing school needs for stronger instructional leadership.[114] Teacher leaders can teach students part of the day or week while also serving in leadership roles, such as mentors for new teachers, student support or curriculum specialists, teacher educators, and part-time administrators. Such career advancement opportunities can be tied to **enhanced compensation**, thereby addressing the problem of low salaries pushing teachers out of the profession.[115]

5. **Invest in high-quality, clinically-based teacher preparation programs and offer financial support to prospective teachers completing such programs.** A growing body of evidence demonstrates that attrition is highest for those who enter the profession without adequate preparation. According to data from the National Center for Education Statistics, beginning teachers with extensive preparation—those who had practice teaching, received feedback on their teaching, and completed coursework on specific aspects of teaching—were twice as likely to remain in the classroom as compared to teachers with little or no preparation.[116] States and districts, with incentives from the federal government, should invest in teacher preparation programs that place and then retain competent and committed teachers in the highest-need schools.

   One promising model is **teacher residency programs**, which provide talented college graduates with a year-long paid residency under the guidance of an accomplished master teacher as well as coursework closely intertwined with clinical practice, training teachers in the subject areas most in demand in the sponsoring school district. In exchange for this intensive teacher preparation, residents commit to teach in the district for at least four years. Rigorous studies of teacher residency programs have found significantly higher retention rates for graduates of these programs. For example, a recent study of graduates of the 12 oldest and largest residency programs found 82 percent still teaching in the same district in their third and fourth year, compared with 72 percent of non-residency recruits.[117] An in-depth study of the Boston Teacher Residency found that 80 percent of residency graduates were still teaching in Boston Public Schools in their third year compared with 63 percent of non-resident teachers; by their fifth year, 75 percent of residency graduates were still teaching in the district compared with 51 percent of nonresident teachers.[118] **Scholarship and loan forgiveness** programs, which cover the costs of a teacher's training in exchange for a commitment to teach in a high-need school or subject area for 3 to 4 years, are another promising approach for increasing teacher retention.[119] Five-year retention rates for North Carolina teaching scholarship recipients are 75 percent, the highest for any group of teachers in North Carolina and nearly twice as high as for teachers prepared through alternative pathways.[120]

6. **Provide mentoring, support, and other professional learning opportunities—often known as "induction"—for all novice teachers.** Estimates suggest that between 17 and 30 percent of beginning teachers in the United States leave the profession within the first five years.[121] Ironically, just as teachers are making their steepest gains in effectiveness, many decide to leave the profession, leaving students—particularly low-income students and students of color—with inexperienced, less effective teachers. One of the most promising policy solutions to both reduce teacher turnover and accelerate novice teachers' professional learning is high-quality mentoring and induction programs for new teachers. These programs provide new teachers with a mentor teacher in the same subject and/or grade level, regularly scheduled collaboration time with colleagues, and released time for their mentor to provide one-on-one coaching and demonstration lessons in the classroom. Research shows that high-quality mentoring and induction programs lead to teachers who stay in the profession longer, accelerated professional growth among new teachers, and improved student learning.[122]

As states and districts consider how to most wisely spend their educator development dollars, including federal funds provided under Title II of the Every Student Succeeds Act, the findings of this research review suggest that investments in building an experienced, highly-collaborative teacher workforce focused on continual learning, while at the same time reducing teacher attrition, are those most likely to result in greater student learning.

# Conclusion

The 30 studies reviewed here necessarily vary in their selection of target population data (e.g., grade level, subjects, geography) and in their methods. However, looking at this body of different, high-quality studies—each of which analyzes the effects of teaching experience on student achievement employing several different approaches—provides a relatively clear answer for policymakers to the question of "Do teachers continue to improve in their effectiveness as they gain experience in the teaching profession?" The answer is yes.

Our review of the research leads to four key conclusions:

1. Teaching experience is positively associated with student achievement gains throughout a teacher's career. Gains in teacher effectiveness associated with experience are most steep in teachers' initial years, but continue to be significant as teachers reach the second, and often third, decades of their careers.

2. As teachers gain experience, their students not only learn more, as measured by standardized tests, they are also more likely to do better on other measures of success, such as school attendance.

3. Teachers' effectiveness increases at a greater rate when they teach in a supportive and collegial working environment, and when they accumulate experience in the same grade level, subject, or district.

4. More experienced teachers support greater student learning for their colleagues and the school as a whole, as well as for their own students.

The common refrain that teaching experience does not matter after the first few years in the classroom is no longer supported by the preponderance of the research. Based on an extensive research base, it is clear that teachers' effectiveness rises sharply in the first few years of their careers, and this upward trajectory continues well into the second and often third decade of teaching. The overwhelming majority of the 30 studies reviewed here (93 percent)—and 100 percent of the 18 studies using the teacher fixed effects methods—reach this conclusion. The effects of teaching experience on student achievement are significant, and the compounded positive effect of having a series of accomplished, experienced teachers for several years in a row offers the opportunity to reduce or close the achievement gap for low-income students and students of color.[123] Given this knowledge, policymakers should direct renewed attention to developing a teacher workforce composed of high-ability teachers who enjoy long careers in supportive and collegial schools.

Of course, not all experience is educative: some highly experienced teachers are not particularly effective or have retired on the job, and some novice teachers are dynamic and effective. However, by and large, a more experienced teaching workforce offers numerous benefits to students and schools, including greater individual and collective effectiveness in improving student outcomes as well as greater stability and coherence in instruction and relationship-building—the core work of schools.

# Endnotes


1. See John P. Papay et al., "Does an Urban Teacher Residency Increase Student Achievement? Early Evidence from Boston," *Educational Evaluation and Policy Analysis* 34, no. 4 (2012): 413–34; Gary T. Henry, Kevin C. Bastian, and Adrienne A. Smith, "Scholarships to Recruit the 'Best and Brightest' into Teaching: Who Is Recruited, Where Do They Teach, How Effective Are They, and How Long Do They Stay?," *Educational Researcher* 41, no. 3 (2012): 83–92; Richard M. Ingersoll and Michael Strong, "The Impact of Induction and Mentoring Programs for Beginning Teachers: A Critical Review of the Research," *Review of Educational Research* 81, no. 2 (2011): 201–33; LPI Paper, "Recruiting and Retaining Excellent Educators: Research, Policies, and Strategies to Strengthen the Teaching Workforce" (forthcoming), Learning Policy Institute (2016); LPI Paper "Teacher Residencies: An Innovative Model for Preparing Teachers" (forthcoming), Learning Policy Institute (2016).

2. See, e.g., Matthew A. Kraft and John P. Papay, "Can Professional Environments in Schools Promote Teacher Development? Explaining Heterogeneity in Returns to Teaching Experience," *Educational Evaluation and Policy Analysis* 36, no. 4 (2014): 476–500; Helen F. Ladd and Lucy C. Sorensen, "Returns to Teacher Experience: Student Achievement and Motivation in Middle School" (Washington, DC: American Institutes for Research, 2015), http://www.caldercenter.org/publications/returns-teacher-experience-student-achievement-and-motivation-middle-school; Douglas N. Harris and Tim R. Sass, "Teacher Training, Teacher Quality and Student Achievement," *Journal of Public Economics* 95, no. 7–8 (2011): 798–812; Douglas O. Staiger and Jonah E. Rockoff, "Searching for Effective Teachers with Imperfect Information," *Journal of Economic Perspectives* 24, no. 3 (2010): 97–118; Donald Boyd et al., "The Narrowing Gap in New York City Teacher Qualifications and Its Implications for Student Achievement in High-Poverty Schools," *Journal of Policy Analysis and Management* 27, no. 3 (2008): 793–818.

3. Jennifer King Rice, "Learning from Experience? Evidence on the Impact and Distribution of Teacher Experience and the Implications for Teacher Policy," *Education Finance and Policy* 8, no. 3 (2013): 332–48.

4. Robert S. Huckman and Gary P. Pisano, "The Firm Specificity of Individual Performance: Evidence from Cardiac Surgery," *Management Science* 52, no. 4 (2006): 473–88.

5. Wai Fong Boh, Sandra A. Slaughter, and J. Alberto Espinosa, "Learning from Experience in Software Development: A Multilevel Analysis," *Management Science* 53, no. 8 (2007): 1315-31.

6. Richard M. Ingersoll, Lisa Merrill, and Daniel Stuckey, "Seven Trends: The Transformation of the Teaching Force" (Philadelphia, PA: Consortium for Policy Research in Education, 2014).

7. See, e.g., Julian R. Betts, Kim S. Reuben, and Anne Danenberg, *Equal Resources, Equal Outcomes? The Distribution of School Resources and Student Achievement in California* (San Francisco: Public Policy Institute of California, 2000); Dan Goldhaber, Lesley Lavery, and Roddy Theobald, "Uneven Playing Field? Assessing the Teacher Quality Gap Between Advantaged and Disadvantaged Students," *Educational Researcher* 44, no. 5 (2015): 293–307; Boyd et al., "The Narrowing Gap in New York City Teacher Qualifications and Its Implications for Student Achievement in High-Poverty Schools"; Tim R. Sass et al., "Value Added of Teachers in High-Poverty Schools and Lower Poverty Schools," *Journal of Urban Economics* 72, no. 2–3 (2012): 104–22.

8. U.S. Department of Education, *New Data from the U.S. Department of Education 2009–10 Civil Rights Data Collection Show Continuing Disparities in Educational Opportunities and Resources* (Washington, DC: June 2011), http://www.ed.gov/news/press-releases/new-data-us-department-education-2009 E.g., 10-civil-rights-data-collection-show-continuing-disparities-educational-opportunities-and-resources.

9. U.S. Department of Education, Office of Civil Rights, *Civil Rights Collection Data Snapshot: Teacher Equity* (Washington, DC: March 2014), http://www2.ed.gov/about/offices/list/ocr/docs/crdc-teacher-equity-snapshot.pdf.

10. National Center for Education Statistics, SASS, *Schools and Staffing Survey* (Washington, DC: U.S. Department of Education, 2012).

11. U.S. Department of Education, *Highly Qualified Teachers Enrolled in Programs Providing Alternative Routes to Teacher Certification or Licensure* (Washington, DC: 2015), https://www2.ed.gov/rschstat/eval/teaching/hqt-teacher-certification/report.pdf.

12. Harris and Sass, "Teacher Training, Teacher Quality and Student Achievement," 798–812.The authors note that earlier research (published prior to 2003) about teaching experience and productivity has been thoroughly reviewed.

13. See appendix for more information.

14. For examples of studies that applied a cross-sectional analysis, see Julian R. Betts, Andrew C. Zau, and Lorien A. Rice, *Determinants of Student Achievement: New Evidence from San Diego*, 2003; Barbara Nye, Spyros Konstantopoulos, and Larry V. Hedges, "How Large Are Teacher Effects?," *Educational Evaluation and Policy Analysis* 26, no. 3 (2004): 237–57; Thomas S. Dee, "Teachers, Race, and Student Achievement in a Randomized Experiment," *Review of Economics and Statistics* 86, no. 1 (2004): 195–210; Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor, "Teacher-Student Matching and the Assessment of Teacher Effectiveness," *Journal of Human Resources* 41, no. 4 (2006): 778–820; Francis L. Huang and Tonya R. Moon, "Is Experience the Best Teacher? A Multilevel Analysis of Teacher Characteristics and Student Achievement in Low Performing Schools," *Educational Assessment, Evaluation and Accountability* 21, no. 3 (2009): 209–34.

15. Daniel Aaronson, Lisa Barrow, and William Sander, "Teachers and Student Achievement in the Chicago Public High Schools," *Journal of Labor Economics* 25, no. 1 (2007): 95–135; Steven G. Rivkin, Eric A. Hanushek, and John F. Kain, "Teachers, Schools, and Academic Achievement," *Econometrica* 73, no. 2 (2005): 417–58, http://www.jstor.org/stable/3598793; Betts, Zau, and Rice, *Determinants of Student Achievement: New Evidence from San Diego*.

16. John P. Papay and Matthew A. Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," *Journal of Public Economics* 130 (2015): 105–19; Matthew Wiswall, "The Dynamics of Teacher Quality," *Journal of Public Economics* 100 (2013): 61–78.

17. Boyd et al., "The Narrowing Gap in New York City Teacher Qualifications and Its Implications for Student Achievement in High-Poverty Schools," 793–818; Harris and Sass, "Teacher Training, Teacher Quality and Student Achievement," 798–812; Wiswall, "The Dynamics of Teacher Quality," 61–78.

18. Papay and Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," 105–19.

19. Wiswall, "The Dynamics of Teacher Quality," 61–78.

20. Rivkin, Hanushek, and Kain, "Teachers, Schools, and Academic Achievement"; Betts, Zau, and Rice, *Determinants of Student Achievement: New Evidence from San Diego*.

21. Hamilton Lankford, Susanna Loeb, Andrew McEachin, Luke C. Miller, and James Wyckoff, "Who Enters Teaching? Encouraging Evidence That the Status of Teaching Is Improving," *Educational Researcher* 43, no. 9 (2014): 444–53.

22. In practice the data sets are not sufficiently long to follow individual teachers over the full length of a career. Instead, the method in effect controls for ability by grouping teachers with similar ability together to construct the returns to experience over many years.

23. Papay and Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," 105–19.

24. Wiswall, "The Dynamics of Teacher Quality," 71.

25. For studies finding that the most effective teachers leave the profession earlier, see also Boyd et al., "The Narrowing Gap in New York City Teacher Qualifications and Its Implications for Student Achievement in High-Poverty Schools"; Wiswall, "The Dynamics of Teacher Quality"; Harris and Sass, "Teacher Training, Teacher Quality and Student Achievement"; Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor, "Teacher Credentials and Student Achievement: Longitudinal Analysis with Student Fixed Effects," *Economics of Education Review* 26, no. 6 (2007): 673–82. But see Gary T. Henry, Kevin C. Bastian, and C. Kevin Fortner, "Stayers and Leavers: Early-Career Teacher Effectiveness and Attrition," *Educational Researcher* 40, no. 6 (2011): 271–80. This study, which did not apply teacher fixed effects, discusses an "emerging consensus" that "less effective teachers are more likely to exit the profession" and finds that less effective teachers exit after one year.

26. Demetra Kalogrides, Susanna Loeb, and Tara Beteille, "Systematic Sorting: Teacher Characteristics and Class Assignments," *Sociology of Education* 86, no. 2 (2012): 103–23; Clotfelter, Ladd, and Vigdor, "Teacher-Student Matching and the Assessment of Teacher Effectiveness."

27. Kane, Rockoff, and Staiger, "What Does Certification Tell Us about Teacher Effectiveness? Evidence from New York City."

28. Kalogrides, Loeb, and Beteille, "Systematic Sorting: Teacher Characteristics and Class Assignments," 103–23; Clotfelter, Ladd, and Vigdor, "Teacher-Student Matching and the Assessment of Teacher Effectiveness," 778–820.

29. Ladd and Sorensen, "Returns to Teacher Experience: Student Achievement and Motivation in Middle School."

30. See, e.g., Nye, Konstantopoulos, and Hedges, "How Large Are Teacher Effects?," 248 (returns to experience for teachers with three or more years of experience were combined); Staiger and Rockoff, "Searching for Effective Teachers with Imperfect Information," 97–117 (returns to experience for teachers with three or more years of experience were combined). See also Eric A. Hanushek et al., "The Market for Teacher Quality," *National Bureau of Economic Research Working Paper Series*, 2005, 17 (returns to experience for teachers with six or more years of experience were combined, although authors note that "preliminary analysis, not shown, found no experience effects beyond five years of experience"); Rivkin, Hanushek, and Kain, "Teachers, Schools, and Academic Achievement," 442 (returns to experience for teachers with five or more years of experience were combined; the authors note, but do not provide data to demonstrate, that "including the percentages of teachers with 5 to 9 and 20+ years of experience as separate categories did not change any of the results, and the hypotheses that teachers with five to nine or twenty or more years of experience had a different impact from those with ten or more years of experience was rarely rejected at any conventional significance level.").

31. Wiswall, "The Dynamics of Teacher Quality," 108.

32. Papay and Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," 112–13.

33. Ibid., 111.

34. See, e.g., Matthew M. Chingos and Paul E. Peterson, "It's Easier to Pick a Good Teacher Than to Train One: Familiar and New Results on the Correlates of Teacher Effectiveness," *Economics of Education Review* 30, no. 3 (2011): 449–65 (used indicator variables for 1-2, 3-5, 6-12, 13-20, & 21+ years); Harris and Sass, "Teacher Training, Teacher Quality and Student Achievement," 798–812 (used indicator variables for 1–2, 3–4, 5–9, 10–14, 15–24, and 25+ years); Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor, "Teacher Credentials and Student Achievement in High School," *The Journal of Human Resources* 45, no. 3 (2010): 655–81 (used indicator variables for 1–2, 3–5, 6–12, 13–20, 21–27, and 27+ years); C. Kirabo Jackson and Elias Bruegmann, "Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers," *American Economic Journal: Applied Economics* 1, no. 4 (2009): 85–108 (used indicator variables for 1–3, 4–9, 10–24 and 25+ years); Clotfelter, Ladd, and Vigdor, "Teacher Credentials and Student Achievement: Longitudinal Analysis with Student Fixed Effects" (used indicator variables for 1–2, 3–5, 6–12, 13–20, 21–27, and 27+ years); Clotfelter, Ladd, and Vigdor, "Teacher-Student Matching and the Assessment of Teacher Effectiveness" (used indicator variables for 1–2, 3–5, 6–12, 13–20, 21–27, and 27+ years); David Blazar, "Grade Assignments and the Teacher Pipeline: A Low-Cost Lever to Improve Student Achievement?," *Educational Researcher* 44, no. 4 (2015): 213–27 (used indicator variables for Year 2, 3, 4, 5, 6, & 7+ of teaching).

35. Papay and Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," 108.

36. Ibid.

37. Ibid., 111.

38. Ibid., 113.

39. Wiswall, "The Dynamics of Teacher Quality," 61–78.

40. Ibid., 64.

41. Carolyn J. Hill et al., “Empirical Benchmarks for Interpreting Effect Sizes in Research,” *Child Development Perspectives* 2, no. 3 (2008): 172–77.

42. Ibid., 173.

43. E. Cremata, D. Davis, K. Dickey, K. Lawyer, Y. Negassi, M. E. Raymond, and J. L. Woodworth, *National Charter School Study 2013* (Stanford, CA: Stanford University, 2013).

44. Eric A. Hanushek, Paul E. Peterson, and Ludger Woessmann, “Achievement growth: International and US state trends in student achievement,” *Education Next* 12, no. 4 (2012): 24–33.

45. Henry M. Levin, Gene V. Glass, and Gail R. Meister, “Cost-Effectiveness of Computer-Assisted Instruction,” *Evaluation Review* 11, no. 1 (1987): 50–72.

46. Hill et al., “Empirical Benchmarks for Interpreting Effect Sizes in Research,” 172–177.

47. See Andrew Maul, *Review of Urban Charter School Study 2015* (Boulder, CO: National Education Policy Center, 2015), http://nepc.colorado.edu/files/ttr-urbancharter-credo.pdf.

48. Hill et al., “Empirical Benchmarks for Interpreting Effect Sizes in Research,” 172–77.

49. Ibid.

50. Ibid.

51. Staiger and Rockoff, “Searching for Effective Teachers with Imperfect Information.”

52. Hill et al., “Empirical Benchmarks for Interpreting Effect Sizes in Research,” 172–77.

53. John Hattie, *Visible Learning: A synthesis of over 800 meta-analyses relating to achievement*, Routledge (2008).

54. Hattie, *Visible Learning*, 16-17.

55. Clotfelter, Ladd, and Vigdor, “Teacher-Student Matching and the Assessment of Teacher Effectiveness”; Clotfelter, Ladd, and Vigdor, “Teacher Credentials and Student Achievement: Longitudinal Analysis with Student Fixed Effects”; Harris and Sass, “Teacher Training, Teacher Quality and Student Achievement”; Kane, Rockoff, and Staiger, “What Does Certification Tell Us about Teacher Effectiveness? Evidence from New York City”; Ladd and Sorensen, “Returns to Teacher Experience: Student Achievement and Motivation in Middle School”; Boyd et al., “The Narrowing Gap in New York City Teacher Qualifications and Its Implications for Student Achievement in High-Poverty Schools.”

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58. Ladd and Sorensen, “Returns to Teacher Experience: Student Achievement and Motivation in Middle School.”

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60. Clotfelter, Ladd, and Vigdor, “Teacher Credentials and Student Achievement in High School,” 655–81.

61. Ibid., 666. The authors note that this finding is based on a slightly less preferred overall specification.

62. Clotfelter, Ladd, and Vigdor, “Teacher Credentials and Student Achievement: Longitudinal Analysis with Student Fixed Effects,” 673–82.

63. Wiswall, “The Dynamics of Teacher Quality,” 61–78.

64. Harris and Sass, “Teacher Training, Teacher Quality and Student Achievement,” 798–812.

65. Papay and Kraft, “Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement,” 105–19.

66. Henry, Bastian, and Fortner, “Stayers and Leavers: Early-Career Teacher Effectiveness and Attrition,” 271–80.

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71. Papay and Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," 111.

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73. Rivkin, Hanushek, and Kain, "Teachers, Schools, and Academic Achievement," 419.

74. Ibid., 430.

75. See Kraft and Papay, "Can Professional Environments in Schools Promote Teacher Development? Explaining Heterogeneity in Returns to Teaching Experience," 476–500. See also American Statistical Association, "ASA Statement on Using Value-Added Models for Educational Assessment," 2014, http://www.amstat.org/policy/pdfs/asa_vam_statement.pdf.

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78. See, e.g., Robert Balfanz, Liza Herzog, and Douglas J. MacIver, "Preventing Student Disengagement and Keeping Students on the Graduation Path in Urban Middle-Grades Schools: Early Identification and Effective Interventions," *Educational Psychologist* 42, no. 4 (2007): 223–35; Robert Balfanz and Vaughan Byrnes, "The Importance of Being There: A Report on Absenteeism in the Nation's Public Schools" (Baltimore, MD: Johns Hopkins University Center for Social Organization of Schools, 2012), http://new.every1graduates.org/wp-content/uploads/2012/05/FINALChronicAbsenteeismReport_May16.pdf.

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87. Ost, "How Do Teachers Improve? The Relative Importance of Specific and General Human Capital," 127–51.

88. Ibid., 136.

89. Ibid., 129, 138.

90. Blazar, "Grade Assignments and the Teacher Pipeline: A Low-Cost Lever to Improve Student Achievement?," 213–27.

91. Huang and Moon, "Is Experience the Best Teacher? A Multilevel Analysis of Teacher Characteristics and Student Achievement in Low Performing Schools," 209–34.

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93. Jackson and Bruegmann, "Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers," 85–108.

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# Appendix: Summary of Recent Studies of the Returns to Teaching Experience

## Studies Using Teacher Fixed Effects

**1. Helen F. Ladd and Lucy C. Sorensen, “Returns to Teacher Experience: Student Achievement and Motivation in Middle School,” *Forthcoming in Education Finance and Policy* (2016).**

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Middle School*<br>• Math ++<br>• Reading ++<br><br>*Middle-School Non-Cognitive*<br>• Absences -- (indicates a positive outcome, that increased teaching experience is associated with decreased student absences)<br>• Homework 0<br>• Reading for pleasure ++<br>• Behavior Mix | 28+ (included indicator variables for each year of experience 1–12, and then for 13–20, 21–27, & 28+ years compared to teachers with no experience) | • Dependent Variable: test scores, absences, disciplinary offenses, time spent on homework, and free time spent reading<br>• The three preferred models measuring gains to experience included teacher and grade-by-year fixed effects. In addition, one model included school fixed effects, and the other two models included student fixed effects (but no school fixed effects)<br>• Data: North Carolina, 6th, 7th, and 8th grades |

**Findings on Returns to Experience**

- Found gains to experience through at least 12 years of teaching (with declines in productivity occurring after 28 years) in middle school math and ELA in each of the three preferred models, which all included indicator variables for experience and teacher and grade-by-year fixed effects; one model additionally included school fixed effects; the two other models additionally included student fixed effects (and no school fixed effects)
- Found significantly smaller gains to experience in middle school math and reading in two non-preferred specifications (i.e., one model included teacher fixed effects but used indicator variables for bins of teacher experience (1–2, 3–5, 6–12, 13–20, 21–27, and 28+ years), and the other model used the preferred experience specification (indicator variables for each year of experience to 12, with bins thereafter), but did not include teacher fixed effects)
- Found increased teaching experience in middle school ELA and math was associated with decreased student absences, with an ELA teacher “who obtains over 21 years of experience on average reduc[ing] the incidence of high student absenteeism by 14.5 percentage points,” and a math teacher with 28+ years of experience associated with reducing absenteeism rates by 11.5 percentage points in a model with teacher, student, and grade-by-year fixed effects and indicator variables for experience
- Found increased teaching experience (up to 21–27 years) in middle school math was associated with decreased student classroom offenses in a model with teacher, student, and grade-by-year fixed effects and indicator variables for experience
- Found 3 and 4 years of teaching experience in middle school ELA was associated with increased student classroom offenses in a model with teacher, student, and grade-by-year fixed effects and indicator variables for experience
- Found increased teaching experience (up to 21–27 years) in middle school ELA was associated with increased amount of time students spent reading in their free time in a model with teacher, student, and grade-by-year fixed effects and indicator variables for experience

** Under the “Grade Level Results” column, the specific subject is listed (e.g., Math, Reading), including “Combined” to represent when the study included multiple subjects. After each subject, the study’s findings are listed:
++ Positive and statistically significant effect in nearly all models
+ Often positive and statistically significant effect
0 Insignificant
- Often negative and statistically significant effect
-- Negative and statistically significant effect in nearly all models
Mix Mix of positive / significant and negative / significant

## 2. David Blazar, "Grade Assignments and the Teacher Pipeline: A Low-Cost Lever to Improve Student Achievement?," *Educational Researcher* 44, no. 4 (2015): 213–27.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | 7+ (teachers with more than 7 years of experience were coded as having exactly 7 years of experience) | • Dependent Variable: test scores<br>• The model measuring gains to experience included teacher, school, and grade-by-year fixed effects<br>• Indicator variables for experience (Year 2, 3, ..,7) indicate gains relative to Year 1<br>• Effect sizes are larger in math than ELA; effects appear moderately linear in math but taper in ELA<br>• Data: California urban school district, elementary grades, includes only teachers who were observed in first year of teaching |

**Findings on Returns to Experience**

- Found gains to experience through 7 years of teaching in elementary school math and English Language Arts; coefficients relative to Year 1

## 3. John P. Papay and Matthew A. Kraft, "Productivity Returns to Experience in the Teacher Labor Market: Methodological Challenges and New Evidence on Long-Term Career Improvement," *Journal of Public Economics* 130 (2015): 105–19.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math ++<br>• Reading + | No limit (the authors reported receiving total years of "experience as defined on the teacher salary scale") | • Dependent Variable: test scores<br>• The authors investigate four different models: Censored Growth Model (experience is censored at 10 years), an Indicator Variable Model (indicator variables for bins of experience ranges), Discontinuous Career Model (experience modeled non-parametrically), Two-Stage Model (experience modeled non-parametrically, grade-year fixed effects estimated in first stage without teacher fixed effects, teacher fixed effects estimated in second stage)<br>• Table 2 summarizes the implied returns across different ranges of experience (despite differences in estimation); figures used splines fit to the fully non-parametric results to enable better comparison across models<br>• All four models included teacher, school, and grade-by-year fixed effects<br>• Data: A large urban school district in the South, 4th–8th grades<br>• Note: This study is methodologically unique in that it looks at the potential bias in different types of estimates via simulation |

**Findings on Returns to Experience**

- For all models, the authors plot productivity-experience profiles (Figures 5 and 6) in both subjects which show the majority of growth in the first 5 years of teaching in the Two-Stage, Censored Growth, and Indicator Variable Model followed by evidence of growth (at a slower rate) in later years. For the Discontinuous Career Model, the authors show a more steady rate of increase over experience, noting that elementary and middle school math teachers improved at the same rate from years 29 to 30 as they did from years 2 to 3
- Found gains to experience through 5 years of teaching in elementary and middle school math and reading using their preferred specifications for the: (1) "Censored Growth Model" (buckets 20+ years of experience together), and (2) "Two-Stage Model" ("first model[s] productivity as a function of both experience and year effects," with teacher fixed effects in the second stage); both models included teacher, school, and grade-by-year fixed effects
- Found gains to experience through 5 to 15 years of experience teaching in elementary and middle school math using their preferred specification for the "Discontinuous Career Model" (sample of teachers with discontinuous careers, with teacher, school, and grade-by-year fixed effects)
- Found gains to experience through 10 to 25 years of teaching in elementary and middle school math using their preferred specification for the "Indicator Variable Model" (indicator variables for 1–2, 3–4, 5–9, 10–14, 15–24, and 25+ years) that included teacher, school, and grade-by-year fixed effects
- Found gains to experience through 5 years of teaching in elementary and middle school reading using their preferred specification for the: (1) "Censored Growth Model" (buckets 20+ years of experience together), (2) "Indicator Variable Model" (indicator variables for 1–2, 3–4, 5–9, 10–14, 15–24, & 25+ years), and (3) "Two-Stage Model" ("first model[s] productivity as a function of both experience and year effects," with teacher fixed effects in the second stage); all three models included teacher, school, and grade-by-year effects

## 4. Matthew A. Kraft and John P. Papay, "Can Professional Environments in Schools Promote Teacher Development? Explaining Heterogeneity in Returns to Teaching Experience," *Educational Evaluation and Policy Analysis* 36, no. 4 (2014): 476–500.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math ++ | 10 (the authors reported measuring "a teacher's level of experience using her step on the state salary scale;" the authors note that they censor experience at 10 years, meaning that teachers with more than 10 years of experience were coded as having 10 years; authors note that their results were "quite consistent" when they censored experience at 20 years) | • Dependent Variable: test scores<br>• The model measuring average gains to experience included teacher and grade-by-year effects (Model 1)<br>• Model 2 looks at the variability of returns to experience across teachers and schools by adopting a random effects framework, with random slopes on experience for each teacher; includes random effects for each teacher (not fixed effects)<br>• The model comparing differential returns to teaching experience across schools with different levels of supportive professional environments included specifications with teacher fixed effects (preferred model, Model 4), teacher & school fixed effects, and teacher-by-school fixed effects<br>• Experience coded as continuous, but censored at 10 years<br>• Data: A North Carolina urban school district, 4th–8th grades |

**Findings on Returns to Experience**

- Found non-linear gains to experience through 10 years of teaching in elementary & middle school math in Model 1
- Found non-linear gains to experience in model that adds a measure of schools' professional environment and interaction of that variable with experience

## 5. Ben Ost, "How Do Teachers Improve? The Relative Importance of Specific and General Human Capital," *American Economic Journal: Applied Economics* 6, no. 2 (2014): 127–51.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | 8 (the author censored experience coding 8+ years as 8; authors note that "years of teaching experience is based on the number of years credited to a teacher for the purposes of salary calculation and thus should reflect all experience in any district") | • Dependent Variable: test scores<br>• Use Value-Added model to measure gains to experience. Experience is coded as an indicator variable by year. Model (1) included teacher and grade-by-year fixed effects. Note: the estimation is run in two stages; grade-by-year fixed effects are estimated in first stage, and held constant in second stage when estimating teacher fixed effects<br>• A variant of primary model included school and grade-by-year fixed effects<br>• Specifications of the model include either total experience alone or with grade level experience<br>• Data: North Carolina, 3rd–4th grades, only teachers observed in first year of teaching during time period of study |

**Findings on Returns to Experience**

- Found gains to experience through 8+ years of teaching in elementary school math and reading in: (1) a model with teacher and grade-by-year fixed effects, and (2) a model with school and grade-by-year fixed effects; estimates are relative to no experience
- Found significant gains to grade-level experience in elementary school math (not reading) when included in model with total experience, total experience remained significant; grade-level gains are not monotonic over experience
- Gains smaller in reading than math; gains in both subjects are non-linear

## 6. Matthew Wiswall, "The Dynamics of Teacher Quality," *Journal of Public Economics* 100 (2013): 61–78.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading + | Sample has no limit in new models (the author reported that data included measures of "years of experience (in North Carolina public schools) … using payroll records"), but models recode experience in various ways to replicate prior studies | • Note: The purpose of this paper is to compare the model specifications for the teacher quality models, showing that they result in different estimates of the gains of experience<br>• Dependent Variable: classroom fixed effects (estimated in a first stage)<br>• Author compares multiple specifications for the "teacher quality model" including replications of prior studies. Replicates Kane et al. (2008); Clotfelter et al. (2007); Hanushek et al. (2005); Rockoff (2004); and Harris & Sass (2011); used restrictive empirical specifications (e.g., bucketing 5+ years of experience together in one categorical variable); all models have teacher fixed effects with and without student fixed effects as well as school and year fixed effects<br>• Includes alternative specifications with other parameterizations of experience; models include teacher fixed effects with and without student fixed effects as well as school and year fixed effects, as well as classroom covariates<br>• Data: North Carolina, 5th grade |

**Findings on Returns to Experience**

- Replicated gains to experience in elementary school math found in Clotfelter et al. (2007), Harris & Sass (2011), Hanushek et al. (2005), Kane et al. (2008), and Rockoff (2004)
- Fixed Effects: Found gains to experience in elementary school math: (1) in a model with a continuous linear experience variable with teacher fixed effects, (2) in a model with a continuous linear experience variable with teacher and student fixed effects (in place of lagged scores), (3) in a model with a linear and quadratic experience specification with teacher fixed effects, (4) in a model with a linear and quadratic specification with teacher and student fixed effects, (5) in the linear and quadratic model adding indicators for 1 and 2 years of experience with teacher fixed effects, (6) in the linear and quadratic model adding indicators for 1 and 2 years of experience with teacher and student fixed effects
- OLS & Random Effects (RE): Found very low returns to experience over the first few years of teaching in elementary school math using (1) an OLS model with linear & quadratic experience terms and indicator variables for 1 and 2 years of experience and teacher characteristics, (2) a RE model with linear and quadratic experience terms and indicator variables for 1 and 2 years of experience. But found gains when specifying experience as an indicator variable over the first 4 years in both the OLS and RE specifications
- Fixed Effects: Failed to find the same gains in reading over time found with math teaching using continuous variables and indicators for the first 2 years for experience. But found gains using a restrictive non-parametric specification for experience (experience indicators for 1, 2, 3, & 4+)
- OLS & RE: Failed to find gains in both the OLS and RE model when experience was coded continuously with indicators for the first 2 years. But found gains using a restrictive non-parametric specification for experience (experience indicators for 1, 2, 3, & 4+)

## 7. Tim R. Sass, Jane Hannaway, Zeyu Xu, David Figlio, and Li Feng, "Value Added of Teachers in High-Poverty Schools and Lower Poverty Schools," *Journal of Urban Economics* 72, no. 2 (2012): 104–22.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | 28+ (the authors reported that data included measures of years of experience; regression included indicator variables for experience (3–5, 6–12, 13–20, 21–27, & 28+ compared to teachers with 0–2 years of experience)) | • Dependent Variable: teacher fixed effects (value added estimates)<br>• The model measuring value-added to experience included student fixed effects and "an indicator for teacher k," which in other words is a teacher fixed effect<br>• Results of regression of teacher value-added on characteristics shown in Table 9<br>• Data: Florida & North Carolina, 3rd–5th grades |

**Findings on Returns to Experience**

- Found gains to experience through 6–12 years of teaching in math in low-poverty elementary schools in Florida
- Found gains to experience through 21–27 years of teaching in math in low-poverty elementary schools in North Carolina
- Found gains to experience through 28+ years of teaching in math in high-poverty elementary schools in North Carolina
- Found gains to experience through 13–20 years of teaching in reading in low-poverty elementary schools in Florida
- Found gains to experience through 21–27 years of teaching in low-poverty elementary schools in North Carolina
- Found gains to experience through 3–5 years of teaching in reading in high-poverty elementary schools in Florida
- Found gains to experience through 28+ years of teaching in reading in high-poverty elementary schools in North Carolina

## 8. Matthew M. Chingos and Paul E. Peterson, "It's Easier to Pick a Good Teacher than to Train One: Familiar and New Results on the Correlates of Teacher Effectiveness," *Economics of Education Review* 30, no. 3 (2011): 449–65.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math ++<br>• Reading ++ | 21+ (the authors reported that data included measures of years of experience; the regression included indicator variables for 1–2, 3–5, 6–12, 13–20, and 21+ years) | • Dependent Variable: test scores<br>• Baseline model includes school fixed effects (Table 4)<br>• Three additional models: simple experience (teacher fixed effects, no year effects); censored growth model (assumes no returns to experience after a cut point, and uses teachers past that point to estimate year effects, Rockoff (2004); two-stage model (estimate year fixed effects in stage 1, hold constant to estimate teacher fixed effects, Papay & Kraft (2010))<br>• The authors reported statistically significant gains to experience in their model that included only school fixed effects (Table 4); however, the authors did not report significance levels for their models including teacher-by-school fixed effects (Figures 1 and 2)<br>• Data: Florida, 4th–8th grades |

**Findings on Returns to Experience**

- Found gains to experience through 21+ years of teaching in elementary school math and reading, and middle school reading in a model with indicator variables for experience and school fixed effects; estimates are relative to zero experience
- Found gains to experience through 13–20 years of teaching in middle school math in a model with indicator variables for experience and school fixed effects; estimates are relative to zero years of experience; coefficient for 21+ years was still positive, statistically significantly different from no experience
- Found steady gains to experience through 25 years of teaching in elementary school reading and math in the author's two-stage least squares regression model using teacher fixed effects (the authors note "the two-stage model indicates more steady growth over a longer period of time in both subjects [math and reading] in [Grades 4–5], with a leveling off not occurring until about 25 years of experience")
- Found more modest but steady gains to experience through 5 years of teaching in middle school reading using the authors' two-stage least squares regression model that included teacher fixed effects
- Found "steady (but still modest)" gains to experience through 20 years of teaching in middle school math using the authors' two-stage least squares regression model that included teacher fixed effects

| **9. Douglas N. Harris and Tim R. Sass, "Teacher Training, Teacher Quality and Student Achievement,"** ***Journal of Public Economics*** **95, no. 7 (2011): 798–812.** | | |
|---|---|---|
| **Grade-Level Results**** | **Year Through Which the Effects of Experience Were Studied** | **Notes on Methodology** |
| *Elementary School*<br>• Math ++<br>• Reading ++<br><br>*Middle School*<br>• Math ++<br>• Reading ++<br><br>*High School*<br>• Math --<br>• Reading -- | 25+ (the regression included indicator variables for years of experience (1–2, 3–4, 5–9, 10–14, 15–24, and 25+ years compared to 1st year teachers)) | • Dependent Variable: test scores<br>• The model measuring gains to experience included teacher, student, and school fixed effects<br>• Data: Florida, 3rd–10th grade |
| **Findings on Returns to Experience**<br>• Found gains to experience through 15 to 24 years of teaching for elementary and middle school reading; estimates are relative to zero years<br>• Found gains to experience through 25+ years of teaching for middle school math; estimates are relative to zero years<br>• Found gains to experience through 3–4 years of teaching for elementary school math; estimates are relative to zero years<br>• Found increasingly negative returns to experience relative to zero years for high school math and reading | | |

| **10. Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor, "Teacher Credentials and Student Achievement in High School,"** ***The Journal of Human Resources*** **45, no. 3 (2010): 655–81.** | | |
|---|---|---|
| **Grade-Level Results**** | **Year Through Which the Effects of Experience Were Studied** | **Notes on Methodology** |
| *High School*<br>• Combined subjects ++ | 27+ (the authors' "measure of teaching experience includes all previous years of teaching, whether in North Carolina or elsewhere;" the regression included indicator variables for experience (1–2, 3–5, 6–12, 13–20, 21–27, and 27+ years compared to teachers with 0 years of experience)) | • Dependent Variable: test scores<br>• The three models measuring gains to experience included: (1) a model with student and subject-by-grade fixed effects, (2) a model with teacher, student, and subject-by-grade fixed effects, and (3) a model with teacher, school, and subject-by-grade fixed effects. Models (2) and (3) not shown<br>• Data: North Carolina, 10th grade |
| **Findings on Returns to Experience**<br>• Found gains to experience through 3–5 years of teaching in high school in the authors' preferred model with student and subject-by-grade fixed effects and indicator variables for experience; coefficient on experience is statistically significantly different from zero years of experience through 21–27 years. Authors note the coefficient "rises to a peak of 0.0628 for a teacher with 21–27 years of experience, the difference between that and the one for 3–5 years of experience is not statistically significant"<br>• Found "a pattern of clearly rising coefficients on the experience variables" in high school in a model with teacher, student, and subject-by-grade fixed effects and indicator variables for experience; the authors noted that "the coefficients are estimated very imprecisely, probably because of the inclusion of the student fixed effects"<br>• Found "a pattern of statistically significant rising coefficients (from 0.06 for 1–2 years of experience to 0.27 for more than 27)" in a model with teacher, school, and subject-by-year fixed effects and indicator variables for experience | | |

### 11. Richard Buddin and Gema Zamarro, "Teacher Qualifications and Student Achievement in Urban Elementary Schools," (RAND Corporation, 2009).

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | No limit (the authors reported that data included measures of years of experience) | • Dependent Variable: teacher quality (i.e., estimated teacher fixed effects from first stage model—run with both test scores and gains as outcomes—including teacher and student fixed effects)<br>• Second stage is a regression (correlational) looking at relationship of teacher characteristics with quality estimates<br>• First stage models are run with four possible test outcomes: all tests, CBEST only, CSET, and RICA<br>• Authors additionally run a model with only student fixed effects, directly modeling the impact of experience on test scores (no second stage)<br>• Data: Los Angeles Unified School District, 2nd–5th grades |

**Findings on Returns to Experience**

- Found a positive coefficient on a linear, continuous experience variable for elementary school math and reading in all model specifications; coefficients are larger in reading than math in all models except the student fixed effects only model
- Found a negative coefficient on an experience-squared variable for elementary school math and reading, suggesting that returns to experience in math and reading increase at a decreasing rate in all model specifications

### 12. C. Kirabo Jackson and Elias Bruegmann, "Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers," *American Economic Journal: Applied Economics* 1, no. 4 (2009): 85–108.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | 25+ (the authors reported that data included measures of years of experience; regression included indicator variables for experience (1–3, 4–9, 10–24, and 25+ years compared to teachers with 0 years of experience)) | • Dependent Variable: test scores<br>• The three models measuring gains to experience included: (1) a model with school and grade-by-year fixed effects, (2) a model with student-school and grade-by-year fixed effects, and (3) a model with teacher-school, school-year, and grade-by-year fixed effects<br>• Data: North Carolina, 3rd–5th grades |

**Findings on Returns to Experience**

- Found gains to experience through 10–24 years of teaching in elementary school math in: (1) a model with student-school and grade-by-year fixed effects, and (2) a model with teacher-school, school-year, and grade-by-year fixed effects; both models included indicator variables for experience; 25+ years coefficient positive and statistically significantly different from zero years of experience
- Found gains to experience through 25+ years of teaching in elementary school math and reading in a model with school and grade-by-year fixed effects that included indicator variables for experience
- Found gains to experience through 25+ years of teaching in elementary school reading in a model with student-school and grade-by-year fixed effects that included indicator variables for experience
- Found gains to experience through 10–24 years of teaching in elementary school reading in a model with teacher-school, school-year, and grade-by-year fixed effects that included indicator variables for experience; 25+ years coefficient positive and statistically significantly different from zero years of experience

### 13. Sharon Kukla-Acevedo, “Do Teacher Characteristics Matter? New Results on the Effects of Teacher Preparation on Student Achievement,” *Economics of Education Review* 28 (2009): 49–57.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++ | No limit (the author reported that data included measures of years of experience) | • Dependent Variable: test scores<br>• The model measuring gains to experience for all students included teacher and school fixed effects<br>• Data: A Kentucky school district, 5th grade |

**Findings on Returns to Experience**

- Found a positive coefficient on a linear, continuous experience variable in elementary school math in a model with teacher and school fixed effects
- Found a negative coefficient on an experience-squared variable for elementary school math, suggesting that returns to experience in math increase at a decreasing rate in a model with teacher and school fixed effects

### 14. Donald Boyd, Hamilton Lankford, Susanna Loeb, Jonah Rockoff, and James Wyckoff, “The Narrowing Gap in New York City Teacher Qualifications and Its Implications for Student Achievement in High-Poverty Schools,” *Journal of Policy Analysis and Management* 27, no. 3 (2008): 793–818.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math ++ | 21+ (“teaching experience is measured by separate indicator variables for each year of teaching experience up to a category of 21 and more years”) | • Dependent Variable: gain scores (note that they also ran models with achievement levels and results similar)<br>• The three models measuring gains to experience included: (1) a model with student, grade, and time fixed effects (Table 4), (2) a model with teacher fixed effects (the authors do not specify whether other fixed effects were included in this model; Figure 7)<br>• Data: New York City, 4th–8th grades |

**Findings on Returns to Experience**

- Found gains to experience through 21+ years of teaching in elementary & middle school math in a model with indicator variables for each year of teaching experience up to 21+ that included student, grade, and time fixed effects
- Found gains to experience through 6–10 years of experience in elementary school math in a model with teacher fixed effects
- Found gains to experience in middle school through 6–10 years of experience

**15. Thomas J. Kane, Jonah E. Rockoff, and Douglas O. Staiger, "What Does Certification Tell Us about Teacher Effectiveness? Evidence from New York City," *Economics of Education Review* 27, no. 6 (2008): 615–31.**

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math ++<br>• Reading ++ | 5 (to analyze returns to teaching experience for recently hired teachers, the authors restricted the sample to teachers with 5 years of experience or less; the authors note that they received "salary schedule variables to construct measures of teachers' … experience") | • Dependent Variable: test scores<br>• The model measuring gains to experience included teacher, grade, and year fixed effects<br>• Sample restricted to teachers with 5 or fewer years of experience<br>• Gains smaller in reading than math<br>• Data: New York City, 4th–8th grades |

**Findings on Returns to Experience**

- Found gains to experience through 5 years of teaching in elementary and middle school math and reading in a model with indicator variables for experience (for 2nd, 3rd, 4th, and 5th year teachers compared to 1st year teachers) that included teacher, grade, and year fixed effects
- The authors note that "results are very similar whether we use school level mean characteristics as regressors or fixed effects by school and by school, grade and year"

**16. Cory Koedel and Julian R. Betts, "Re-Examining the Role of Teacher Quality in the Educational Production Function," *National Center on Performance Incentives, Vanderbilt, Peabody College* (2007).**

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading 0 | 10+ ("teachers with over 10 years of experience are input as having 10 years of experience") | • Dependent Variable: teacher effects<br>• The model measuring gains to experience included teacher, student, and school fixed effects<br>• Data: San Diego Unified School District, 2nd–5th grades |

**Findings on Returns to Experience**

- Found a positive coefficient on a linear, continuous experience variable capped at 10 years of experience for elementary school math in a model with teacher, school, and student fixed effects (student fixed effects were demeaned)
- Found a positive (but not statistically significant) coefficient on a linear, continuous experience variable capped at 10 years of experience for elementary school reading in a model with teacher, school, and student fixed effects (student fixed effects were demeaned)

## 17. Eric A. Hanushek, John F. Kain, Daniel M. O'Brien, and Steven G. Rivkin, "The Market for Teacher Quality," *National Bureau of Economic Research Working Paper Series* (2005).

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math + | 6+ (the authors reported that data included measures of years of experience; results reported only through 6+ years of experience; the authors note that "preliminary analysis, not shown, found no experience effects beyond five years of experience") | • Dependent Variable: gain scores<br>• The authors used three models to measure gains to experience: (1) a model with no fixed effects, (2) a model with student fixed effects, and (3) a model with student and teacher fixed effects<br>• Data: Texas, 4th–8th grades |

**Findings on Returns to Experience**

- Found that relative to teachers with 6+ years of experience, teachers in their first year performed significantly worse, and that teachers in their fourth year of teaching performed significantly better, in (1) a model with no fixed effects, (2) a model with student fixed effects, and (3) a model with student and teacher fixed effects; all three models included indicator variables for experience (1, 2, 3, 4, and 5 years compared to teachers with 6+ years); no difference from 6+ years in 2, 3, or 5 years of experience

## 18. Jonah E. Rockoff, "The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data," *American Economic Review* (2004): 247–52.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math 0<br>• Reading ++ | 10+ (the authors reported using "an indicator variable for whether [a teacher] has less than [10] years of experience") | • Dependent Variable: test scores<br>• The model measuring gains to experience included teacher and school-year fixed effects<br>• Assume that teacher experience does not affect student test scores after some cut point (number of years) in order to estimate year effects<br>• Data: A New Jersey county, Kindergarten–6th grades |

**Findings on Returns to Experience**

- Found gains to experience through 10 years of teaching in reading comprehension in a model with teacher fixed effects; achievement increases through about 6 years of experience then tapers in vocabulary in a model with teacher fixed effects
- Found gains to experience through 2 years of teaching in math computation (did not find significant returns to experience in math concepts) in a model with teacher fixed effects; unclear if negative trend observed in later years of experience is truly negative given confidence intervals

## Studies Not Using Teacher Fixed Effects

| **19. Gary T. Henry, C. Kevin Fortner, and Kevin C. Bastian, "The Effects of Experience and Attrition for Novice High-School Science and Mathematics Teachers,"** ***Science*** **335, no. 6072 (2012): 1118–21.** | | |
|---|---|---|
| **Grade-Level Results**** | **Year Through Which the Effects of Experience Were Studied** | **Notes on Methodology** |
| *High School*<br>• Math & Science + | 5 | • Dependent Variable: test scores<br>• The three models measuring gains to experience did not include fixed effects<br>• Data: North Carolina high school grades |
| **Findings on Returns to Experience** | | |
| • Studied teachers only in their first 5 years of teaching and found year-to-year gains in effectiveness through all 5 years for high school Algebra I, physics, and non-STEM teachers and gains in effectiveness through at least 4 years for Algebra II, geometry, biology and chemistry teachers in the models measuring gains to experience that included indicator variables for experience (1, 2, 3, and 4 years compared to teachers with 0 years of experience)<br>• Found a positive coefficient on a linear, continuous experience variable capped at 5 years for the combined high school math and science courses<br>• Found a negative coefficient on an experience-squared variable capped at 5 years for the combined high school math and science courses, suggesting that returns to experience in high school math and science increase at a decreasing rate | | |

| **20. Gary T. Henry, Kevin C. Bastian, and C. Kevin Fortner, "Stayers and Leavers: Early-Career Teacher Effectiveness and Attrition,"** ***Educational Researcher*** **40, no. 6 (2011): 271–80.** | | |
|---|---|---|
| **Grade-Level Results**** | **Year Through Which the Effects of Experience Were Studied** | **Notes on Methodology** |
| *Elementary, Middle, and High School*<br>• Math Mix<br>• Reading Mix | 5 (the authors dropped cohorts from their analysis each year, so that during their first school year of analysis, the authors include teachers with 1, 2, 3, 4, or 5 years of experience, and then during their second school year of analysis, the authors include teachers with 2, 3, 4, or 5 years of experience, etc.) | • Dependent Variable: teacher effects<br>• The model measuring gains to experience did not include fixed effects<br>• Sample restricted to "teachers in their first five years of teaching"<br>• Data: North Carolina, 3rd–12th grades |
| **Findings on Returns to Experience** | | |
| • Found that in elementary, middle, and high school in math and reading, teachers who stay at least 5 years tend to improve into their 3rd year, but the differences in effectiveness for teachers between their 3rd and 5th years is not statistically significant<br>• Teachers who stay for at least 5 years are significantly more effective in their 3rd and 4th years on the job than teachers who depart after each of these years | | |

| **21. Douglas O. Staiger and Jonah E. Rockoff, "Searching for Effective Teachers with Imperfect Information," *Journal of Economic Perspectives* 24, no. 3 (2010): 97–118.** | | |
|---|---|---|
| **Grade-Level Results****<br>*Elementary, Middle, and High School*<br>• Math ++<br>• Reading ++ | **Year Through Which the Effects of Experience Were Studied**<br>3+ | **Notes on Methodology**<br>• Dependent Variable: value added achievement<br>• The model measuring gains to experience included grade-by-year fixed effects<br>• The authors did not provide their models measuring gains to experience<br>• Data: Los Angeles and New York City school districts, 4th and 5th grades |
| **Findings on Returns to Experience**<br>• Found gains to experience through 3+ years of teaching (the authors did not provide their models measuring gains to experience) | | |

| **22. Francis L. Huang and Tonya R. Moon, "Is Experience the Best Teacher? A Multilevel Analysis of Teacher Characteristics and Student Achievement in Low Performing Schools," *Educational Assessment, Evaluation and Accountability* 21, no. 3 (2009): 209–34.** | | |
|---|---|---|
| **Grade-Level Results****<br>*Elementary School*<br>• Reading ++ | **Year Through Which the Effects of Experience Were Studied**<br>Unlimited (the authors reported that data included measures of years of experience; the regression included indicator variables for experience through 5+ years (compared teachers with 2 or fewer years to teachers with 2 to 5+ years of total experience)) | **Notes on Methodology**<br>• Dependent Variable: test scores<br>• Random effects modeling strategy using HLM. Students at level 1, nested in teachers/classrooms (level 2), nested in schools (level 3)<br>• Data: Reading First schools in a Mid-Atlantic state, 2nd grade |
| **Findings on Returns to Experience**<br>• Found gains to experience at 5+ years of teaching in elementary school reading at the 10% significance level in a model with indicator variables for experience (relative to 2 to 5 years of experience); negative non-significant coefficient on <2 years of experience relative to 2 to 5 years<br>• Found gains to grade-level experience at 5+ years of experience at the 1% significance level in a model with indicator variables for experience (relative to 2 to 5 years of experience)<br>• Found positive returns to grade level experience in elementary school reading through 21 years of teaching, with teachers' effectiveness increasing at a decreasing rate thereafter, using a model with a continuous grade variable (linear and polynomial specification) for experience | | |

### 23. Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor, "Teacher Credentials and Student Achievement: Longitudinal Analysis with Student Fixed Effects," *Economics of Education Review* 26, no. 6 (2007): 673–82.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
| --- | --- | --- |
| *Elementary School*<br>• Math ++<br>• Reading ++ | 27+ (the authors "measure years of teaching experience as the number of years used by the state to determine a teacher's salary;" regression included indicator variables for experience through 27+ years) | • Dependent Variable: test scores and gain scores<br>• Gains and levels models to experience included student fixed effects<br>• The authors reported that they "included teacher fixed effects in comparable models without student (or school) fixed effects. The findings are consistent with those reported in the text." But also, "We have not tried to add teacher fixed effects to [the model including experience] because of the technical difficulties of doing so."<br>• Data: North Carolina, 3rd–5th grades |

**Findings on Returns to Experience**

- Found gains to experience through 21 to 27 years of teaching in elementary school math and reading in: (1) a levels model, and (2) a gains model; both models using indicator variables for experience (1–2, 3–5, 6–12, 13–20, 21–27, and 27+ years; compared to teachers with no experience) and included student fixed effects; coefficient on 27+ years is positive, statistically significantly different from no experience

### 24. Donald Boyd, Pamela Grossman, Hamilton Lankford, Susanna Loeb, and James Wyckoff "How Changes in Entry Requirements Alter the Teacher Workforce and Affect Student Achievement," *Education Finance and Policy*, no. 2 (2006): 176–216.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
| --- | --- | --- |
| *Elementary and Middle School*<br>• Math ++<br>• Reading ++ | 20+ ("experience is measured by indicator variables for each year of teaching from the first year through the twentieth and then an additional indicator variable for experience greater than twenty years") | • Dependent variable: test scores<br>• The model measuring gains to experience included school, year, and grade fixed effects<br>• Data: New York City, 3rd–8th grades |

**Findings on Returns to Experience**

- Found gains to experience in elementary and middle school math through 6 years and then gains level off through 14 years and subsequently drop
- Found gains to experience in elementary and middle school ELA through 9 years and then gains level off until 18 years and subsequently drop
- Significant year-to-year fluctuation in size of achievement gain by experience; estimates are not monotonically increasing over years of experience to the peak value of experience gains

## 25. Charles T. Clotfelter, Helen F. Ladd, and Jacob L. Vigdor, "Teacher-Student Matching and the Assessment of Teacher Effectiveness," *Journal of Human Resources*, vol. 41 (2006): 778–820.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | 27+ (the authors reported that data included measures of years of experience "used by the state to determine a teacher's salary, and generally counts all years of teaching whether in the State of North Carolina, or elsewhere;" the regression included indicator variables for experience (1–2, 3–5, 6–12, 13–20, 20–27, and 27+ years compared to teachers with 0 years)) | • Dependent Variable: test scores<br>• Four out of the seven models measuring gains to experience included school fixed effects<br>• Ran models on various data samples (full, balanced)<br>• Data: North Carolina, 5th grade |

**Findings on Returns to Experience**

- Found gains to experience through 27+ years of teaching in elementary school math and reading in the balanced-sample models with school fixed effects, with indicator variables for experience, and with and without including lagged achievement
- Found gains to experience through 20–27 years of experience in elementary school math and reading for the full sample models with school fixed effects, with indicator variables for experience, and with and without including lagged achievement
- Found gains to experience through 13–20 years of teaching in elementary school math and reading in models without student covariates or fixed effects, and included indicator variables for experience
- Found gains to experience through 27+ years of teaching in elementary school math and reading in models without student covariates or fixed effects, with indicator variables for experience, omitting and including lagged test scores

## 26. Christopher Jepsen, "Teacher Characteristics and Student Achievement: Evidence from Teacher Surveys," *Journal of Urban Economics* 57, no. 2 (2005): 302–19.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math +<br>• Reading + | No limit (the author reported that data included measures of years of experience) | • Dependent Variable: predicted classroom effect (taken from a model predicting test scores with classroom and student fixed effects)<br>• The models measuring contribution of experience included school and year fixed effects; model included linear and quadratic experience terms<br>• Data: Prospects (data from a Congressionally mandated study of the Title I program that includes over 200 schools and nearly 10,000 students), 1st and 3rd grades |

**Findings on Returns to Experience**

- Found a positive coefficient on a linear, continuous experience variable in 3rd grade math and 3rd grade reading in a model that included lagged student test scores, school and year fixed effects; results for other models of 1st and 3rd grade math and reading were not statistically significant
- Found a negative coefficient on an experience-squared variable in 3rd grade reading, suggesting that returns to experience in elementary school reading increase at a decreasing rate in a model that included lagged student test scores, school and year fixed effects

**27. Steven G. Rivkin, Eric A. Hanushek, and John F. Kain, "Teachers, Schools, and Academic Achievement," *Econometrica* 73, no. 2 (2005): 417–58.**

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary and Middle School*<br>• Math +<br>• Reading 0 | 5+ (the authors reported regression results through 5+ years, but measure experience at the school level, through a measure with indicator variables of the proportion of teachers at a given experience level in the school (proportion 0 years, proportion 1 year, proportion 2 years, proportion 3–5 years compared to the proportion of teachers with 5+ years); the authors note that "including the percentages of teachers with 5 to 9 and 20+ years of experience as separate categories did not change any of the results, and the hypotheses that teachers with five to nine or twenty or more years of experience had a different impact from those with ten or more years of experience was rarely rejected at any conventional significance level") | • Dependent Variable: gain scores<br>• The authors used four model specifications to measure gains to experience, including: (1) no fixed effects, (2) student and school fixed effects, (3) student and school-by-year fixed effects, and (4) student, school-by-grade, and school-by-year fixed effects<br>• Data: Texas, 3rd–7th grades |

**Findings on Returns to Experience**

- Found that teachers in the first year of teaching in math perform significantly worse than teachers with 5+ years of experience in the model with student, school-by-grade, and school-by-year fixed effects
- Found that teachers in the 1st, 2nd, and 3rd years of teaching perform significantly worse relative to teachers with 5+ years in math (negative, significant point estimates) in models with student and school fixed effects and with student and school-by-year fixed effects
- Found that teachers in their first and second years of teaching in reading performed significantly worse than teachers with 5+ years of experience, in models with student and school fixed effects and with student and school-by-year fixed effects
- All other effects are non-significant
- Found that "beginning teachers and to a lesser extent second and third year teachers in mathematics perform significantly worse than more experienced teachers. There may be some additional gains to experience in the subsequent year or two, but the estimated benefits are small and not statistically significant in both mathematics and reading in any of the fixed effect specifications"

## 28. Thomas S. Dee, "Teachers, Race, and Student Achievement in a Randomized Experiment," *Review of Economics and Statistics* 86, no. 1 (2004): 195–210.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
| --- | --- | --- |
| *Elementary School*<br>• Math 0<br>• Reading ++ | No limit (the author reported that data included measures of years of experience) | • Dependent Variable: percentile test rank<br>• The models measuring gains to experience included grade, entry-wave (kindergarten, grades 1st–3rd), and school-of-entry fixed effects<br>• Data: Tennessee Class Size Experiment, Kindergarten–3rd grades |

**Findings on Returns to Experience**

- Found a positive coefficient on a linear, continuous experience variable for white males and females in elementary school reading, and white males in elementary school math in: (1) an OLS model, and (2) a two-stage least squares model; both models included grade, entry-wave (kindergarten, grades 1 through 3), and school-of-entry fixed effects
- Found a negative coefficient on an experience-squared variable for white males and females in elementary school reading and white males in elementary school math, suggesting that returns to experience increase at a decreasing rate, in: (1) an OLS model, and (2) a two-stage least squares model; both models included grade, entry-wave (kindergarten, grades 1 through 3), and school-of-entry fixed effects
- Found a positive coefficient (significant at the 10% level) on a linear continuous experience variable for black females in elementary school reading in: (1) an OLS model, and (2) a two-stage least squares model; both models included grade, entry-wave (kindergarten, grades 1 through 3) and school-of-entry fixed effects
- Other coefficients for experience were non-significant

## 29. Barbara Nye, Spyros Konstantopoulos, and Larry V. Hedges, "How Large Are Teacher Effects?," *Educational Evaluation and Policy Analysis* 26, no. 3 (2004): 237–57.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
| --- | --- | --- |
| *Elementary School*<br>• Math +<br>• Reading + | 3+ (the authors reported using indicator variables for experience and compared teachers with 3 years of experience or less to teachers with 3+ years) | • Dependent Variable: achievement gains and achievement "status"<br>• The authors used a random effects model that included a "fixed effect" for experience (indicator variable for less/more than 3 years)<br>• Classroom random effects capture teacher effect; between-classroom and between-teacher used interchangeably<br>• Data: Tennessee Class Size Experiment, Kindergarten–3rd grade |

**Findings on Returns to Experience**

- Found gains to experience for having 3+ years of teaching in 3rd grade math and 2nd grade reading in a model with indicator variables for experience (compared teachers with 3 years of experience or less to teachers with 3+ years) where achievement gains were the outcome
- Found gains to experience for having 3+ years of teaching experience in 2nd grade reading in the model where achievement status was the outcome
- Other coefficients for experience were non-significant

### 30. Julian R. Betts, Andrew C. Zau, and Lorien A. Rice, *Determinants of Student Achievement: New Evidence from San Diego* (2003).

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
| --- | --- | --- |
| *Elementary School*<br>• Math 0<br>• Reading 0<br><br>*Middle School*<br>• Math +<br>• Reading 0<br><br>*High School*<br>• Math 0<br>• Reading 0 | 10+ (the authors reported using indicator variables for experience through 10+ years and "interact experience variables with the full, emergency, and intern variables. The omitted or comparison group is teachers with a full credential and more than nine years of teaching experience") | • Dependent Variable: achievement gains<br>• The model measuring gains to experience included student, school, zip code, grade-level, and year fixed effects<br>• Data: San Diego Unified School District, Kindergarten–12th grades |

**Findings on Returns to Experience**

- Did not find a "statistically significant difference between the effectiveness of fully credentialed [elementary school] teachers with [10+] years of experience and teachers with less experience, regardless of whether they held a full or emergency credential or an internship," in a model with indicator variables for experience interacted with credential type (0–1, 2-5, and 6–9 compared to fully credentialed teachers with 10+ years) that included student, school, zip code, grade-level, and year fixed effects
- Did not find a statistically significant relationship between teacher experience (interacted with credentials) and student achievement in middle school reading and high school math and reading in a model with indicator variables for experience (0–1, 2–5, and 6–9 compared to fully credentialed teachers with 10+ years) that included student, school, zip code, grade-level, and year fixed effects
- Found that middle school math achievement test scores rose "more slowly when [students were] taught by teachers with 0–2 or 6–9 years of experience instead of by teachers with [10+] years" in a model with indicator variables for experience interacted with credential type (0–1, 2–5, and 6–9 compared to fully credentialed teachers with 10+ years) that included student, school, zip code, grade-level, and year fixed effects

## Studies Not Meeting Criteria*

### 1. Matthew Ronfeldt, Susanna Owens Farmer, Kiel McQueen, and Jason A. Grissom, "Teacher Collaboration in Instructional Teams and Student Achievement," *American Educational Research Journal* 52, no. 3 (2015): 475–514.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary, Middle, and High School*<br>• Math +<br>• Reading 0 | Unlimited (the authors reported that data included measures of years of experience; the authors interacted experience with measures of collaboration within a school) | • Dependent Variable: value added in achievement (modeled using test scores)<br>• The model measuring value added to experience included teacher and year random effects<br>• Modeled experience as a quartic polynomial<br>• Data: Miami-Dade County Public School System, all grades |

**Findings on Returns to Experience**

- No main effects of experience were presented
- Found a positive coefficient on a linear, continuous experience variable interacted with school-level measures of general and assessment collaboration for elementary, middle, and high school math in a model with teacher and year fixed effects
- Found a positive (but not statistically significant) coefficient on a linear, continuous experience variable interacted with four school-level measures of collaboration for elementary, middle, and high school reading in a model with teacher and year fixed effects

### 2. Dan Goldhaber and Joe Walch, "Strategic pay reform: A student outcomes-based evaluation of Denver's ProComp teacher pay initiative," *Economics of Education Review* 31, no. 6 (2012): 1067-1083.

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary, Middle, and High School*<br>• Math ++<br>• Reading ++ | 3+ (the authors reported experience as an indicator variable for 1, 2, and 3+ years) | • Dependent Variable: test scores<br>• The model measuring gains to experience included school fixed effects and grade fixed effects<br>• Data: Denver Public Schools, 3rd–10th grades |

**Findings on Returns to Experience**

- Found gains to experience through 3+ years of teaching in elementary school math and reading in a model with indicator variables (for 1, 2, and 3+ years) that included school fixed effects
- Found gains to experience in middle and high school; the authors note that they found "larger effect sizes in math (.02 [to] .05) than in reading (0.02) and smaller effect sizes in high school compared to elementary and middle school"

* "Studies Not Meeting Criteria" = studies that either did not specifically focus on gains to experience or were not published in a peer-reviewed journal or by an organization with rigorous peer-review processes

### 3. Dan Goldhaber and Michael Hansen, "Is It Just a Bad Class? Assessing the Stability of Measured Teacher Performance," *Center for Education Data & Research Working Paper* #2010-3 (2010).

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++<br>• Reading ++ | 13+ (the authors reported experience as indicator variables for 1–2, 3–5, 6–12, and 13+ years) | • Dependent Variable: teacher-by-year fixed effects from prior model<br>• The model measured the amount that the teacher-by-year effects can be attributed to experience; they only included teachers with at least 4 years of effect estimates<br>• Data: North Carolina, 3rd–5th grades |

**Findings on Returns to Experience**

- Found gains to experience through 13+ years of teaching in elementary school math and reading in a model with teacher fixed effects and indicator variables for experience
- Looking at point estimates, gains are non-linear over experience; little change in estimates between 3 and 12 years of experience

### 4. Dan Goldhaber, Stephanie Liddle, Roddy Theobald, and Joe Walch, "Teacher Effectiveness and the Achievement of Washington's Students in Mathematics," *Center for Education Data and Research Working Paper* #2010-6 (2010).

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Elementary School*<br>• Math ++ | 4+ (the authors reported that data included measures of years of experience; the regression included indicator variables for experience only through 4+ years) | • Dependent Variable: value added in achievement<br>• The published version of the study did not include a description of the models, and therefore, it is unclear whether the model measuring gains to experience included fixed effects<br>• Data: Washington State, 3rd–6th grades |

**Findings on Returns to Experience**

- Found gains to experience through 4+ years of teaching in elementary school math
- "Students with novice teachers would score about 3% of a standard deviation lower on math achievement tests than students with teachers of average experience"
- "Students assigned to teachers with 4+ years of experience would score about 2% of a standard deviation higher than those with a teacher with average experience"

| **5. Daniel Aaronson, Lisa Barrow, and William Sander, "Teachers and Student Achievement in the Chicago Public High Schools," *Journal of Labor Economics* 25, no. 1 (2007): 95–135.** | | |
|---|---|---|
| **Grade-Level Results**** | **Year Through Which the Effects of Experience Were Studied** | **Notes on Methodology** |
| *High School*<br>• Math 0 | 10+ (the authors reported "using various combinations for experience and tenure (e.g., 0–3, 3–7, 7–10, 10 plus) … None of these adjustments show a large or statistically important effect for either tenure or experience") | • Dependent Variable: "teacher quality" as estimated from a model with teacher fixed effects (as well as with and without school fixed effects); note that they also tried the specification with teacher-year fixed effects<br>• Use a generalized least squares (GLS) approach to model the relationship between teacher effects and teacher characteristics<br>• Data: Chicago Public School District, 9th grade |
| **Findings on Returns to Experience**<br>• Did not find a statistically significant relationship between experience and a teacher's effectiveness in raising students' high school math achievement on a linear, squared, and cubed variable for experience<br>• The authors report a "0.02 grade-equivalent increase in quality over the first few years of experience that flattens and eventually recedes"<br>• The authors estimate experience through a measure of "potential experience," which is calculated as "age – education – 6 and is the average over the 3 years in the sample" | | |

| **6. Heather C Hill, Brian Rowan, and Deborah Loewenberg Ball, "Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement," *American Educational Research Journal* 42, no. 2 (2005): 371–406.** | | |
|---|---|---|
| **Grade-Level Results**** | **Year Through Which the Effects of Experience Were Studied** | **Notes on Methodology** |
| *Elementary School*<br>• Math 0 | No limit (the authors reported that data included measures of years of experience) | • Dependent Variable: achievement gains<br>• The model measuring gains to experience did not include fixed effects<br>• Data: 115 elementary schools that participated in study of the Comprehensive School Reform program |
| **Findings on Returns to Experience**<br>• Did not find a statistically significant gain to experience in elementary school math on a linear, continuous experience variable | | |

### 7. Elizabeth Greenberg, David Rhodes, Xiaolan Ye, and Fran Stancavage, "Prepared to teach: Teacher preparation and student achievement in eighth-grade mathematics," *Annual Meeting of the American Education Research Association, San Diego, California* vol. 16, (2007).

| Grade-Level Results** | Year Through Which the Effects of Experience Were Studied | Notes on Methodology |
|---|---|---|
| *Middle School*<br>• Math + | + (the authors reported experience as an indicator variable for < 5 and > 5 years of experience in general, and also as < 5 and > 5 years of experience teaching math) | • Dependent Variable: test scores<br>• The model measuring gains to experience did not include fixed effects<br>• Data: National Assessment of Educational Progress, 8th grade |

**Findings on Returns to Experience**

- Found gains to experience through 5+ years of teaching middle school math when comparing mean scores of students whose teachers have more or less than 5 years of experience teaching math
- Did not find statistically significant gains to experience in middle school math for total years of teaching generally (not math specific)
- Did not find a statistically significant gain to experience in middle school math through 5+ years of teaching math in a multiple regression analysis of teacher characteristics and student achievement

## About the Authors

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