

Executive Summary:

Examining Teacher and Principal Effectiveness and Longevity on Mitigating the Negative Impacts of the Pandemic

The [Office of Learning Recovery and Acceleration](#) (OLR) studies COVID-recovery initiatives within North Carolina's public schools. OLR has partnered with the [EVAAS team at SAS](#) to measure the pandemic's overall effect on academic progress, based on the results of state standardized tests, by comparing individual students to their own expected performance rather than the average performance of pre-pandemic cohorts. This analysis is one of the most comprehensive of its kind and should inform education policy throughout the state. See [preliminary report released in March 2022](#) and [full technical report released in December 2022](#).

From conversations with critical stakeholders, including superintendents, chief academic officers, and other district and school leaders, during the 2022 year two questions emerged about teacher and principal characteristics during the pandemic that provides the focus for this analysis:

- Were teaching effectiveness and longevity before the pandemic related to the pandemic's impact on student learning?
- Were principal effectiveness and longevity before the pandemic related to the pandemic's impact on student learning?

Based on these discussions with educators in the field, this analysis focused on the impact of certain characteristics of teachers and principals on student growth using a robust data system that utilized students' entire history of standardized test scores. We found that students linked to teachers identified as effective or higher prior to the pandemic experienced less impact on academic achievement during the pandemic than students linked to teachers identified as less effective prior to the pandemic. Based on student outcomes, teachers and principals who had been at their school for more than three years moderately mitigated the negative effects of the pandemic on students' performance. The impact of the pandemic on student achievement was much more closely related to teachers than to their principals.

Based on the findings from this analysis some initial policy considerations include:

- Teacher longevity appears to have less influence on student learning than effectiveness. District and school leaders should consider placing their best, not necessarily most experienced, teachers where they can have the most impact, especially early grades reading and middle grades math and science.
- Principal effectiveness or longevity does not appear to have a consistent impact on student learning. District leaders should consider placing their best principals in schools where they are needed the most - in schools that have struggled to increase student achievement; where staff morale needs to be improved; or where school culture needs to be changed.
- Future analysis should consider other variables, such as teacher and principal credentials, the impact of school culture as defined by the [NC Teacher Working Conditions Survey](#), and how teacher effectiveness and longevity interact to support student learning.

Examining Teacher and Principal Effectiveness and Longevity on Mitigating the Negative Impacts of the Pandemic

The [Office of Learning Recovery and Acceleration](#) (OLR) studies COVID-recovery initiatives within North Carolina's public schools. OLR has partnered with the [EVAAS team at SAS](#) to measure the pandemic's overall effect on academic progress, based on the results of state standardized tests, by comparing individual students to their own expected performance rather than the average performance of pre-pandemic cohorts. This analysis is one of the most comprehensive of its kind and should inform education policy throughout the state. See [preliminary report released in March 2022](#) and [full technical report released in December 2022](#).

Throughout the spring and summer of 2022, the OLR team facilitated a series of in-person and virtual presentations on the findings from the preliminary report to gather input from stakeholders on the following questions: What resonates? What is surprising? What could be the cause? How can we further explore the data? What will improve practice?

From those conversations, two interesting questions emerged about teacher and principal characteristics during the pandemic that provides the focus for this analysis:

- Were teaching effectiveness and longevity before the pandemic related to the pandemic's impact on student learning?
- Were principal effectiveness and longevity before the pandemic related to the pandemic's impact on student learning?

Summary of Methods

North Carolina maintains a robust data system that includes each student's previous standardized test scores. These data are used to measure student-level differences between projected and observed achievement. This process is straightforward and features four steps. First, benchmarks for current achievement are created using students' previous assessment scores and the performance of other students prior to the pandemic. Then, students' actual scores are subtracted from these "projected scores." Negative differences indicate that students fell short of their projections and positive differences indicate that students exceeded their projections. Next, these differences are converted into "effect sizes" to allow for comparisons between tests. Finally, student-level effect sizes are averaged by test and/or subgroup.

Effectiveness

Using the student-teacher linkages for the 2020-21 school year, the difference between a student's projected and actual scores was linked to their teacher for a specific assessment, and results were aggregated across students according to their teacher's 2019 (or 2017 for historical comparison) effectiveness category. For the purposes of this analysis, pre-pandemic principal effectiveness was assumed to be the school-level composite growth score across all available assessments at the school (known as the Educator Effectiveness Measure) based on one-year estimates from the 2018-19 school year (or 2016-17 school year for the historical analysis).

Longevity

Teacher longevity at their pandemic school was identified using payroll data provided by NCDPI. This dataset spanned the 2013-14 school year to the 2020-21 school year, and longevity was determined by counting the number of consecutive years that the teacher had been linked to their school in 2020-21. Based on available data, this analysis did not consider the total number of years of experience as a teacher. Principal longevity at their school, during the pandemic was identified using payroll data provided by NCDPI. This dataset spanned the 2013-14 school year to the 2020-21 school year, and longevity was determined by counting the number of consecutive years that the principal had been linked to their pandemic school in 2020-21.

Relevant Literature – Teaching Characteristics

Extensive research demonstrates that teachers and principals are essential components in impacting student learning and are strong determinants in enhancing the outcomes of their lives (Chetty, Friedman, & Rockoff, 2014; Rivkin, Hanushek, & Kain, 2005; Rockoff, 2004; Hattie, 2003). As a result, the characteristics, factors, and measures of teacher and principal effectiveness and student outcomes are a continuous focus for policymakers, researchers, and school/community stakeholders. There is a growing body of research that situates teacher and principal experience as a major characteristic that is linked to their effectiveness.

Decades of empirical research show that teacher experience has a positive impact on student achievement (Betts, Zau, & Rice, 2003; Clotfelter, Ladd, & Vigdor, 2006; Dee, 2004; Huang & Moon, 2009; Nye, Konstantopoulos, & Hedges, 2004). Nevertheless, these studies do not distinguish between two effects: the benefits of teacher experience and the factors that shape a cohort of teachers (Podolsky, Kini, & Darling-Hammond, 2019) and present challenges to more accurate findings in relationship to student outcomes (Papay & Kraft, 2015; Wiswall, 2013). While most of these research studies focus on student achievement, some have shown positive effects on high-risk students and non-academic outcomes such as attendance (Ladd & Sorenson, 2017; Balfanz & Byrnes, 2012; Balfanz, Herzog, & Maclver, 2007).

Evidence within the literature suggests that student achievement gains are the highest in the initial years of a teacher's career and continue to improve during the latter stages of their career but at lesser rates (Harris & Sass, 2011; Gerritsen, Plug, & Webbink, 2014; Kane, Rockoff, & Staiger, 2008; Ladd & Sorensen, 2017; Papay & Kraft, 2015). Findings for statistical modeling on the fixed effects (within teacher groups) for teachers suggest that the greatest gains are during the earlier years, and they continue to make meaningful improvements after these initial gains (Ladd & Sorensen, 2017; Papay & Kraft, 2015; Kraft & Papay, 2014; Ost, 2014; Wiswall, 2013; Sass, Hannaway, Xu, Figlio, & Feng, 2012; Chingos & Peterson, 2011; Harris & Sass, 2011; Clotfelter, Ladd, & Vigdor, 2010). Additionally, more recent studies (15 studies) reveal that on the secondary level in math and reading, there were statistically significant student outcomes for teachers who had seven or more years in the classroom (Ladd & Sorensen, 2017).

It is pertinent to add that within current literature the various types of teaching experience have positive effects on their improvement over time. A growing number of studies show that context matters in shaping returns of teacher experience (Podolsky et al., 2019). Collegial experience in a supportive learning environment (Kraft & Papay, 2014; Ronfeldt, Farmer, McQueen, & Grissom, 2015) as well as teaching in the same grade level, subject matter, and district play an important role in their effectiveness (Ost, 2014; Blazar, 2015; Huang & Moon; 2009).

Results

Effect sizes from 2018 are interpreted as student progress in a standard pre-pandemic year. However, because 2021's projected scores are created from pre-pandemic test scores, 2021's average effect sizes illustrate the pandemic's influence on the typical student, comparing individual students to their own expected performance rather than the average performance of pre-pandemic cohorts.

Teacher Effectiveness

The following figures (see Figures 1a-d.) group students into three categories based on whether their teachers did not meet, met, or exceeded expected growth. The bar charts represent how those groups of students performed based on their teacher effectiveness when comparing their 2018 to 2021 expected versus actual scores on North Carolina's standardized, summative assessments. Please see pages 125-130 for details charts and tables in [full technical report released in December 2022](#).

Findings

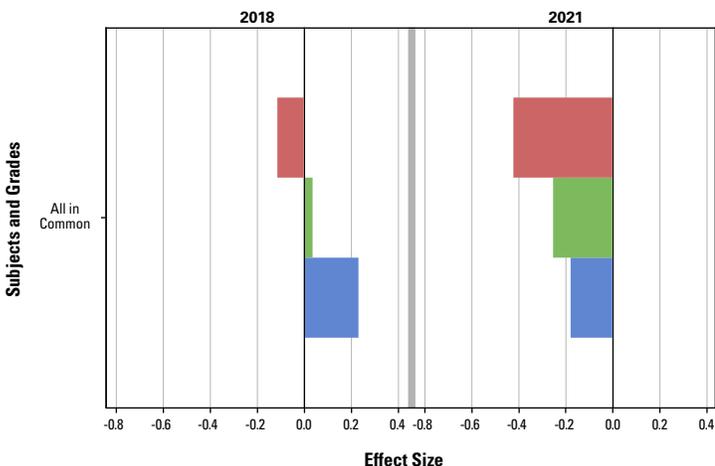
- During the 2020-21 school year, on average, there was less negative impact observed among students linked to teachers who were identified as effective prior to the pandemic.
- Results show negative impacts were mitigated for students whose teachers were identified as meeting or exceeding expected growth across all tested subjects and especially for Reading Grade 4; Math Grade 5; Math Grade 6; NC Math 3; and Science Grade 5.
- Pre-pandemic teaching effectiveness did not appear to mitigate negative impacts in Reading Grades 7 and 8.

Figures 1a-d. Relationship between Pre-Pandemic Teaching Effectiveness and Lost Instructional Time for all Subjects, Reading, Math, and Science

1 Does Not Meet Expected Growth **2 Meets Expected Growth** **3 Exceeds Expected Growth**

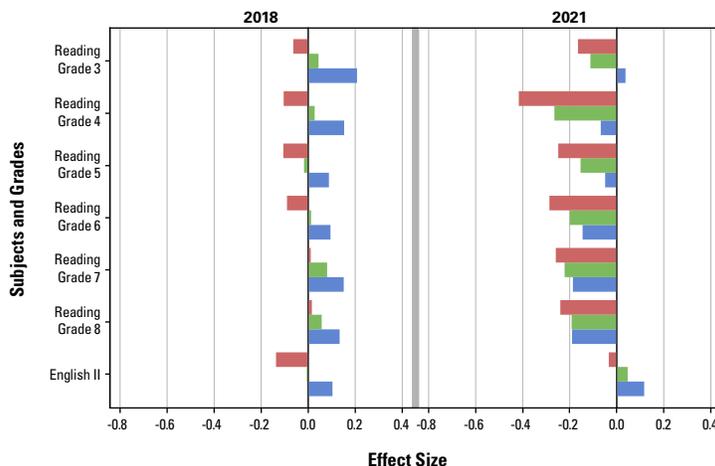
1a. All Grades All Tested Subjects

Effect Size by Subject Grade - Teacher Previous Effectiveness Level



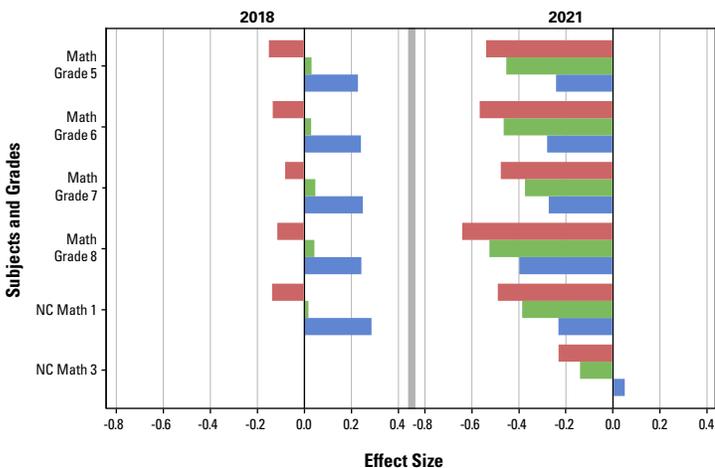
1b. Reading EOGs and EOCs

Effect Size by Subject Grade - Teacher Previous Effectiveness Level



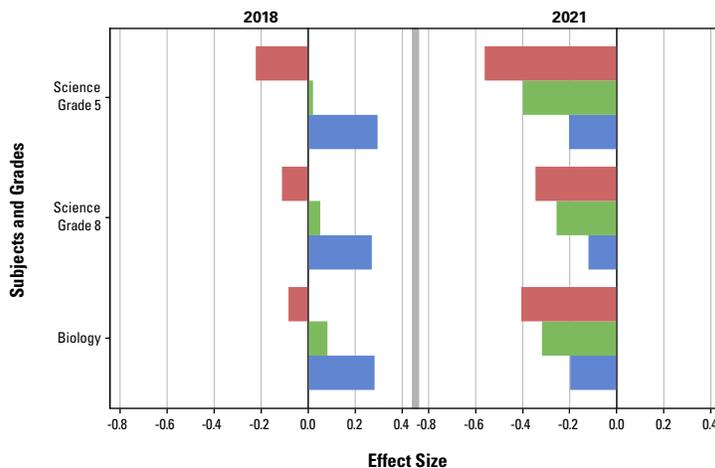
1c. Math EOGs and EOCs

Effect Size by Subject Grade - Teacher Previous Effectiveness Level



1d. Science EOGs and EOCs

Effect Size by Subject Grade - Teacher Previous Effectiveness Level



Teacher Longevity

The following figures (see Figures 2a-d.) group students into three categories based on the number of years of their teacher worked at their pandemic school. The bar charts represent how those groups of students performed when comparing their 2018 to 2021 expected versus actual scores on North Carolina’s standardized, summative assessments. Please see pages 120-124 for details charts and tables in the [full technical report released in December 2022](#).

Findings

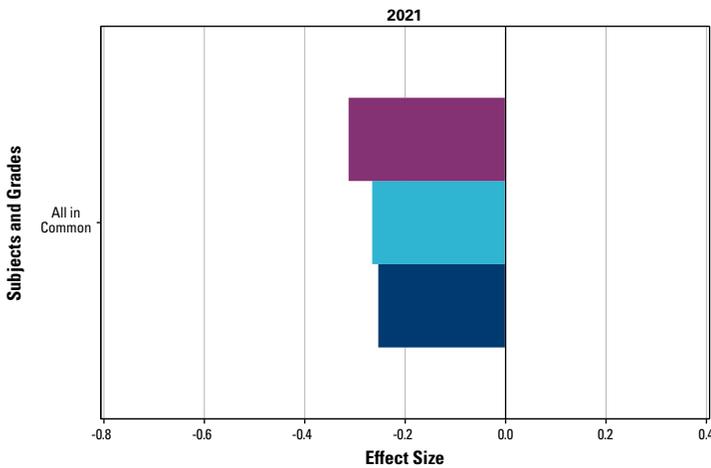
- Compared to teacher effectiveness, teacher longevity played a negligible role in mitigating the negative impacts of the pandemic.
- On average, there were slightly more negative impacts observed among students linked to teachers who had been in their school for 1 to 3 years, especially for Reading Grade 4, Math Grade 5 and Science Grade 5.
- Overall, very little difference was observed in student performance during the pandemic when comparing their teachers’ longevity at their school for teachers serving 4-7 years or 8 or more years.

Figures 2a-d. Relationship between Pre-Pandemic Teaching Longevity and Lost Instructional Time for all Subjects, Reading, Math, and Science



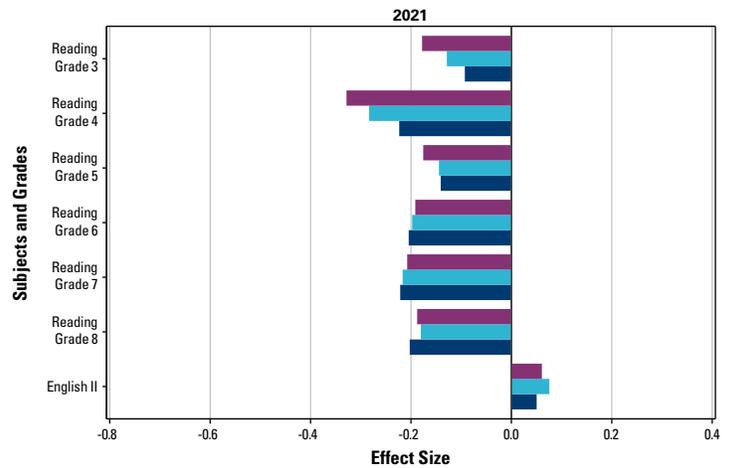
2a. All Grades All Tested Subjects

Effect Size by Subject Grade - Teacher Longevity at a School



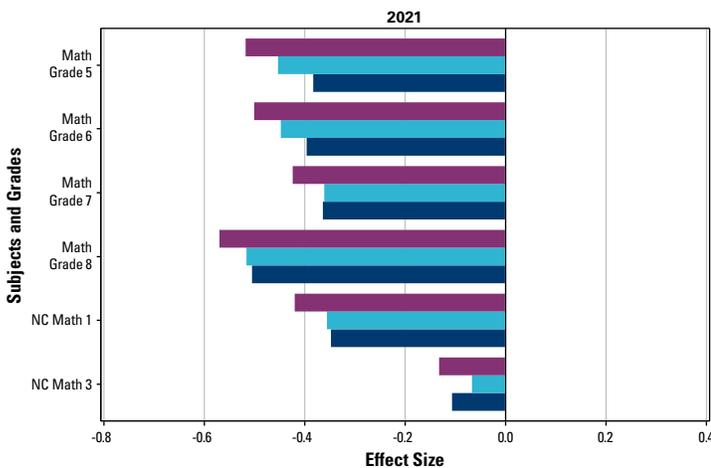
2b. Reading EOGs and EOCs

Effect Size by Subject Grade - Teacher Longevity at a School



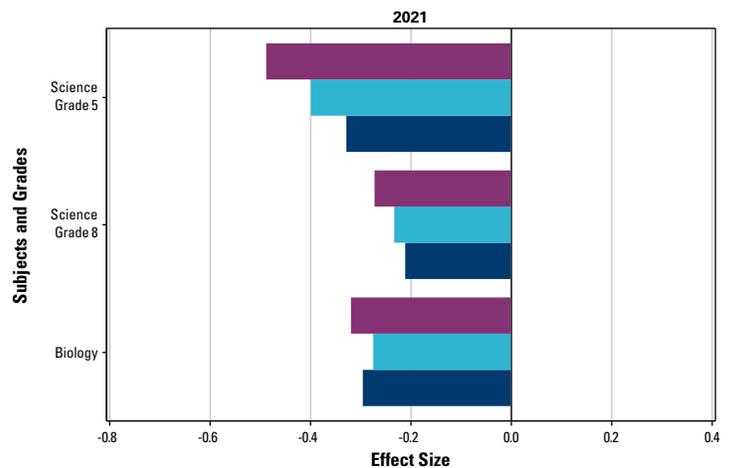
2c. Math EOGs and EOCs

Effect Size by Subject Grade - Teacher Longevity at a School



2d. Science EOGs and EOCs

Effect Size by Subject Grade - Teacher Longevity at a School



Relevant Literature – Principal Characteristics

Principal effectiveness is a key component of school performance. Research shows that similarly to teachers, principals become more effective with experience, especially within their first three years (Clark et al., 2009). High-quality leadership matters and is a driver for student success and demonstrates that principals have a significant impact on student learning. There is substantial evidence of recent estimates of principal effects on math achievement range from .05 to .20 student-level standard deviations (Branch, Hanushek, & Rivkin, 2012; Dhuey & Smith, 2018; Grissom, Kalogrides, & Loeb, 2015). However, these estimates are smaller in magnitude than teacher effects (Bartanen, 2019).

The research literature shows that a principal's years of experience in a specific setting is an indicator of school quality. For instance, research finds that new principals obtain their initial experiences in challenging placements and transfer to schools that are 'easier' to manage as positions open (by 2nd to 3rd school assignment) (Béteille, Kalogrides, & Loeb, 2009; Miller, 2013). Furthermore, the lowest-achieving schools are more likely than other schools to have principals who are in their first year at the school and are least likely to have principals with at least six years of experience at a school (Branch et al., 2012). In fact, more recent literature shows that novice principals are more likely to be placed in higher-poverty public schools (Grissom, Egalite, & Lindsay, 2021).

Given the complexities and nuances of school leadership effectiveness being viewed over time, the skills and dispositions tied to principal quality are treated as fixed (either effective or ineffective) which presents limitations for previous studies (Bartanen, 2019). Models using a school fixed effects approach show that there are consistent positive outcomes between experience and principal effectiveness for principals who lead the same school in different years (Bastian & Henry, 2015; Clark, Martorell, & Rockoff, 2009; Grissom, Blissett, & Mitani, 2018). Nevertheless, it has been noted that these estimates present a combined effect on principal returns to effectiveness (Clark et al., 2009).

There is a growing body of research that addresses these variations within principal quality as a driver of student outcomes (Branch et al., 2012; Coelli & Green 2012; Dhuey & Smith 2014, 2018; Grissom et al., 2015; Chiang, Lipscomb, & Gill, 2016; Bartanen, 2020). Even with the consistent findings of these studies around value-added models, there are more rigorous evaluations that challenge whether these models measure individual principal effectiveness and the... "dynamic nature of school value-added measures" (Bartanen, Husain, & Liebowitz, 2022).

Principal Effectiveness

The following figures (see Figures 3a-d.) group students into three categories based on the number of years of their principal worked at their pandemic school. The bar charts represent how those groups of students performed when comparing their 2018 to 2021 expected versus actual scores on North Carolina's standardized, summative assessments. Please see pages 137-143 for details charts and tables in the [full technical report released in December 2022](#).

Findings

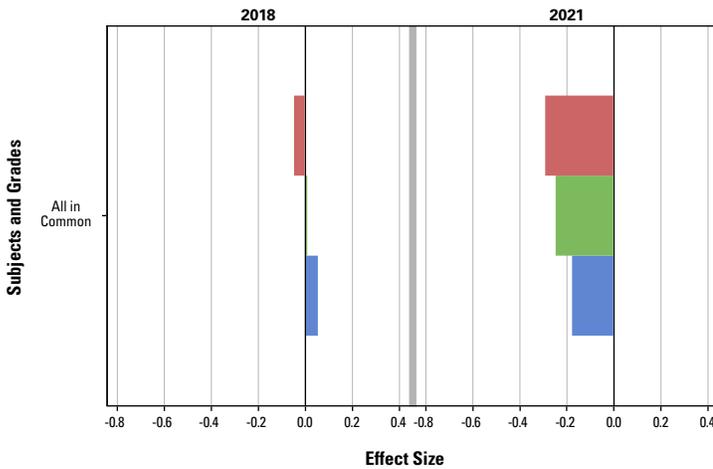
- Analysis on principal effectiveness shows little impact on mitigating the negative impact of the pandemic on student learning, especially for reading.

Figures 3a-d. Relationship between Pre-Pandemic Principal Effectiveness and Lost Instructional Time for all Subjects, Reading, Math, and Science

■ 1 Does Not Meet Expected Growth
 ■ 2 Meets Expected Growth
 ■ 3 Exceeds Expected Growth

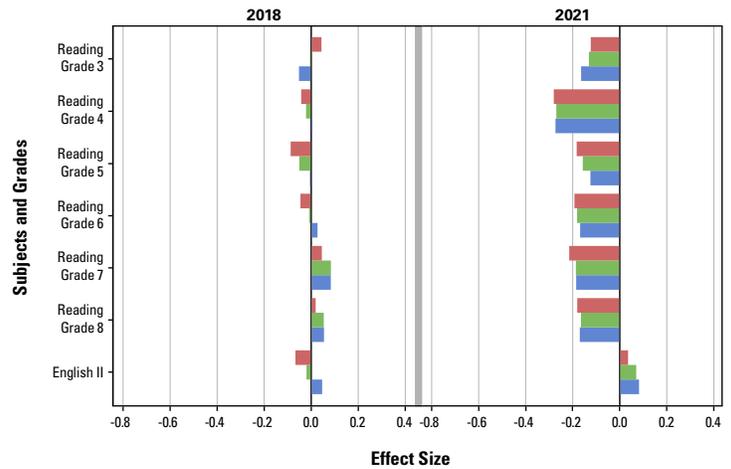
3a. All Grades All Tested Subjects

Effect Size by Subject Grade - Principal Previous Effectiveness Level



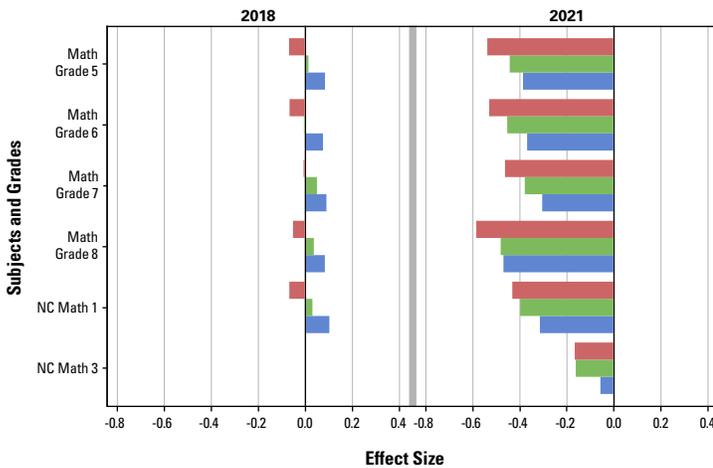
3b. Reading EOGs and EOCs

Effect Size by Subject Grade - Principal Previous Effectiveness Level



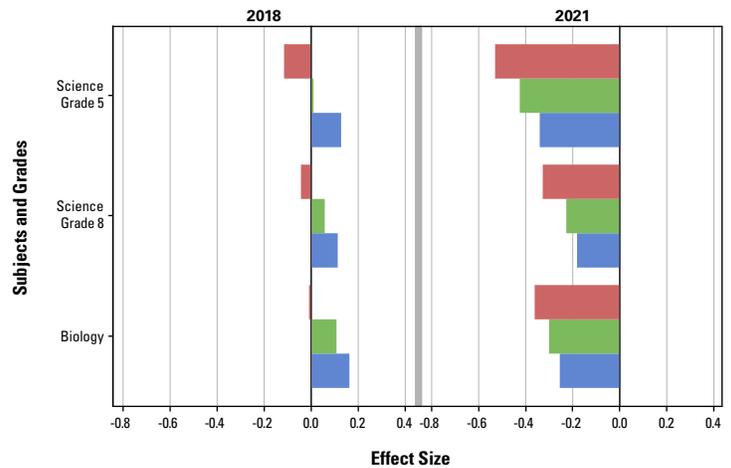
3c. Math EOGs and EOCs

Effect Size by Subject Grade - Principal Previous Effectiveness Level



3d. Science EOGs and EOCs

Effect Size by Subject Grade - Principal Previous Effectiveness Level



Principal Longevity

The following figures (see Figures 4a-d.) group students into three categories based on the number of years of a principal worked at their pandemic school. The bar charts represent how those groups of students performed when comparing their 2018 to 2021 expected versus actual scores on North Carolina's standardized, summative assessments. Please see pages 131-136 for details charts and tables in the [full technical report released in December 2022](#).

Findings

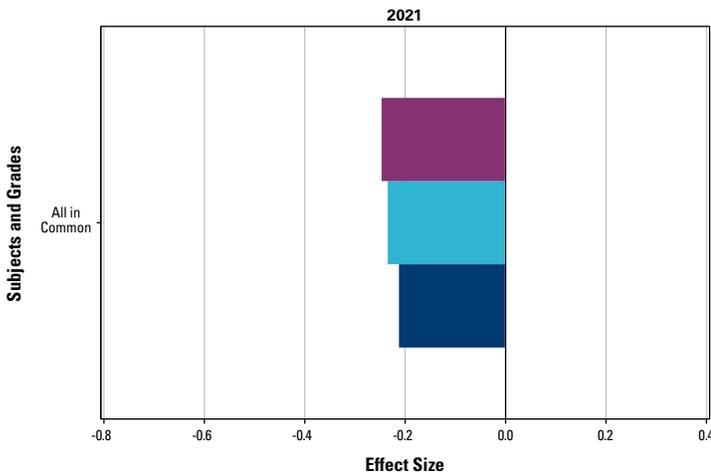
- Data on principal longevity show little impact on mitigating the negative impact of the pandemic on student learning.
- Overall, very little difference was observed for student performance during the pandemic when comparing their principals' longevity at their school for principals serving 4-7 years or 8 or more years.

- There was slightly more negative impact observed among students linked to principals who had been in their school between 1 and 3 years, especially for Math Grade 5 and NC Math 1.
- There was slightly more negative impact observed among students linked to principals who had been in their school for 8 or more years, especially for Math Grade 8.

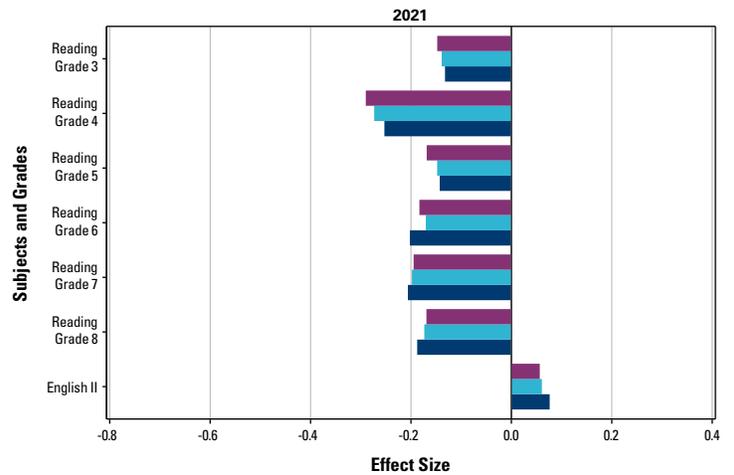
Figures 4a-d. Relationship between Pre-Pandemic Teaching Longevity and Lost Instructional Time for all Subjects, Reading, Math, and Science



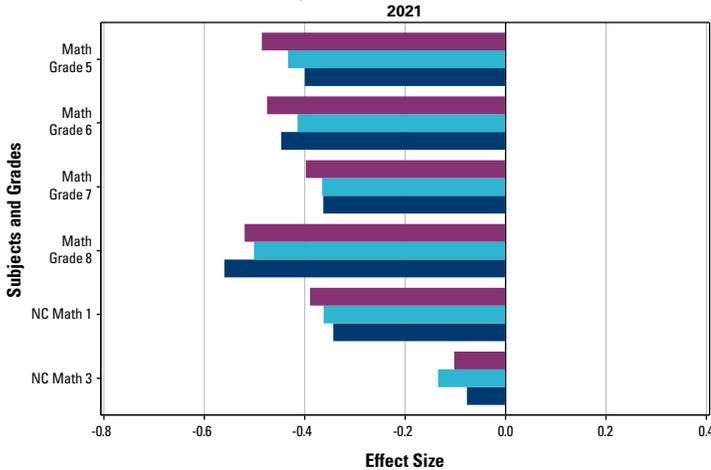
4a. All Grades All Tested Subjects
Effect Size by Subject Grade - Principal Longevity at a School



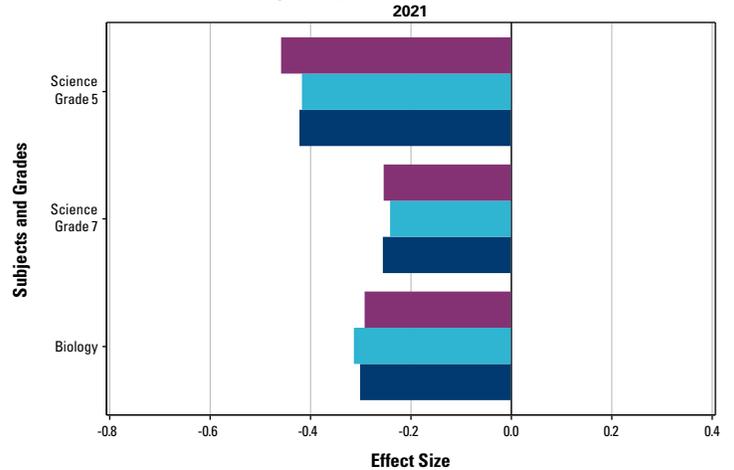
4b. Reading EOGs and EOCs
Effect Size by Subject Grade - Principal Longevity at a School



4c. Math EOGs and EOCs
Effect Size by Subject Grade - Principal Longevity at a School



4d. Science EOGs and EOCs
Effect Size by Subject Grade - Principal Longevity at a School



Conclusion

Based on feedback from the field, this analysis focused on the impact of certain characteristics of teachers and principals on student growth using a robust data system that includes each student's previous standardized test scores. We found that students linked to teachers identified as effective or higher prior to the pandemic experienced less impact on academic achievement during the pandemic than students linked to teachers identified as less effective prior to the pandemic. Teachers and principals who had been at their school for more than three years moderately mitigated the negative effects of the pandemic on students' performance. The impact of the pandemic on student achievement was much more closely related to teachers than to their principals.

Based on the findings from this analysis some initial policy considerations include:

Teacher longevity appears to have less influence on student learning than effectiveness. District and school leaders should consider placing their best, not necessarily most experienced, teachers where they can have the most impact, including early grades reading and middle grades math and science.

Principal effectiveness or longevity does not appear to have a consistent impact on student learning. District leaders should consider placing their best principals in schools that have struggled to increase student achievement; where staff morale needs to be improved; or where school culture needs to be changed.

Future analysis should consider other variables, such as teacher and principal credentials, and the impact of school culture as defined by the [NC Teacher Working Conditions Survey](#).

References

- Balfanz, R., Herzog, L., & Mac Iver, D.J. (2007), Preventing student disengagement and keeping students on the graduation path in urban middle-grades schools: Early identification and effective interventions. *Educational Psychologist*, 42(4), 223-235.
- Balfanz, R., & Byrnes, V. (2012). The importance of being there: A report on absenteeism in the nation's public schools. Johns Hopkins University Center for Social Organization of Schools. http://new.every1graduates.org/wp-content/uploads/2012/05/FINALChronicAbsenteeismReport_May16.pdf
- Bartanen, B. (2019). Identifying principal improvement. (EdWorkingPaper: 19-136). Annenberg Institute at Brown University. <https://doi.org/10.26300/kcrz-tm19>
- Bartanen, B., Husain, A. N., & Liebowitz, D. D. (2022). Rethinking principal effects on student outcomes. (EdWorkingPaper: 22-621). Annenberg Institute at Brown University: <https://doi.org/10.26300/r5sf-3918>
- Bastian, K. C., & Henry, G. T. (2015). The apprentice: Pathways to the principalship and student achievement. *Educational Administration Quarterly*, 51(4), 600–639.
- Béteille, T., Kalogrides, D., & Loeb, S., (2009). Effective schools: Managing the recruitment, development, and retention of high-quality teachers. (CALDER Working Paper 37). The Urban Institute, Washington, DC.
- Betts, J.R., Zau, A.C. & Rice, L.A. (2003). Determinants of student achievement: New evidence from San Diego. Public Policy Institute of California, San Francisco, CA.
- Blazar, D. (2015), Grade assignments and the teacher pipeline: a low-cost lever to improve student achievement? *Educational Researcher*, 44(4), 213-227. <https://doi.org/10.3102/0013189X15580944>
- Branch, G. F., Hanushek, E. A., & Rivkin, S. G. (2012). Estimating the effect of leaders on public sector productivity: The case of school principals
- Chetty, R., Friedman, J. N., & Rockoff, J. E. (2014). Measuring the impacts of teachers II: Teacher value-added and student outcomes in adulthood. *American Economic Review*, 104(9), 2633–2679.
- Chiang, H., Lipscomb, S., & Gill, B. (2016). Is school value-added indicative of principal quality? *Education Finance and Policy*, 11(3), 283–309.
- Chingos, M.M., & Peterson, P.E. (2011), 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(3), 49-465.
- Clark, D., Martorell, P., & Rockoff, J., (2009). School principals and school performance. (CALDER Working Paper 38). The Urban Institute. Washington, DC.

- Clotfelter, C.T., Ladd, H.F. & Vigdor, J.L. (2006). Teacher-student matching and the assessment of teacher effectiveness. *Journal of Human Resources*, 41(4),778-820.
- Clotfelter, C.T., Ladd, H.F. & Vigdor, J.L. (2010). Teacher credentials and student achievement in high school. *The Journal of Human Resources*, 45(3),655-681.
- Coelli, M., & Green, D.A. (2012). Leadership effects: School principals and student outcomes. *Economics of Education Review*, 31(1), 92–109.
- Dee, T.S. (2004). Teachers, race, and student achievement in a randomized experiment. *Review of Economics and Statistics*, 86(1), 195-210. <https://doi.org/10.1162/003465304323023750>.
- Dhuey E. & Smith (2018). How school principals influence student learning. *Empirical Economics*, 54(2), 851-882.
- Gerritsen, S., Plug, E., & Webbink, D. (2014). Teacher quality and student achievement: Evidence from a Dutch sample of twins. (CPB discussion paper 294). Central Plan Bureau/Netherlands Bureau for Economic Policy Analysis. The Hague, The Netherlands: <https://ideas.repec.org/p/cpb/discus/294.html>.
- Grissom, J. A., Kalogrides, D., & Loeb, S. (2015). Using student test scores to measure principal performance. *Educational Evaluation and Policy Analysis*, 37(1), 3–28.
- Grissom, J. A., Blissett, R. S. L., & Mitani, H. (2018). Evaluating school principals: Supervisor ratings of principal practice and principal job performance. *Educational Evaluation and Policy Analysis*, 40(3), 446–472.
- Grissom, J. A., Egalite, A. J., & Lindsay, C.A. (2021). How principals affect students and schools: A systematic synthesis of two decades of research. The Wallace Foundation. <http://www.wallacefoundation.org/principalsynthesis>
- Harris, D.N. & Sass, T.R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics*, 95(7-8),798-812. <https://doi.org/10.1016/j.jpubeco.2010.11.009>
- Hattie, J.A.C. (2003, October). Teachers make a difference: What is the research evidence? [Paper Presentation]. Building Teacher Quality: What does the research tell us ACER Research Conference, Melbourne, Australia. http://research.acer.edu.au/research_conference_2003/4/
- Huang, F.L. & Moon, T.R. (2009). Is experience the best teacher? A multilevel analysis of teacher characteristics and student achievement in low-performing schools. *Educational Assessment, Evaluation and Accountability*, 21(3), 209-234. <https://doi.org/10.1007/s11092-009-9074-2>
- Kane, T.J., Rockoff, J.E. & Staiger, D.O. (2008). What does certification tell us about teacher effectiveness? Evidence from New York City. *Economics of Education Review*, 27(6), 615-63. <https://doi.org/10.1016/j.econedurev.2007.05.005>
- Kraft, M.A. & Papay, J.P. (2014). Can professional environments in schools promote teacher development? Explaining heterogeneity in returns to teaching experience. *Educational Evaluation and Policy Analysis*, 36(4), 476-500. <https://doi.org/10.3102/0162373713519496>.

- Ladd, H.F. & Sorensen, L.C. (2017). Returns to teacher experience: student achievement and motivation in middle school. *Education Finance and Policy*, 12(2), 241-279.
- Miller, A. (2013). Principal turnover and student achievement. *Economics of Education Review*, 36, 60-72.
- Nye, B., Konstantopoulos, S., & Hedges, L.V. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis*, 26(3), 237-257. <https://doi.org/10.3102/01623737026003237>.
- Ost, B. (2014). How do teachers improve? The relative importance of specific and general human capital. *American Economic Journal: Applied Economics*, 6(2), 127-151. <https://doi.org/10.1257/app.6.2.127>
- Papay, J.P. & Kraft, M.A. (2015). Productivity returns to experience in the teacher labor market: Methodological challenges and new evidence on long-term career improvement. *Journal of Public Economics*, 130, 105-119.
- Podolsky, A., Kini, T., & Darling-Hammond, L. (2019). Does teaching experience increase teacher effectiveness? A review of US research. *Journal of Professional Capital and Community*.
- Rivkin, S., Hanushek, E., & Kain, J. (2005). Teachers, schools, and academic achievement. *Econometrica*, 73(2), 417–458.
- Rockoff, J. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *The American Economic Review*, 94(2), 247–252.
- Ronfeldt, M., Farmer, S.O., McQueen, K. & Grissom, J.A. (2015). Teacher collaboration in instructional teams and student achievement. *American Educational Research Journal*, 52(3), 475-514. <https://doi.org/10.3102/0002831215585562>.
- Sass, T.R., Hannaway, J., Xu, Z., Figlio, D.N. & Feng, L. (2012). Value added of teachers in high poverty schools and lower-poverty schools. *Journal of Urban Economics*, 72(2), 104-122. <https://doi.org/10.1016/j.jue.2012.04.004>.
- Wiswall, M. (2013). The dynamics of teacher quality. *Journal of Public Economics*, 100, 61-78. <https://doi.org/10.1016/j.jpubeco.2013.01.006>