

# Education Bond Act of 2019

## What is the goal of this health note?

Decisions made in sectors outside of public health and health care, such as in education, housing, and employment, can affect health and well-being. Health Notes are intended to provide objective, nonpartisan information to help legislators understand the connections between these various sectors and health. This document summarizes evidence analyzed by the North Carolina Budget & Tax Center (BTC) while creating a Health Note for North Carolina House Bill 241. Health Notes are not intended to make definitive or causal predictions about how a proposed bill will affect health and well-being of constituents. Rather, legislators can use a Health Note as one additional source of information to consider during policy-making. The analysis does not consider the fiscal impacts of the bill.

## How and why was this bill selected?

This bill was identified as one of several important policy issues being considered by the North Carolina General Assembly in 2019, and as a prominent policy proposal on the issues of education and capital investments. The Health Note screening criteria were used to confirm the bill was appropriate for analysis. (See Appendix: Methodology on Page 10). BTC’s focus areas for Health Notes include housing, education, and employment.

Educational adequacy is a prominent issue currently in North Carolina, with the long-awaited release of the court-ordered WestEd report in December 2019 and subsequent consent order in January 2020 calling for remedial actions to improve education conditions across the state.<sup>1</sup> HB 241 presented an opportunity to closely examine the potential effects of school capital funding on health.

1 WestEd, Learning Policy Institute, & Friday Institute for Educational Innovation at North Carolina State University (2019). Sound Basic Education for All: An Action Plan for North Carolina. San Francisco, CA: WestEd. Accessed at <http://www.ncpolicywatch.com/wp-content/uploads/2019/12/Sound-Basic-Education-for-All-An-Action-Plan-for-North-Carolina.pdf>; Hoke County Board of Education v. State, 95 CVS 1158 (North Carolina 2020). Accessed at <https://www.ncjustice.org/wp-content/uploads/2020/01/EdLaw-Learn-dro-File-stamped-Order-dated-1-21-2020.pdf>

### Bill Authors

**Bill Authors:** Representatives Moore; L. Johnson; Elmore; Horn (Primary), and nearly 60 more bill sponsors.

### Bill Provisions Examined

**This bill, subject to a public bond referendum put forth in the 2020 election, would provide a total of \$1.9 billion to public schools, community colleges, and University of North Carolina institutions for the purposes listed below.<sup>1</sup>**

- Construction of one or more new buildings
- Renovation of one or more existing buildings
- Construction, acquisition and installation of technology infrastructure
- Acquisition and installation of equipment to ensure building security
- Acquisition and installation of instructional-related equipment
- Purchase of land necessary for construction
- Other projects to provide facilities for instructional or related purposes

**This Health Note specifically examines the public school component of the bill since public schools would receive \$1.5 billion, nearly 80 percent of the bond funds distributed. In addition to dollars distributed to counties through the bond, counties that do not receive low wealth or adjustment factor designation allocations are required to match funds based on their development tier, a three-tier designation based on the county’s economic well-being.<sup>2</sup>**

### Health Note Analyst

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1 Education Bond Act of 2019, H.B. 241. Session 2019, General Assembly of North Carolina. Accessed at <https://www.ncleg.gov/Sessions/2019/Bills/House/PDF/H241v3.pdf>

2 North Carolina Department of Commerce. 2019. County Distress Rankings (Tiers). Accessed at <https://www.nccommerce.com/grants-incentives/county-distress-rankings-tiers>

# Summary of health note findings

**This review found that the improvement of public school facilities through new construction and renovation of existing facilities could improve the health and educational outcomes of North Carolina students, the working conditions and social climate for teachers and other public school employees, and the communities in which the new or renovated schools are located.** Here is a summary of the key findings of this Health Note:<sup>2</sup>

- There is strong evidence that higher quality public school building conditions contribute to **increased test scores, student achievement, and overall academic outcomes**, particularly in math, English, reading, and language arts subjects.<sup>3,4,5,6,7</sup>
- There is very strong evidence between higher educational attainment and **improved health over the life course**, in addition to the survival of the next generation.<sup>8,9,10,11,12,13,14</sup>
- There is strong evidence that improved **school attendance is a mediating factor** by which school facility improvements lead to improved academic performance.<sup>15,16</sup> There is a fair amount of evidence that **improved temperature conditions, such as heat, as well as teacher retention** may also mediate the relationship between school facilities and educational outcomes.<sup>17,18,19</sup>
- There is strong evidence that school construction projects that improve public school quality also

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- 2 **Very strong evidence:** The literature review yielded robust evidence supporting a causal relationship with few if any contradictory findings. The evidence indicates that the scientific community largely accepts the existence of the relationship. **Strong evidence:** The literature review yielded a large body of evidence on the association, but the body of evidence contained some contradictory findings or studies that did not incorporate the most robust study designs or execution or had a higher than average risk of bias; or some combination of those factors. **A fair amount of evidence:** The literature review yielded several studies supporting the association, but a large body of evidence was not established; or the review yielded a large body of evidence but findings were inconsistent with only a slightly larger percent of the studies supporting the association; or the research did not incorporate the most robust study designs or execution or had a higher than average risk of bias. **Mixed evidence:** The literature review yielded several studies with contradictory findings regarding the association. **Not well researched:** The literature review yielded few if any studies or yielded studies that were poorly designed or executed or had high risk of bias.
- 3 Earthman, G. I. 2017. The relationship between school building condition and student achievement: A critical examination of the literature. *Journal of Ethical Educational Leadership*, 4(3): 1-16. Accessed at <http://cojeel.org/wp-content/uploads/2013/06/JEELVol4No3.pdf>
- 4 Lavy, S., Nixon, J. L., & Samant, S. 2016. An analysis of student performance measures in newly constructed schools. *CIB World Building Congress 2016*, Vol. I, pp. 361-371. Accessed at [https://tutcris.tut.fi/portal/files/6186667/WBC16\\_Vol\\_1.pdf](https://tutcris.tut.fi/portal/files/6186667/WBC16_Vol_1.pdf)
- 5 Martorell, P., Stange, K., & McFarlin Jr., I. 2016. Investing in schools: capital spending, facility conditions, and student achievement. *Journal of Public Economics*, 140:13-29. Accessed at <https://doi.org/10.1016/j.jpubeco.2016.05.002>
- 6 Hewitt, C. D. 2017. An analytic synthesis of research studies dealing with the relationship between school building condition and student academic achievement. (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University. Blacksburg, United States. Accessed at <https://vtechworks.lib.vt.edu/handle/10919/89606>
- 7 Lumpkin, R. B., Goodwin Jr, R. T., Hope, W. C., & Lutfi, G. 2014. Code compliant school buildings boost student achievement. *SAGE Open*, 4(4): 1-8. Accessed at <https://journals.sagepub.com/doi/full/10.1177/2158244014556993>
- 8 Center on Society and Health. 2014. Why education matters to health: Exploring the causes. Accessed at <https://societyhealth.vcu.edu/media/society-health/pdf/test-folder/CSH-EHI-Issue-Brief-2.pdf>
- 9 Egarter, S., Braveman, P., Sadegh-Nobari, T., Grossman-Kahn, R., & Dekker, M. 2011. Education and health: An examination of the many ways in which education can influence health, including how educational attainment affects health across generations and the social and economic advantages it represents. Accessed at <https://www.rwjf.org/en/library/research/2011/05/education-matters-for-health.html>
- 10 National Center for Health Statistics. Health, United States, 2011: With Special Feature on Socioeconomic Status and Health. Hyattsville, MD. 2012. Accessed at <https://www.ncbi.nlm.nih.gov/books/NBK98752/>
- 11 Rogers R. G., Everett B. G., Zajacova, A., & Hummer, R. A. 2010. Educational degrees and adult mortality risk in the United States. *Biodemography Soc Biol*. 56(1):80-99. Accessed at <https://doi.org/10.1080/19485561003727372>
- 12 Center on Society and Health. 2015. Education: It matters more to health than ever before. Accessed at <https://societyhealth.vcu.edu/work/the-projects/education-it-matters-more-to-health-than-ever-before.html>
- 13 Mathews, T.J. & MacDorman, M.F. 2013. Infant mortality statistics from the 2009 period linked birth/infant death dataset. *National Vital Statistics Reports*; vol 60 no 5. Hyattsville, MD: National Center for Health Statistics; 2013. Accessed at [www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61\\_08.pdf](http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_08.pdf).
- 14 Understanding the Relationship Between Education and Health: A Review of the Evidence and an Examination of Community Perspectives. Content last reviewed September 2015. Agency for Healthcare Research and Quality, Rockville, MD. <https://archive.ahrq.gov/professionals/education/curriculum-tools/population-health/zimmerman.html>
- 15 Maxwell, L. E. 2016. *Journal of Environmental Psychology*. School building condition, social climate, student attendance, and academic achievement: A mediation model, 46:206-216. Accessed at <https://doi.org/10.1016/j.jenvp.2016.04.009>
- 16 Durán-Narucki, V. 2008. School building condition, school attendance, and academic achievement in New York City public schools: A mediation model. *Journal of Environmental Psychology*, 28(2008): 278-286. Accessed at <https://doi.org/10.1016/j.jenvp.2008.02.008>
- 17 Park, J. 2016. Temperature, test scores, and educational attainment. Unpublished working paper. Accessed at [https://www.switzer-network.org/sites/default/files/file-attachments/temperature\\_test\\_scores\\_and\\_educational\\_attainment\\_-\\_j\\_park\\_-\\_9-13-2016.pdf](https://www.switzer-network.org/sites/default/files/file-attachments/temperature_test_scores_and_educational_attainment_-_j_park_-_9-13-2016.pdf)
- 18 Goodman, J., Hurwitz, M., Park, R. J., & Smith, J. 2019. Heat and learning. EdWorkingPaper No. 19-30. Accessed at <https://edworkingpapers.com/ai19-30>
- 19 Schneider, M. 2002. Public school facilities and teaching: Washington, DC and Chicago. (Research Report 143). Washington, D.C., Twenty-First Century School Fund. (ERIC Document Reproduction Service No. ED474242). Accessed at <https://eric.ed.gov/?id=ED474242>

## Why do these findings matter for North Carolina?

Many public schools across North Carolina are in poor condition, over-crowded, and lack the facilities necessary to support students in their educational attainment. In a 2017 assessment of nine rural North Carolina counties, total facility needs exceeded \$600 million, with most of the counties serving fewer than 6,000 students in total.<sup>1</sup>

In North Carolina, enrollment in charter schools has increased rapidly over the past 15 years as has the number of charter schools,<sup>2</sup> and the number of students enrolled in private schools has increased at a slower but steady pace.<sup>3</sup> There is strong evidence that private<sup>4</sup> and charter schools<sup>5</sup> contribute to racial and economic segregation in schools, a trend that may be exacerbated by underfunding of public schools. Policymakers could consider the use of capital funding to boost enrollment at public schools to mitigate the negative effects of school segregation.

- 1 MGT Consulting Group. 2017. Final Report: Public school construction needs survey and recommendations for funding options for selected districts. The Legislative Services Commission of the North Carolina General Assembly. Accessed at [https://www.ncleg.net/PED/Reports/documents/SchoolConstruction/School\\_Construction\\_Report.pdf](https://www.ncleg.net/PED/Reports/documents/SchoolConstruction/School_Construction_Report.pdf)
- 2 U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," 2000-01 through 2016-17. Accessed at [https://nces.ed.gov/programs/digest/d18/tables/dt18\\_216.90.asp](https://nces.ed.gov/programs/digest/d18/tables/dt18_216.90.asp)
- 3 North Carolina Department of Administration. 2019. North Carolina private K-12 school statewide statistical history: 1991-1992 through 2018-2019 school years. Accessed at [https://files.nc.gov/ncdoa/documents/files/History\\_Enrollment\\_-\\_Schools.pdf](https://files.nc.gov/ncdoa/documents/files/History_Enrollment_-_Schools.pdf)
- 4 Clotfelter, C. T. 2004. Private schools, segregation, and the Southern states. *Peabody Journal of Education*, 79(2): 74-97. Accessed at [https://doi.org/10.1207/s15327930pje7902\\_6](https://doi.org/10.1207/s15327930pje7902_6)
- 5 Nordstrom, K. 2018. Stymied by segregation: How integration can transform North Carolina schools and the lives of its students. Accessed at <https://www.ncjustice.org/publications/stymied-by-segregation-how-integration-can-transform-nc-schools/>

**increase home values** and, relatedly, **increase public school enrollment.**<sup>20</sup>

- There is strong evidence that **good indoor air quality and temperature control** are important for student health and success, and changes to improve poor conditions lead to improvements in academic outcomes.<sup>21,22,23,24,25</sup>
- There is strong evidence demonstrating that school architecture and design, particularly in school cafeterias and through school garden programs, can lead to **healthier eating behaviors, improved social skills, and better dietary outcomes.**<sup>26</sup>

- 20 Neilson, C. A. & Zimmerman, S. D. 2014. The effect of school construction on test scores, school enrollment, and home prices. *Journal of Public Economics*, 120:18-31. Accessed at <https://doi.org/10.1016/j.jpubeco.2014.08.002>
- 21 Mendell, M. J., & Heath, G. A. 2005. Do indoor pollutants and thermal conditions in schools influence student performance? A critical review of the literature. *Indoor Air*, 15:27-52. Accessed at <https://doi.org/10.1111/j.1600-0668.2004.00320.x>
- 22 Schneider, M. 2002. Do school facilities affect academic outcomes? Washington, DC and Chicago. (Research Report 143). Washington, D.C., National Clearinghouse for Educational Facilities. (ERIC Document Reproduction Service No. ED470979). Accessed at <https://eric.ed.gov/?id=ED470979>
- 23 Magzamen, S., Mayer, A. P., Barr, S., Bohren, L., Dunbar, B., Manning, D., . . . Cross, J. E. 2017. A multidisciplinary research framework on green schools: Infrastructure, social environment, occupant health, and performance. *Journal of School Health*, 87(5): 376-387. Accessed at <https://doi.org/10.1111/josh.12505>
- 24 Paulson, J. A., Barnett, C. L. 2016. Public health stops at the school house door. *Environmental Health Perspectives*, 124(10):A171-A175. Accessed at <https://doi.org/10.1289/EHP530>
- 25 Berman, J. D., McCormack, M. C., Koehler, K. A., Connolly, F., Clemons-Erby, D., Davis, M. F., . . . Curriero, F. C. 2018. School environmental conditions and links to academic performance and absenteeism in urban, mid-Atlantic public schools. *International Journal of Hygiene and Environmental Health*, 221:800-808. Accessed at <https://doi.org/10.1016/j.ijheh.2018.04.015>
- 26 Frerichs, L., Brittin, J., Sorensen, D., Trowbridge, M. J., Yaroch, A. L., Siahpush, M., . . . Huang, T. T. K. 2015. Influence of school architecture and design on healthy eating: A review of the evidence. *American Journal of Public Health*, 105: e46—e57. Accessed at <https://doi.org/10.2105/AJPH.2014.302453>

# What are the potential effects of improved public school infrastructure on student academic performance?

Peer-reviewed literature examining the effect of public school facilities on elementary through high school students' academic performance largely supports the idea that improved facilities lead to higher test scores; however, a few studies found no relationship. Methodological differences in data gathering explains why some studies find significant differences in student performance in good and poor buildings while others do not, including the process for determining whether a school building is in good or poor condition, student achievement assessments and their lack of uniformity, and building assessment instruments.<sup>27</sup>

- In their original research study, Lavy, Nixon, and Samant compared replacement (rebuilt) and control (not rebuilt) magnet elementary (grades kindergarten through 5) schools in Houston, Texas. Their research did not find observable differences between student enrollment or attendance at the public magnet schools at replacement schools versus existing schools. However, the study found a positive association between replacement schools and higher student achievement – measured by improved reading and math test scores – and half of the variance in test scores among students in the replacement versus the control schools. These results suggest that newer school buildings are correlated with higher academic achievement.<sup>28</sup>
- Martorell, Stange, and McFarlin analyzed the student achievement effect of nearly 1,400 capital campaigns initiated by local school districts.<sup>29</sup> The authors found that school renovations had little to no impact on student academic achievement based on test scores for 4th- through 8th-graders and 10th- or 11th-graders. However, they note that there may be other benefits to improving school facilities such as improving student health, teacher morale, or neighborhood amenities.<sup>30</sup>
- In a meta-analysis of 30 studies that examined the relationship between school building condition and student academic achievement, Hewitt found that 83 percent of the studies showed a positive relationship between school facility condition and student academic achievement both at the elementary and secondary education levels.<sup>31</sup>
- In a natural experiment in North Florida, researchers examined pre- and post-test scores of over 125,000 students in 4th, 8th, 9th, and 10th grades who moved from old school facilities to new school facilities due to the implementation of building code standards.<sup>32</sup> Analysis showed that passing percentages on the Florida Comprehensive Assessment Test, an annual exam for all students grades 3 through 11, were higher at new schools compared to old schools, with a mean 6.6 percentage point increase in math scores and 1 percentage point increase in reading scores, aggregated across grades 4, 8, 9, and 10.
- In their study of 3rd- through 8th-graders at 149 schools in and around Baltimore, Maryland, Berman and colleagues examined school building conditions and their association with academic performance

27 Earthman, G. I. 2017. The relationship between school building condition and student achievement: A critical examination of the literature. *Journal of Ethical Educational Leadership*, 4(3): 1-16. Accessed at <http://cojeel.org/wp-content/uploads/2013/06/JEELVol4No3.pdf>

28 Lavy, S., Nixon, J. L., & Samant, S. 2016. An analysis of student performance measures in newly constructed schools. *CIB World Building Congress 2016*, Vol. 1, pp. 361-371. Accessed at [https://tutcris.tut.fi/portal/files/6186667/WBC16\\_Vol\\_1.pdf](https://tutcris.tut.fi/portal/files/6186667/WBC16_Vol_1.pdf)

29 Martorell, P., Stange, K., & McFarlin Jr., I. 2016. Investing in schools: capital spending, facility conditions, and student achievement. *Journal of Public Economics*, 140:13-29. Accessed at <https://doi.org/10.1016/j.jpubeco.2016.05.002>

30 Ibid.

31 Hewitt, C. D. 2017. An analytic synthesis of research studies dealing with the relationship between school building condition and student academic achievement. (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University. Blacksburg, United States. Accessed at <https://vtechworks.lib.vt.edu/handle/10919/89606>

32 Lumpkin, R. B., Goodwin Jr, R. T., Hope, W. C., & Lutfi, G. 2014. Code compliant school buildings boost student achievement. *SAGE Open*, 4(4): 1-8. Accessed at <https://journals.sagepub.com/doi/full/10.1177/2158244014556993>

as measured by results from annual assessments.<sup>33</sup> Worse school facility environments were associated with decreased math and reading performance at the elementary level (grades 3 through 5); however, the association between improved building conditions and better math performance was only marginally statistically significant for students in middle school (grades 6 through 8).

## What are the potential effects of improved academic achievement on health?

**Much of the research on the effect of public school building conditions on students falls short of claims to impact student health. Instead, research focuses on the effect of building conditions on student achievement, and this is reflected in much of the literature referenced in subsequent sections. A substantial body of evidence provides very strong support for the positive relationship between student academic achievement and lifelong health and economic success.**

- Work by the Center on Society and Health highlights the many connections between health and education. These include the health benefits of education, including better jobs, higher earnings, and greater access to resources for good health.<sup>34</sup> In addition, the authors point out that poor health affects education when health conditions such as asthma or other chronic illnesses can cause setbacks to learning and recurring absences. Finally, conditions throughout life can affect both health and education, including exposure to adverse childhood experiences, which can cause stress on the developing brain and can begin in early childhood.<sup>35</sup>
- Researchers at the Robert Wood Johnson Foundation have identified three major interrelated pathways by which education can affect health over the life course: improved health knowledge and behaviors, better employment opportunities and higher income, and improved social and psychological factors.<sup>36</sup>
- Research shows that educational attainment affects not only an individual's own life expectancy, but also the next generation's survival and well-being. By age 25, adults without a high school diploma are likely to die nine years earlier than college graduates,<sup>37</sup> and national data show that mortality risk declines significantly with increasing education, with mortality risk highest among people age 25 and older who do not have a high school diploma.<sup>38</sup> On average, individuals with lower educational attainment experience more psychological distress, are more likely to experience chronic health conditions, and bear a higher burden of health care costs.<sup>39</sup> In addition, babies born to mothers who did not complete high school are twice as likely to die before their first birthday compared to babies born to college graduates.<sup>40</sup>
- In a report jointly published by the U.S. Agency for Healthcare Research and Quality and the U.S. Office of Behavioral and Social Sciences Research at the National Institutes of Health examining the relationship between education and health, the authors review existing literature that points to the range of outcomes that result from educational attainment. These include the improved ability to navigate the health care

33 Berman, J. D., McCormack, M. C., Koehler, K. A., Connolly, F., Clemons-Erby, D., Davis, M. F., . . . Curriero, F. C. 2018. School environmental conditions and links to academic performance and absenteeism in urban, mid-Atlantic public schools. *International Journal of Hygiene and Environmental Health*, 221:800-808. Accessed at <https://doi.org/10.1016/j.ijheh.2018.04.015>

34 Center on Society and Health. 2014. Why education matters to health: Exploring the causes. Accessed at <https://societyhealth.vcu.edu/media/society-health/pdf/test-folder/CSH-EHI-Issue-Brief-2.pdf>

35 Ibid.

36 Egarter, S., Braveman, P., Sadegh-Nobari, T., Grossman-Kahn, R., & Dekker, M. 2011. Education and health: An examination of the many ways in which education can influence health, including how educational attainment affects health across generations and the social and economic advantages it represents. Accessed at <https://www.rwjf.org/en/library/research/2011/05/education-matters-for-health.html>

37 National Center for Health Statistics. *Health, United States, 2011: With Special Feature on Socioeconomic Status and Health*. Hyattsville, MD. 2012. Accessed at <https://www.ncbi.nlm.nih.gov/books/NBK98752/>

38 Rogers R. G., Everett B. G., Zajacova, A., & Hummer, R. A. 2010. Educational degrees and adult mortality risk in the United States. *Biodemography Soc Biol*. 56(1):80-99. Accessed at <https://doi.org/10.1080/19485561003727372>

39 Center on Society and Health. 2015. Education: It matters more to health than ever before. Accessed at <https://societyhealth.vcu.edu/work/the-projects/education-it-matters-more-to-health-than-ever-before.html>

40 Mathews, T.J. & MacDorman, M.F. 2013. Infant mortality statistics from the 2009 period linked birth/infant death dataset. *National Vital Statistics Reports*; vol 60 no 5. Hyattsville, MD: National Center for Health Statistics; 2013. Accessed at [www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61\\_08.pdf](http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_08.pdf).

system, decreased likelihood of engaging in risky behaviors such as smoking and drinking, greater likelihood of engaging in healthy behaviors related to diet and exercise, and lower stress exposure due to greater economic security.<sup>41</sup>

## What potential factors mediate the link between improved public school infrastructure, student academic achievement, and health?

**In addition to examining a potential connection between school building condition and academic performance, some studies have examined possible mediating factors that may contribute to or explain the effect on academic performance. These mediating factors include school attendance, heat, student stability, and teacher retention.**

- In their analysis of data from the natural experiment on school construction in the New Haven Public School district, Neilson and Zimmerman observed increases in student reading scores among elementary and middle school students comparable to one year of attendance at a high-performing charter school.<sup>42</sup> Their research puts forth possible mediators for improved test scores, including improved teacher motivation and student motivation, as well as increased parent involvement, and identifies library improvements, heating, air conditioning, and ventilation as building features particularly important to student success.
- Maxwell observed, using data from New York City middle schools (grades 6-8), that the effect of school building condition on academic achievement is mediated by student attendance and perception of social climate. Social climate, or social environment, is defined by the author as the system of relationships, values, expectations, and mutual respect that are communicated to the school population. The author tested mechanisms along the pathway and found that school building condition was a predictor of student test scores. In addition, school building conditions predicted higher student assessment of the school's social climate, and improved perception of social climate was associated with reduced absenteeism, which in turn was associated with higher standardized test scores.<sup>43</sup>
- Durán-Narucki observed that school attendance mediated the relationship between school building condition and academic achievement in the areas of English language arts and, to a lesser extent, mathematics, such that poorer school building conditions led to worse attendance and poorer performance on standardized tests.<sup>44</sup> The author found that school building conditions predicted both academic achievement and student attendance, after controlling for other factors such as teacher quality, school size, and student ethnicity and socioeconomic status.
- In two working papers, researchers find that heat, exacerbated by climate change and poor air conditioning, has a direct negative effect on student academic outcomes. Park finds that, compared to more optimal 72 degree Fahrenheit conditions, a 90-degree day results in a 4.5 percent reduction in high school exit exam performance, contributing to a nearly 11 percent reduction in passing rates

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41 Understanding the Relationship Between Education and Health: A Review of the Evidence and an Examination of Community Perspectives. Content last reviewed September 2015. Agency for Healthcare Research and Quality, Rockville, MD. <https://archive.ahrq.gov/professionals/education/curriculum-tools/population-health/zimmerman.html>

42 Neilson, C. A. & Zimmerman, S. D. 2014. The effect of school construction on test scores, school enrollment, and home prices. *Journal of Public Economics*, 120:18-31. Accessed at <https://doi.org/10.1016/j.jpu-beco.2014.08.002>

43 Maxwell, L. E. 2016. *Journal of Environmental Psychology*. School building condition, social climate, student attendance, and academic achievement: A mediation model, 46:206-216. Accessed at <https://doi.org/10.1016/j.jenvp.2016.04.009>

44 Durán-Narucki, V. 2008. School building condition, school attendance, and academic achievement in New York City public schools: A mediation model. *Journal of Environmental Psychology*, 28(2008): 278-286. Accessed at <https://doi.org/10.1016/j.jenvp.2008.02.008>

and 2.5 percent lower rate of on-time graduation.<sup>45</sup> Goodman et al., in their study of 3rd- through 8th-graders, observed that the average American student experiences approximately 12 school days above 90 degrees per year and that heat may be more damaging to academic achievement in more humid areas. Additionally the authors point out that minority and lower-income students experience more heat exposure as a result of attendance at lower resourced schools that are unable to make capital investments, while wealthier students may be able to compensate for their lost learning due to heat exposure through additional instruction by private tutors or parents.<sup>46</sup>

- Evans et al. observed a positive association between school building condition and student standardized test scores in their study of 511 public elementary schools in New York City. Additionally, they found that high building quality, together with high student stability (defined as the percentage of students who were also enrolled in that school during the previous year), contributed to even greater effects on student academic performance.<sup>47</sup>
- Schneider and Buckley et al. observed that building conditions, and especially design, are important factors for teaching quality and teacher retention. Schneider surveyed a random sample of all public school teachers in Chicago and Washington, D.C., and found that 75 to 80 percent of respondents reported that facility conditions were very important to teaching quality.<sup>48</sup> Buckley, Schneider, and Shang found that facilities' quality, pay, and parent and community involvement are factors that significantly affect teacher retention and are largely within the control of administrators.<sup>49</sup> The authors go on to say that the benefits of facility improvements for retention may be equal or greater than the benefits from pay increases.

**Peer-reviewed literature on how school building conditions affect health primarily relate to environmental factors, particularly the effects of air quality and ventilation. While this is a large area of research, the focus of this literature review on public school infrastructure did not yield many results. However, the connection between poor environmental conditions and health, particularly children's health, is well supported.<sup>50</sup>**

- In a literature review by Schneider, environmental conditions within public school facilities are discussed in connection with student academic outcomes. The author notes that nationally, 1 in 5 students in 1995 was at risk of poor indoor air quality in their school facility. Poor air quality can lead to symptoms including dizziness, upper respiratory infections, and headaches, and has been associated with increased student absenteeism, particularly because of asthma exacerbated by poor indoor air quality.<sup>51</sup>
- A literature review by Magzamen et al. defines poor indoor air quality as the presence of harmful allergens, mold, bioaerosols, chemical and volatile organic compounds, and particulate matter that contribute to a range of health effects in children and adults.<sup>52</sup> The authors also cite studies demonstrating

45 Park, J. 2016. Temperature, test scores, and educational attainment. Unpublished working paper. Accessed at [https://www.switznetwork.org/sites/default/files/file-attachments/temperature\\_test\\_scores\\_and\\_educational\\_attainment\\_-\\_j\\_park\\_-\\_9-13-2016.pdf](https://www.switznetwork.org/sites/default/files/file-attachments/temperature_test_scores_and_educational_attainment_-_j_park_-_9-13-2016.pdf)

46 Goodman, J., Hurwitz, M., Park, R. J., & Smith, J. 2019. Heat and learning. EdWorkingPaper No. 19-30. Accessed at <https://edworkingpapers.com/ai19-30>

47 Evans, G. W., Yoo, M. J., & Sipple, J. 2010. The ecological context of student achievement: School building quality effects are exacerbated by high levels of student mobility. *Journal of Environmental Psychology*, 30(2010): 239-244. Accessed at <https://doi.org/10.1016/j.jenvp.2010.01.001>

48 Schneider, M. 2002. Public school facilities and teaching: Washington, DC and Chicago. (Research Report 143). Washington, D.C., Twenty-First Century School Fund. (ERIC Document Reproduction Service No. ED474242). Accessed at <https://eric.ed.gov/?id=ED474242>

49 Buckley, J., Schneider, M., & Shang, Y. 2004. The effects of school facility quality on teacher retention in urban school districts. (Research Report). Washington, D.C., National Clearinghouse for Educational Facilities. (ERIC Document Reproduction Service No. ED539484). Accessed at <https://eric.ed.gov/?id=ED539484>

50 Mendell, M. J., & Heath, G. A. 2005. Do indoor pollutants and thermal conditions in schools influence student performance? A critical review of the literature. *Indoor Air*, 15:27-52. Accessed at <https://doi.org/10.1111/j.1600-0668.2004.00320.x>

51 Schneider, M. 2002. Do school facilities affect academic outcomes? Washington, DC and Chicago. (Research Report 143). Washington, D.C., National Clearinghouse for Educational Facilities. (ERIC Document Reproduction Service No. ED470979). Accessed at <https://eric.ed.gov/?id=ED470979>

52 Magzamen, S., Mayer, A. P., Barr, S., Bohren, L., Dunbar, B., Manning, D., . . . Cross, J. E. 2017. A multidisciplinary research framework on green schools: Infrastructure, social environment, occupant health, and performance. *Journal of School Health*, 87(5): 376-387. Accessed at <https://doi.org/10.1111/josh.12505>

that improvements in indoor air quality are associated with fewer encounters with the medical system for a range of health conditions, including respiratory symptoms.

- In their brief communication piece, Paulson and Barnett describe the potential environmental health problems in schools, including indoor dangers such as infiltration from outdoor air pollution, mold due to water damage, excess carbon dioxide from inadequate ventilation, inadequate lighting, allergens, radon, asbestos, lead in paint or water, and inadequate heating or cooling.<sup>53</sup> In addition, they discuss that green buildings do not ensure child health within the school building, as no single definition for green buildings exists on which to develop standards.

**Research has found evidence that public school facility conditions may also impact a host of factors directly affecting the health of students, teachers, and school staff including chronic absences, perception of unsafe schools, exposure to environmental pollutants, healthy eating behaviors, and public school enrollment.**

- Berman and colleagues found that worse school condition indices contributed to increased perception of unsafe schools, which was associated with decreased attendance rates and increased chronic absences (defined as missing more than 20 days of school), both measures that the authors note may be proxies for health.<sup>54</sup> Industrial pollutant exposure significantly impacted student attendance and may have implications for indoor air quality at the schools given that open windows are used to compensate for variable heating and inadequate cooling.
- A systematic review by Frerichs et al. studied the effect of school architecture and design on healthy eating, noting that 14 studies found that a lack of appropriate kitchen facilities and equipment hindered the school's ability to provide nutritionally rich meals.<sup>55</sup> One study showed that over-crowding contributed to students' negative social experiences but did not report that it affected eating choices, and two studies suggested that improving cafeteria aesthetics may improve dietary behaviors. The review also found significant improvements in dietary psychosocial outcomes, such as a willingness to try vegetables, dietary behavior outcomes, and social skills as a result of school garden programs.
- Neilson and Zimmerman observed that home values and public school enrollments increased among families with children in New Haven, Connecticut, following a substantial school construction project totaling \$1.4 billion for the city's public school district.<sup>56</sup> Home prices increased by 10 percent on average, which the authors note supports an existing body of literature on the way housing markets reflect school quality.

## Which populations are most likely to be affected by this bill?

Approximately one-quarter of operating funds for public education in North Carolina come from local sources, typically through the collection of property taxes, compared to 66 percent from the state and 10 percent from federal funds.<sup>57</sup> While the proportion of funds relying on local sources is relatively small compared to other states, it remains true nationally that counties with low poverty and high wealth have better-resourced school

53 Paulson, J. A., Barnett, C. L. 2016. Public health stops at the school house door. *Environmental Health Perspectives*, 124(10):A171-A175. Accessed at <https://doi.org/10.1289/EHP530>

54 Berman, J. D., McCormack, M. C., Koehler, K. A., Connolly, F., Clemons-Erby, D., Davis, M. F., . . . Curriero, F. C. 2018. School environmental conditions and links to academic performance and absenteeism in urban, mid-Atlantic public schools. *International Journal of Hygiene and Environmental Health*, 221:800-808. Accessed at <https://doi.org/10.1016/j.ijheh.2018.04.015>

55 Frerichs, L., Brittin, J., Sorensen, D., Trowbridge, M. J., Yaroch, A. L., Siahpush, M., . . . Huang, T. T. K. 2015. Influence of school architecture and design on healthy eating: A review of the evidence. *American Journal of Public Health*, 105: e46—e57. Accessed at <https://doi.org/10.2105/AJPH.2014.302453>

56 Neilson, C. A. & Zimmerman, S. D. 2014. The effect of school construction on test scores, school enrollment, and home prices. *Journal of Public Economics*, 120:18-31. Accessed at <https://doi.org/10.1016/j.jpu-beco.2014.08.002>

57 North Carolina Department of Public Instruction. Statistical profile - current expense expenditures, school year 2018-2019. Accessed at <http://apps.schools.nc.gov/ords/f?p=145:32:::NO::>



districts, and counties with high poverty and low wealth have more poorly resourced school districts;<sup>58</sup> however, this trend may not be the case in North Carolina. Given increasing enrollment in North Carolina private and charter schools by wealthier and white families.<sup>59, 60</sup>

A substantial body of research points to the lifelong effects of low educational attainment on health, with widening gaps by race and gender such that Black men and women with 12 or fewer years of education have a life expectancy four years shorter than similarly-educated white males and females, respectively.<sup>61</sup> Still, health disparities by race and gender exist beyond the positive effects of high educational attainment.<sup>62</sup> Supporting students on their way to academic achievement as a means to improved health and lifelong opportunity should be done in conjunction with other efforts to decrease the deep and longstanding effects of racism that have existed and persisted in the area of education as a means to justice.

## How large might the impact be?

Where possible, the North Carolina Budget & Tax Center describes how large the impact may be based on the bill language and literature, such as describing the size, extent, and population distribution of an effect. During the 2018-2019 academic year, North Carolina had more than 1.5 million public school students attending more than 2,400 public schools across the state supported by more than 170,000 full-time public school personnel.<sup>63</sup> Given that all 115 local public school districts in North Carolina would receive capital funding from the passage of House Bill 241,<sup>64</sup> it is reasonable to expect that all public school students and personnel will somehow be impacted by this legislation, indirectly or directly.

It remains unclear from the bill language how the total allocation of bond funds detailed in the bill was calculated across school districts aside from fund-matching exemptions for counties with low-wealth and adjustment factor designations. It is also unclear how the districts themselves will allocate funds to specific schools, or if each district has the discretion to allocate the funds as they see fit. The equitable distribution of bond funds to schools and districts with the greatest capital need and least capacity to generate revenue locally due to low wealth would result in the greatest positive benefit for students and communities alike.

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58 U.S. Department of Education. National Center for Education Statistics. *Inequalities in Public School District Revenues*, NCEES 98-210, by Thomas B. Parrish and Christine S. Hikido. Project Officer, William J. Fowler. Washington, DC: 1998. Accessed at <https://nces.ed.gov/pubs98/98210.pdf>

59 Nordstrom, K. 2018. *Stymied by segregation: How integration can transform North Carolina schools and the lives of its students*. Accessed at <https://www.ncjustice.org/publications/stymied-by-segregation-how-integration-can-transform-nc-schools/>

60 Center on Society and Health. 2015. *Investments in education are investments in health: The state perspective*. Accessed at <https://societyhealth.vcu.edu/media/society-health/pdf/EH14StateBrief.pdf>

61 Olshansky, S. J., Antonucci, T., Berkman, L., Binstock, R. H., Boersch-Supan, A., Cacioppo, J. T., . . . Rowe, J. 2012. Differences in life expectancy due to race and educational differences are widening, and many may not catch up. *Health Affairs*, 31(8):1803-1813. Accessed at <https://doi.org/10.1377/hlthaff.2011.0746>

62 Goldman, D. & Smith, J. P. 2011. The increasing value of education to health. *Social Science Medicine*, 72(10):1728-1737. Accessed at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3119491/>; Olshansky, S. J., Antonucci, T., Berkman, L., Binstock, R. H., Boersch-Supan, A., Cacioppo, J. T., . . . Rowe, J. 2012. Differences in life expectancy due to race and educational differences are widening, and many may not catch up. *Health Affairs*, 31(8):1803-1813. Accessed at <https://doi.org/10.1377/hlthaff.2011.0746>

63 North Carolina Department of Public Instruction. 2019. *Highlights of the North Carolina Public School Budget*, Accessed at <https://files.nc.gov/dpi/documents/fbs/resources/data/highlights/2019highlights.pdf>

64 See Education, Pre-K to 12, About NC. n.d. Accessed at <https://www.nc.gov/about>

## Appendix: Methodology

To complete this Health Note, the North Carolina Budget & Tax Center staff conducted an expedited literature review using a systematic approach to minimize bias and identify studies to answer each of the identified research questions. In this note, “health impacts” refer to effects on determinants of health, such as education, employment, and housing, as well as effects on health outcomes, such as injury, asthma, chronic disease, and mental health. The strength of the evidence is qualitatively described and categorized as: **not well researched, mixed evidence, a fair amount of evidence, strong evidence, or very strong evidence**. It was beyond the scope of analysis to consider the fiscal impacts of this bill<sup>65</sup> or the effects any funds dedicated to implementing the bill may have on other programs or initiatives in the state. To the extent that this bill requires funds to be shifted away from other purposes or would result in other initiatives not being funded, policymakers may want to consider additional research to understand the relative effect of devoting funds for this bill relative to another purpose.

Once the bill was selected, a research team from the North Carolina Budget & Tax Center hypothesized a pathway between the bill, health determinants, and health outcomes. The hypothesized pathway was developed using research team expertise and a preliminary review of the literature. The bill components were mapped to steps on this pathway and the team developed research questions and a list of keywords to search. The research team reached consensus on the final conceptual model, research questions, contextual background questions, keywords, and keyword combinations. The conceptual model, research questions, search terms, and list of literature sources were peer-reviewed by an external subject matter expert. The external subject matter expert also reviewed a draft of the note. A copy of the conceptual model is available upon request.

- The North Carolina Budget & Tax Center developed and prioritized the following research questions related to the bill components examined:
- To what extent does improved public school infrastructure affect student academic performance in the short-term? Long-term?
- To what extent does improved public school infrastructure affect classroom size? Student behavior? Student engagement?
- To what extent does improved public school infrastructure affect teacher retention?
- To what extent does improved public school infrastructure affect the mental and behavioral health of teachers and students? Quality of instruction?
- To what extent does improved public school infrastructure affect teachers’ and students’ exposure to environmental hazards? (air quality, spaces for physical activity, mold, lead paint, lead water, asbestos, radon)

Next, the research team conducted an expedited literature review using a systematic approach to minimize bias and answer each of the identified research questions.<sup>66</sup> The team limited the search to systematic reviews and meta-analyses of studies first, since they provide analyses of multiple studies or address multiple research questions. If no appropriate systematic reviews or meta-analyses were found for a specific question, the team

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<sup>65</sup> The fiscal note, prepared by the Fiscal Research Division of the North Carolina General Assembly is available at <https://www.ncleg.gov/BillLookup/2019/hb241>

<sup>66</sup> Expedited reviews streamline traditional literature review methods to synthesize evidence within a shortened timeframe. Prior research has demonstrated that conclusions of a rapid review versus a full systematic review did not vary greatly. Watt A. et al., “Rapid reviews versus full systematic reviews: an inventory of current methods and practice in Health Technology Assessment,” (Australia: ASERNIP-5, 2007): 1–105, [https://www.surgeons.org/media/297941/rapidvsfull2007\\_systematicreview.pdf](https://www.surgeons.org/media/297941/rapidvsfull2007_systematicreview.pdf)

searched for nonsystematic research reviews, original articles, and research reports from U.S. agencies and nonpartisan organizations. The team limited the initial search to electronically available sources published between January 2014 and June 2019. Select sources published earlier than January 2014 were included if located through systematic reviews or meta-analyses published between January 2014 and June 2019 or if found during a secondary search for reports from U.S. agencies and nonpartisan organizations.

The research team searched Google Scholar and PubMed, along with the following leading journals in public health, school health, and environmental science to explore each research question: American Journal of Public Health, Social Science & Medicine, Health Affairs, Journal of School Health, Journal of Environmental Psychology, Environmental Health Perspectives, Journal of Environmental Health and Occupational Health Policy, Journal of Public Economics, Early Childhood Research Quarterly, and The Review of Educational Research. The team used the following keywords during searches: public school, public school building, public school facility, construction, renovation, school building condition, building condition, school facility condition, facility condition, student health, air quality, condition, mental health, student performance, student behavior, absence, absent, academic achievement, student achievement, instructional quality, teaching quality, environment, hazard, danger, toxin, and toxic. The team also searched for relevant publications from the Robert Wood Johnson Foundation, the Agency for Healthcare Research and Quality, Virginia Commonwealth University's Center on Society and Health, Education Resources Information Center, and the National Center for Education Statistics.

After following the above protocol, the team screened 1,398 titles and abstracts,<sup>67</sup> identified 121 abstracts for potential inclusion and reviewed the full text corresponding to each of these abstracts. After applying the inclusion criteria, 98 articles were excluded. In addition, the team identified 13 resources with relevant research outside of the peer-reviewed literature. A final sample of 8 resources was used to create the Health Note. In addition, the team used 10 references to provide contextual information.

Of the studies included, the strength of the evidence was qualitatively described and categorized as: **not well researched, mixed evidence, a fair amount of evidence, strong evidence, or very strong evidence.** The evidence categories were adapted from a similar approach from another state.<sup>68</sup>

- **Very strong evidence:** The literature review yielded robust evidence supporting a causal relationship with few if any contradictory findings. The evidence indicates that the scientific community largely accepts the existence of the relationship.
- **Strong evidence:** The literature review yielded a large body of evidence on the association, but the body of evidence contained some contradictory findings or studies that did not incorporate the most robust study designs or execution or had a higher than average risk of bias; or some combination of those factors.
- **A fair amount of evidence:** The literature review yielded several studies supporting the association, but a large body of evidence was not established; or the review yielded a large body of evidence but findings were inconsistent with only a slightly larger percent of the studies supporting the association; or the research did not incorporate the most robust study designs or execution or had a higher than average risk of bias.
- **Mixed evidence:** The literature review yielded several studies with contradictory findings regarding the association.
- **Not well researched:** The literature review yielded few if any studies or yielded studies that were poorly designed or executed or had high risk of bias.

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67 Many of the searches produced duplicate articles. The number of sources screened accounts for duplication across searches in different databases.

68 Washington State Board of Health, 2016 "Executive Summary: Health Impact Review of HB 2969," <http://sboh.wa.gov/Portals/7/Doc/HealthImpactReviews/HIR-2016-05-HB2969.pdf>.

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