ADDRESSING A

Multi-Billion Dollar CHALLENGE

Advancing Knowledge of How High-Quality School Environments Can Positively Affect Educational Outcomes

FINAL REPORT | DECEMBER 2023

APPENDICES

Study Replication Resources

PERKINS EASTMAN

AIA COLLEGE OF FELLOWS

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J+J FLOORING

CDEO

BALTIMORE CITY PUBLIC SCHOOLS

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APPENDIX B

Suggestions for Future Research

While the research team developed a comprehensive analysis of the built school environment through this study and found significant benefits from modernization across the three variables of Indoor Environmental Quality, Educational Adequacy, and Community Connectivity, the investigation also raised new questions that warrant further research and potential modifications to the data collection methods/tools used for this study, as follows.

Indoor Environmental Quality: Further Research

The research team suggests the following to further expand the exploration of IEQ in schools.

- Collect IEQ data not only in cold seasons but also in warm months.
- Although this study's evaluation of school modernization did show improvements in air quality (in terms of particulate matter), there was no significant difference from non-modernized schools in CO_2 or occupied noise levels. Despite research that has shown the effect CO_2 levels have on cognitive function, this study revealed that current modernization efforts are not having a significant impact on CO_2 levels in classrooms. Research-based modernization strategies should be developed to reduce CO_2 levels in classrooms.
- Air quality is a complex factor, with many possible contributors and indicators to consider. More multi-factor assessments of air quality in school environments should be conducted to better understand this metric and to begin to prioritize air quality metrics to use moving forward. For instance, in addition to CO_2 and particulate matter, volatile organic compounds (VOCs) data could also be collected when assessing air quality.
- Given the different metabolic rates between children and adults—and the preferences they have between warm and cool classrooms as a result—future researchers should more closely analyze their ASHRAE Standard 55 calculations following the PMV and PPD method* so they can better understand the two groups' perceived comfort differences.
- Explore thermal comfort factors holistically (i.e., dry bulb temperature, relative humidity, mean radiant temperature, air speed, clothing level, and metabolic rate) and over time, and the impact across a variety of (e.g.) ages, genders, and races.
- Even though people are typically dissatisfied with acoustics in schools, current modernization efforts are not making significant progress to reduce occupied noise levels. Further investigation should be pursued to generate design strategies aimed at improving occupied noise conditions in modernized classrooms.
- This study revealed a disconnect between perceived satisfaction with classroom noise levels and the noise levels measured on-site. Further research needs to be conducted to understand the complex relationship between noise, engagement, and learning.
- Investigate the acoustic needs of special education and non-native-language learners in classroom environments.
- Better tools/methods could be deployed to measure glare in an indoor environment so comparisons can be made between design level modeling of Annual Sunlight Exposure (ASE) and real-world measurements in the built environment.

Educational Adequacy: Further Research

The research team suggests the following for further exploration on EA in schools.

- One of the factors that generated the most questions from the EA portion of this study was the use of transparency—often through glazed sidelights at doorways and interior windows between formal and informal program spaces, like the view from classrooms into circulation or extended learning spaces. The use of transparency was inconsistent throughout the sample, even among the modernized buildings. In addition, students in their questionnaires said this visual connectivity could be distracting. Unfortunately, given the overall poor response rates from participating schools, there were no questionnaire responses available from the schools that do have transparency

* Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) are methods to determine thermal comfort.

features, where the design purposefully organized instructional spaces around extended learning environments. The issue of transparency should be a topic of further research since these aspects of school design relate to pedagogy, extended learning environments, and the passive supervision and general safety within a learning environment.
- Subsequent iterations of the VAT might consider revising or removing the questions about the "heart" of the school, because the sample did not include enough schools with these types of spaces to adequately test the VAT's associated criteria and scoring rubric around this feature.
- Build out the VAT to include criteria related to schools' exterior features (e.g., campus/grounds, parking, pathways).
- The weighting given to the VAT's overarching categories should be evaluated, including potentially emphasizing Instructional Space and Safety and Security.

Community Connectivity: Further Research

The research team suggests the following for further exploration on CC in schools.

- Given the relatively small number of responses to the questionnaire and the limited focus groups and interviews conducted, future studies would benefit from more data to support or clarify CC findings. This further research could be conducted (1) on the sampled schools in Baltimore and Washington, DC, (2) with different schools in those two school districts, or (3) by working with schools in other districts.
- In the midst of the pandemic, the research team decided not to ask external community members to complete a questionnaire, though the researchers would have preferred to have that data. Each community surrounding a school will have physical locations in which a future research team could either personally be present for defined periods of time to recruit participants or hand out paper copies of the questionnaire for people to complete. Ideally, the research team would also circulate an online questionnaire through a reliable community partner-organization that can reach a wide audience.
- Researchers should pose additional questions in the questionnaire, interview guide, and/or focus groups to gather more information from school stakeholders about ways in which schools facilitate connectivity or not. They should also seek to better understand the impacts of that connectivity, such as asking community members exactly how they use open space on the school's campus/grounds.
- The research team still believes that developing a "Community Connectivity scale" would be a worthwhile endeavor. This would require collecting more data from stakeholders so there is a sufficient base from which to identify patterns in their responses. Questionnaires, focus groups/interviews, and additional or different archival data are good ways to gather this information, followed by statistical analysis and then another analytical process to seek connections between stakeholder responses and the community profiles data. Such a scale would enable communities, school districts, and designers to evaluate whether school facilities are truly meeting the needs of their community—data that can inform decision-making and prioritizations for a school modernization.

General Improvements to the Study

In addition to the above suggestions for future research specific to IEQ, EA, and CC, the research team recognizes that general improvements to the study could include the following.

- Refine the questionnaire to get deeper into IEQ, EA, and/or CC data, in particular.
- Hold additional interviews/focus groups with a more diverse and representative sample of school and community stakeholders.
- Engage principals to a greater degree to increase the number of questionnaire respondents and interview/focus group participants. District administrator

buy-in is certainly important as well, but based on the researchers' experience with this study, it does not guarantee access to desired audiences—especially parents/caregivers of students and external community members. The principal would likely know the most effective way to reach their students' parents/caregivers and also be able to make a connection between the research team and the appropriate staff member or parent-teacher representative, or directly do the outreach to parents/caregivers, themselves. The principal could also publicly endorse the study, which would make it more likely that others will participate with or provide support to the researchers.

- In schools that employ a Community School strategy, work with the Community School coordinator, who could play an important role in identifying appropriate individuals and making introductions to arrange the data collection.
- Engage with the participating schools' facility maintenance personnel through questionnaires and/or interviews/focus groups to provide context for IEQ on-site measurements and EA building assessments.
- Seek other kinds of archival data. In this study, the research team was able to identify certain ways modernization impacted trends such as graduation rates and school enrollment. While the research team had access to publicly available data on enrollment, graduation rates, truancy, and standardized test scores—where the researchers uncovered valuable connectivity to modernization status in three of the four measures—schools and school districts routinely collect a wealth of additional data that could lend further support for the modernization of school facilities. Data on such things as the quantity and purpose of student visits to the school nurse, incident reports of bullying, and teacher and staff/administrator recruitment and retention rates, for example, could provide insights into whether teachers, staff/administrators, and students in modernized schools have more positive well-being and performance outcomes than their peers in non-modernized schools.
- Consider recruiting teachers and students as data collectors so they can use the experience as a learning opportunity.

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We welcome further inquiry about the study and how to apply the findings to the modernization of schools.

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