Re-Analysis Report

Daylighting in Schools, Additional Analysis

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EXECUTIVE SUMMARY

This report is a follow-on study to the Daylighting in Schools study1 that was completed in 1999, which found a compelling statistical correlation between the amount of daylighting in elementary school classrooms and the performance of students on standardized math and reading tests. This re-analysis of the original study data was intended to answer key questions raised by the peer review of the earlier study, and expand our understanding of methodological choices for further work.

The original findings potentially have very important implications for the design of schools and other buildings where people live, work and play. Daylight used to be common, and even required in schools, homes and offices, but fully daylit buildings became increasingly rare as electric lighting became more the norm. This re-analysis study helps to provide greater certainty for the original findings.

For this re-analysis study HMG conducted four tasks:

The **Teacher Survey** collected information from a sample of teachers in the Capistrano school district about their education and experience levels, preferences for classroom features and operation of those features. The primary purpose of the survey was to provide input to a subsequent "assignment bias" analysis. In addition, we learned some useful information about teacher preferences, attitudes and behaviors in response to classrooms conditions.

While the teachers we surveyed generally had a preference for windows, daylight and views in their classrooms, these preferences were not found to be driving classroom preferences. Far more important was an almost universal desire for more space, a good location, quiet, lots of storage and water in the classroom.

Environmental control was also found to be an important issue for teachers, especially for those who did not have full control. Teachers seemed to hold a basic expectation that they would be able to control light levels, sun penetration, acoustic conditions, temperature and ventilation in their classrooms. They made passionate comments about the need for improvement if one or more of these environmental conditions could not be controlled in their classroom.

The Teacher **Bias Analysis** further examined information from the Teacher Survey. The survey data was coded into variables and statistically analyzed in relation to both assignment to daylit classrooms and the student performance models. The goal of the Bias Analysis was to discover if the original study had over-inflated the effect of daylight on student learning by not accounting for a potential "assignment bias" of better teachers to more daylit classrooms.

We conclusively found that there was not an "assignment bias" influencing our results. None of the individual teacher characteristics we identified were significant in explaining assignment to a daylit classroom in the Capistrano District. Considering all teacher characteristics together only explained 1 % of the variation in assignment to daylit classrooms. We did find that a few types of teachers, those with more experience or

1 Heschong Mahone Group (1999). Daylighting in Schools. An investigation into the relationship between daylighting and human performance. Detailed Report. Fair Oaks, CA. (http://www.h-m-g.com/Daylighting/daylighting and oroductivitv.htm)

honors, were slightly more likely (1 %-5%) to be assigned to classrooms with more windows or some types of skylights.

When we added the teacher characteristics to the original student performance models, the daylight variables were not reduced in significance. Further analysis of other sub-populations repeated these findings. Among twelve models considered, we identified a central tendency of a 21 % improvement in student learning rates from those in classrooms with the least amount of daylight compared to those with the most.

In the **Grade Level Analysis,** we re-analyzed the original student test score data for both Capistrano and Seattle by separate grade level, instead of aggregating the data across the four grade levels (2-5). Our goal was to determine if this method would more accurately explain the relationship of student performance to daylighting. We tested for statistical significance and correlation, and we looked at any patterns discovered in the analysis.

The data did not show any significant patterns between a daylight effect and the separate grade levels, neither an increase or decrease in daylight effects by grade level. Thus, we conclude that there do not seem to be progressive effects as children get older, nor do younger children seem to be more sensitive to daylight than older children. Allowing the results to vary by grade did not noticeably improve the accuracy of the models. Therefore, we conclude that looking at data across grade levels is a sufficiently accurate methodology.

In the **Absenteeism Analysis,** we used absenteeism and tardiness data in the original Capistrano data set as dependent variables and evaluated them against the full set of explanatory variables from the original study, plus the new information on teacher characteristics. These models would allow us to assess whether daylighting or other classroom physical attributes potentially impacted student health, as measured by changes in student attendance.

Student attendance data is certainly not the best indicator of student health. Yet to the extent that attendance data does reflect student health, our findings do not suggest an obvious connection between physical classroom characteristics and student health. Notably, daylighting conditions, operable windows, air conditioning and portable classrooms were not found to be significant in predicting student absences.

Overall, the strength of the daylight variable in predicting student performance stands out sharply across all of these re-analysis efforts.

This analysis also demonstrated that the findings of these models are more strongly dependent upon the sample population then the subtleties of the explanatory variables. Thus, we believe that it will be more informative to replicate this study with a different population, to continue to try to refine the models with further detail in the explanatory variables.