2015

Green School, Healthy School? The Role of Children in Post-Occupancy Evaluation to Determine Indoor Air Quality in Classrooms

Andrea Wheeler
Iowa State University, andrea1@iastate.edu

Ulrike Passe
Iowa State University, upasse@iastate.edu

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Abstract
Issues of internal and external air pollution, common diseases afflicting children, and concerns for optimizing learning potential are all important factors to consider in post-occupancy evaluations of air quality in schools. However, children's perspectives on air quality are largely overlooked. Developing an appropriate methodology to include children is both important and institutionally difficult. This paper examines child-friendly methods of conducting post-occupancy examination of indoor air quality in school settings. It proposes interdisciplinary work on post-occupancy methodologies, engaging with social-science literature on research with children. The paper identifies barriers to the development of an inclusive post-occupancy methodology that can collect both qualitative and quantitative data. It also incorporates children's experiences by citing research findings from a pilot project that is taking place in a central Iowa school.

Keywords
School design, healthy buildings, sustainable, post-occupancy, indoor air quality

Disciplines
Architectural Engineering | Architectural Technology

Comments
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GREEN SCHOOL, HEALTHY SCHOOL? THE ROLE OF CHILDREN IN POST-OCCUPANCY EVALUATION TO DETERMINE INDOOR AIR QUALITY IN CLASSROOMS (DO NOT CITE WITHOUT PERMISSION OF AUTHORS)

Andrea WHEELER[1,*], Ulrike PASSE[1]

[1]Department of Architecture, Iowa State University, Ames, Iowa, USA

[*]Corresponding email: andrea1@iastate.edu

Keywords: SCHOOLS, Air Quality, Design, Air Pollutants, Post-Occupancy Evaluation

SUMMARY

Issues of internal and external air pollution, common diseases afflicting children, and concerns for optimizing learning potential are all important factors to consider in post-occupancy evaluations of air quality in schools. However, children's perspectives on air quality are largely overlooked. Developing an appropriate methodology to include children is both important and institutionally difficult. This paper examines child-friendly methods of conducting post-occupancy examination of indoor air quality in school settings. It proposes interdisciplinary work on post-occupancy methodologies, engaging with social-science literature on research with children. The paper identifies barriers to the development of an inclusive post-occupancy methodology that can collect both qualitative and quantitative data. It also incorporates children's experiences by citing research findings from a pilot project that is taking place in a central Iowa school.

INTRODUCTION

Air pollution poses a serious risk to the health of children all over the world. More than half of the body's intake of pollutants is inhaled indoors, and children are particularly vulnerable due to their smaller size. However, in most cases the only indoor air monitoring in schools involves CO_2 levels; the wider problems posed by airborne pollutants, which can be more threatening to children's health, are generally not emphasized. The World Health Organization (WHO) recognized the right to clean air in its 1987 publication *Air Quality Guidelines for Europe*, which contained risk assessments for 28 chemicals; however, not until 2010 did the WHO actually cover indoor air quality (IAQ). Even though children are more vulnerable to pollutants than adults, the air inside buildings such as schools can often be more polluted than the air outside (Chatzidiakou et al., 2014; Jovanovic et al., 2014; Bayer et al., 1999; Almeida et al., 2011).

Children are more vulnerable to airborne pollutants because their developing lungs breathe more air in proportion to their body size, and they are relatively incapable of communicating any concerns to those responsible for ensuring air quality. Environmental exposure to high levels of pollution can have long-term adverse consequences for children. Absence from school due to respiratory illnesses and asthma has deleterious educational consequences. For these reasons, the significance of achieving the optimum level of air quality in schools may be greater than in any other type of building. Post-occupancy evaluations of school building are however, not often carried out by design teams despite their potential as useful feedback mechanisms. Post-occupancy evaluation consists of processes of assessment of buildings that have been occupied for some time and typically includes: surveys of building occupants; interviews or observations of occupants; performance measurements in terms of energy or

water consumption; and physical measurements (temperature, humidity, acoustics, artificial or daylighting). Nevertheless, innovative post-occupancy tools that can investigate questions relating air quality and children's comfort and well-being, through either quantitative measures or qualitative data, are rare (Baker, 2011; Mumovic et al., 2009; Pegg et al., 2005), and efforts to include all occupants, including children, in ways that permit them to engage fully with issues of building performance are exceptional (Kaatz et al., 2005). Mumovic et al. argue that post-occupancy methodologies in schools have to take account of the dynamic interaction between ventilation strategies and occupant related issues; however, methods do not generally engage children directly in their study (Mumovic et al 2009, 151). If we continue to rely on traditional methods of post-occupancy IAQ evaluation (as their users often argue is necessary for purposes of comparison) that survey only adult perspectives, such evaluations will always be biased in favor of adult experiences. Since children may feel the effects of poor IAQ in schools more acutely than adults, their perspectives should be included where possible. In their daily routines, children experience the school building differently from adults and may have important information about building performance that adults may lack. On the other hand, they may feel less control over their surroundings than adults have, and they are less likely to understand the technologies available to control air quality. Demand Control Ventilation (DCV) – increasingly being employed in school buildings – is particularly problematic in terms of IAQ as it can depend upon teacher's rather than children's actions (Wheeler, Boughlaghem, and Malekzadeh, 2011).

Levin (2005) contends that IAQ concerns have suffered due to a lack of a comprehensive assessment methodology. This is particularly the case in terms of energy-efficient buildings, where the need to include non-energy performance attributes such as IAQ in assessments is pressing (Persily and Emmerich, 2012). Uccil and Yu (2014) also argue that low-energy buildings pose particular problems, of which IAQ is one of the most typical. Nevertheless, they observe, the potential for indoor pollution caused by new materials, changes in behavior, lack of proper maintenance, or failure to apply suitable operational strategies is under-researched. Furthermore, the complexity of IAQ issues means that "the identification and development of suitable methods and tools for measurement of ventilation rates is critical … and the commonly used method of measuring carbon dioxide is not a fail-safe" (Uccil and Yu, 2014, p. 337).

METHODOLOGY

This paper introduces results from pilot studies being carried out in an Iowa school to develop a methodology that includes children in post-occupancy IAQ evaluations in school settings. The authors examine a variety of post-occupancy methods and consider questions of institutional research ethics and good research practice when working with children (Barratt Hacking et al., 2007; Percey-Smith et al., 2010; Darbyshire et al., 2005; Hill, 2006), so as to determine a method to collect both a wide variety of quantitative performance data and a record of children's perspectives on air quality in schools.

One of the authors has created a tool, the Mobile Data Acquisition System (MiDAS), which can measure a number of indoor environmental quality factors in the classroom. MiDAS is a portable armature for a series of environmental measurement devices, with an accompanying data recording system. MiDAS has been designed to measure accurately the stratification of temperature and airflow direction in full-scale indoor environments over time. It has already been tested in measuring dynamic flows of indoor environments using a series of vertical thermistors and surface temperature sensors to validate boundary conditions for computation fluid dynamic models; it can also be adapted to include a variety of other measuring devices. The

pilot studies carried out thus far have supplemented use of MiDAS with additional measurement criteria and qualitative data collection, and they have also included research activities designed to engage children in the data collection process.

Stevenson (2009, p. 128) has argued that it is desirable to have multiple methods of evaluation within post-occupancy assessment methods, as each building typology requires its own set of criteria. Stevenson indicates that one of the best approaches to post-occupancy evaluation is open questioning, which identifies hidden factors and tacit knowledge not revealed by structured questionnaires. However, using this unstructured method with children raises some difficulties. Moreover, researchers have challenged the uncritical use of social-science methods (such as focus groups and other forms of semi-structured questioning) with children as inappropriate, arguing instead for more "child-friendly" approaches. Such alternative approaches include art-based methods that are less dependent on verbal or written communication skills (Hall et al., 2011), "walk-through" methods (Watson and Thomson, 2005), and video ethnography (Pink, 2007, 2009). An emphasis on storytelling, a qualitative research technique frequently observed in healthcare, social work psychology, criminology, and linguistics, is common to all these approaches. The present researchers have developed methods incorporating these approaches and compared the resulting information with the measures obtained from the modified MiDAS tool.

RESULTS AND DISCUSSION

Full results from the pilot will be discussed in the conference presentation. Children's perception of air quality can reveal data about classroom performance that would otherwise be difficult or even impossible to uncover. Typically, maintaining appropriate CO_2 levels in classrooms is viewed as sufficient to address children's health and educational issues. Thus, new IAQ initiatives in school settings, such as "traffic light" monitors (green, yellow or red light indicates low, medium, or high levels of CO2 respectively) or windows that open automatically in response to readings from electronic sensors, have focused solely on CO_2 issues. The problem with this focus is that it overlooks children's comfort and other, more insidious anthropogenic pollutants such as VOCs and particulate matter that can cause longer-term health problems and lead to absences from school, thereby impacting children's educational performance more severely.

CONCLUSIONS

For many reasons, children are more vulnerable than adults to the effects of environmental contaminants. Use of both quantitative measures and qualitative assessment of building users' environmental experience is essential in order to ensure healthy schools. Research involving children requires attention to the practical, ethical, and institutional issues entailed. Our developing post-occupancy methodology, piloted in an Iowa school, combines quantitative with qualitative data collection and fully involves children, in a manner that is experimentally robust and can be reproduced in other school settings.

ACKNOWLEDGEMENTS

This paper is based on work supported by the National Science Foundation under Grant Number EPS-1101284 and an Iowa State University startup grant to Professor Wheeler.

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