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The Problem

The Cause

The Consequences

Recent data suggest that poor IAQ can reduce a person's ability to perform specific mental tasks requiring concentration, calculation or memory.

Indoor Air Quality and Student Performance

How Does Indoor Air Quality Affect A Child's Ability To Learn?

Poor indoor air quality (IAQ) can cause illness requiring absence from school, and can cause acute health symptoms that decrease performance while at school. In addition, recent data suggest that poor IAQ can reduce a person's ability to perform specific mental tasks requiring concentration, calculation, or memory.

Air in most indoor environments contains a variety of particles and gaseous contaminants. These contaminants are commonly referred to as *indoor pollutants* when they affect human health and performance. Indoor temperature and relative humidity can also affect health and performance directly, and can affect human performance indirectly by influencing the airborne level of molds and bacteria.

Most often, poor indoor air quality results from the failure to follow practices that help create and maintain a healthy indoor environment. Common examples include failure to:

- Control pollution sources such as art supplies and laboratory activities
- Control temperature and humidity
- Control moisture and clean up spills
- Ventilate each classroom adequately
- Adequately perform housekeeping and maintenance operations
- Use integrated pest management to minimize the use of pesticides

Failure to deal adequately with any of these issues may go unnoticed, but can and often does take its toll on health, comfort, and performance.

Specific Studies

Schools should be designed, built, and maintained in ways to minimize and control sources of pollution, provide adequate exhaust and outdoor air ventilation by natural and mechanical means, maintain proper temperature and humidity conditions, and be responsive to students and staff with particular sensitivities, such as persons with allergies or asthma. Adverse consequences can easily result when IAQ problems are not addressed properly.

Effects from Building-Related Illnesses

Children do not perform as well when they are sick or absent from school. Indoor air quality problems can result in absences because of respiratory infections, allergic diseases from biological contaminants, or irritant reactions to chemicals used in virtually every part of the school. Some conditions in the school environment are closely associated with the incidence of sick building syndrome and asthma symptoms[1,2], and asthma-related illness is one of the leading causes of school absenteeism, accounting for over 10 million missed school days per year.[3] In addition, persons with asthma or other sensitivities may

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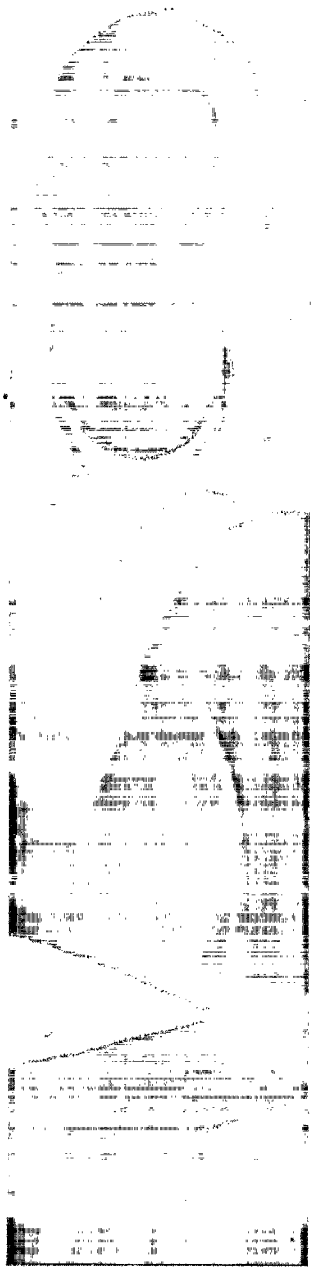

have reduced performance in the presence of environmental factors that trigger their asthma. All of these "building-related illnesses" result from the lack of effective indoor environmental quality management. In extreme cases, schools sometimes have to be closed until problems are investigated and solved.

Effects from Mild Symptoms of Distress

What about people who do not have a diagnosable illness, but simply don't feel well? People may report feeling lethargic, having headaches, having a mild sore throat or itchy eyes; or they may have a sense that the air is "stale," "stuffy," or "too dry." When these types of symptoms are made worse by being in a building, they are referred to as "sick building syndrome."

Estimated Loss in Performance

Motivation can often overcome small burdens of environmental stress so that children's performance may not decline. However, continued environmental stress can drain children's physical and mental resources and ultimately affect their performance. Evidence from office workers suggests that when individuals experience just two symptoms of discomfort, they begin to perceive a reduction in their own performance. That perception increases as the number of symptoms increases, averaging a 3% loss with 3 symptoms, and an 8% loss with 5 symptoms.[4] It follows that when large numbers of students and staff experience signs of discomfort related to the air inside their school, teaching and learning performance will likely degrade over time.

Measured Loss in Performance

Studies relating direct performance measurements to changes in indoor air quality are just now emerging. For example, a recent European study of 800 students from eight different schools provides data on IAQ, health symptoms, and students' ability to concentrate.[5] In the study, carbon dioxide measurements were taken in the classrooms, and students were given a health symptom questionnaire. A computer-based program scored their ability to concentrate. Carbon dioxide itself is not a health threat at levels found indoors, but since the main source of carbon dioxide in buildings is exhaled breath, and the main mechanism for removal is ventilation, high carbon dioxide levels in classrooms are an indication of low ventilation rates and, therefore, high levels of pollution. In classrooms where carbon dioxide levels were high (low ventilation rates), student scores on the concentration tests were low; and their health symptom responses were high. The results were statistically significant and tend to confirm that with IAQ management, including source control and adequate ventilation, student performance can improve.

Another controlled study of adults shows a similar relationship between the presence or absence of an indoor pollution source, health symptoms, and mental function.[6] In this study, a health symptom questionnaire was completed by 30 female subjects who performed various kinds of mental tasks typical of office work in groups of six at a time. They worked in a realistic office environment specifically designed to have good IAQ, with low pollution levels. Because carpeting that is not adequately maintained can sometimes act as a source of pollution, a 20-year-old used carpet from another building was used to represent a potential pollution source. The carpet was periodically introduced on racks behind a screen so that subjects had no way of knowing when the carpet was present. The women were tested in typing, arithmetic, logical reasoning, memory, and creative thinking during several trials with and without the carpet present. During the trials without the pollution source, the subjects' performance was improved. The number of words typed increased 6.5%*, typing errors were reduced by 5%***, the addition test scores increased 3.8%**, and logical reasoning test scores improved by 3-4%***. When the pollution source was present, there

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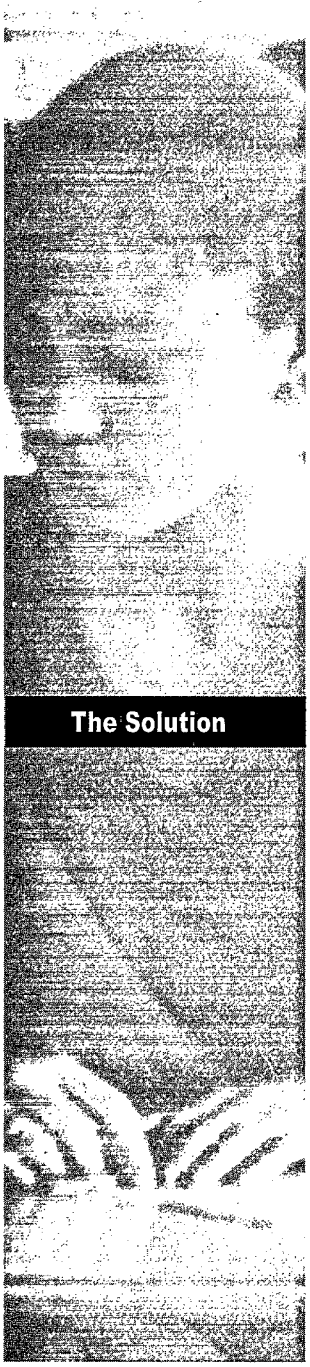

The Solution

was an increased prevalence of headaches during tasks requiring concentration, suggesting that at least part of the affect on performance was from pollution-related adverse health effects. In a later study using the same procedure, increasing ventilation rates also provided a statistically significant improvement in human performance.[7]

*** Statistically significant at 99%; ** at 95%; and *** at 90%**

Measured Effects of Temperature and Humidity

In addition to indoor pollution and ventilation, studies confirm that various human activities such as typing or driving a vehicle are diminished when people are demonstrably too cold or too hot. Temperature is also implicated in studies of sick building syndrome. Maintaining temperature at the high end of the comfort zone tends to increase symptoms, while temperatures at the low end of the comfort zone tend to reduce symptoms. Similarly, individuals perceive the quality of the indoor air to be better when temperature and/or humidity are toward the low end rather than the high end of the comfort zone.[8, 9, 10]

There is also good evidence that moderate changes in room temperature, even within the comfort zone, affect children's abilities to perform mental tasks requiring concentration, such as addition, multiplication, and sentence comprehension. Study results were different for boys and girls, and the effects varied for different types of tasks. But, in general, the evidence strongly supports the need to avoid extreme conditions and to provide for as much individual temperature control as possible.[11, 12]

Will Performance Be Affected Even If No One Is Complaining?

Performance can certainly be expected to suffer if conditions are serious enough for people to complain. However, the lack of complaints is NOT an indication that performance cannot be improved. For example, in the above studies, symptoms were solicited through questionnaires (as opposed to complaints), and tests were performed on individuals in typical kinds of school and office environments. That is, the reductions in performance were recorded in circumstances that could easily have gone unnoticed because of the absence of complaints.

What You Can Do

School systems should take advantage of available programs such as the ***IAQ Tools for Schools*** **Kit** to improve and maintain good indoor air quality in their schools. Programs can be targeted to the maintenance of existing school facilities and to new school construction.

The U.S. Environmental Protection Agency has published voluntary guidance that addresses indoor air quality in schools. The ***IAQ Tools for Schools*** **Kit**, is designed to be a no-cost, or low-cost approach to improving indoor air quality. The Kit is free to schools and school districts. To order the Kit:

EPA Kit
PO Box 37133
Washington, DC 20013-7133
Fax: 703-356-5386 or call: 1-800-438-4318

Visit the *IAQ Tools for Schools* web site at **www.epa.gov/iaq/schools** and download the Kit, learn about training opportunities, and read about schools around the country who are using the Kit.

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