DOCUMENT RESUME

ED 453 643 EF 005 937

| | |
|---|---|
| AUTHOR | Berry, Michael A. |
| TITLE | Educational Performance, Environmental Management, and Cleaning Effectiveness in School Environments. |
| PUB DATE | 2001-03-00 |
| NOTE | 11p. |
| AVAILABLE FROM | For full text: http://www.carpet-schools.com/studies.htm. |
| PUB TYPE | Guides - Non-Classroom (055) |
| EDRS PRICE | MF01/PC01 Plus Postage. |
| DESCRIPTORS | *Academic Achievement; *Cleaning; *Educational Environment; Elementary Secondary Education; Public Schools; Student School Relationship |
| IDENTIFIERS | *Building Maintenance |

ABSTRACT

This paper briefly discusses research on the negative impact of indoor air environments within educational facilities and the positive impact of a scientifically based cleaning process. Included is a form for calculating the environmental performance for a school environment and definitions of relevant terms. Final sections discuss building management and cleaning and list the principles of cleaning effectiveness in school environments. (GR)

# Educational Performance, Environmental Management, and Cleaning Effectiveness in School Environments



By

**Dr. Michael A. Berry**
**March 2001**



**Dr. Michael A. Berry is a Research Professor at the University of North Carolina at Chapel Hill where he teaches and writes on business and environment, built environments, and environmental management systems. His is currently focusing his research in the area of school environments. Dr. Berry retired from the US Environmental Protection Agency in 1998 where as a senior manager and scientist he served as the Deputy Director of National Center for Environmental Assessment at Research Triangle Park, NC. Between 1985 and 1994 he served as EPA's manager for indoor air research. Visit his website www.DrMABerry.com or contact him at DrMABerry@aol.com.**



## Introduction

The focus on indoor environments has evolved from an initial discussion on indoor air to a comprehensive view that recognizes that total environmental quality is related to human performance indoors. This perspective is growing in importance to school systems around the nation, especially as it relates to the health protection and educational performance of students and teachers. It is becoming increasingly recognized that the indoor environments of schools are directly related to human health, image, self-esteem, and attitude, all of which affect academic performance. The environmental management of school facilities has not previously received priority attention. However, there will be a growing demand and need on the part of schools, school districts, and education departments to demonstrate the educational contribution of effective and cost-efficient strategies for managing the indoor environments of schools.

There is clear evidence that a scientifically based cleaning process provides an immediate improvement in the indoor environmental quality of schools. Through an organized environmental management program that emphasizes effective cleaning, exposure to a range of microorganisms, particles, and other harmful substances are reduced. Based on previous research, there is every reason to anticipate a reduction of adverse health effects and environmental impact.



But most importantly, the enhanced management and cleanliness of school environments sends a "we care message to students, teachers, and staff". The evidence suggests that environmental conditions shape attitudes and eventually performance, especially attendance.

To date no school system has examined the relationship of cleaning effectiveness and performance. School authorities and facility managers have an opportunity to become

leaders in management of school environments especially through cleaning effectiveness programs.

A body of technical knowledge currently exists so as to begin the immediate training of school administrators and facility managers in the issues associated with improved to indoor environmental quality of schools, safe and effective facilities management, cleaning and maintenance procedures, and the benefits derived form effective cleaning procedures.

The results of research in the area of cleaning effectiveness programs and environmental improvements in schools and school like environments indicate cleaning procedures that have been highly successful in reducing levels of biocontaminants, particulate matter, and gas phase organic compounds.

Previous studies have shown that cleaning, maintenance and restoration, when consistently implemented are cost effective and can lead to measurable environmental improvements. For example, an EPA sponsored study, "The Total Building Cleaning Effectiveness Study," conducted by RTI in collaboration with the professional cleaning industry, demonstrated for the first time, that an organized cleaning program contributes to reductions in particles, volatile organic compounds (VOCs), and biological pollutants in excess of 50%.

We are now in a position to demonstrate that effective cleaning programs enhance school and student positive self image, and may promote overall higher academic attendance and performance.

## Performance Measures for School Environments

| Focus | Educational Performance Measures |
|---|---|
| | Absenteeism |
| | Chronic Schedule Changes |
| | Disciplinary Incidents |
| | Disruptive Classroom Behavior |
| | Health and Accident Reports |
| | Health Behaviors |
| | Risk Behaviors |
| | Academic Achievement (Long Term Study) |
| | Attitudes |
| | Perception of the School Environment |
| | Experience of Violence/Theft/harassment |
| **Teachers and Other Staff** | Absenteeism |
| | Reports of Disruptive Classroom Behavior |
| | Health and Accident Reports |
| | Health Behaviors |
| | Attitudes |
| | Perception of the School Environment |
| | Experience of Violence/theft/ Harassment |
| **School Organizations** | School Climate |
| | Organizational Health Inventory |
| | School Health Questionnaire |
| | PTA Budget |
| | Parent Perceptions of the School Environment |
| | Parent Reports of Violent/Disruptive Behavior |

**Environmental Measures for School Environments**

A comprehensive environmental management and cleaning program may potentially influence all of the parameters listed below.

| Parameter | | Air | Surface | Dust |
|---|---|---|---|---|
| **Comfort/Environmental** | | | | |
| | Temperature | X | | |
| | Relative Humidity (RH) | X | | |
| | Carbon Dioxide ($CO_2$) | X | | |
| | Light | X | | |
| | Noise | X | | |
| **Building/HVAC** | | | | |
| | Percent Outdoor Air | X | | |
| | Air Flow | X | | |
| | Air Exchange Rate | X | | |
| | Building Pressure | X | | |
| | Operating and Maintenance (O&M) | | | |
| | Location of Air Intakes | | | |
| | Filtration | | | |
| | Air Duct Condition | | | |
| | Water Damage | | | |
| **Contaminants** | | | | |
| | Bacteria | X | X | X |
| | Fungi | X | X | X |
| | Mite and Cockroach Antigens | X | | X |
| | Endotoxins | | | X |
| | 1,3 Glucans | | | X |
| | TVOCs | X | | |
| | Formaldehyde | X | | |
| | Lead | | | X |
| | Carbon Monoxide (CO) | X | | |
| | Asbestos | X | X | X |
| | Pesticides (General) | X | X | X |
| | Particulate Matter($PM_{10}$ and $PM_{2.5}$) | X | | |
| | Particle Counts | X | | |

## Environmental Measurements

### Comfort/Environmental

**Carbon Dioxide ($CO_2$)** - Carbon dioxide is a product of human respiration. Without sufficient ventilation, levels can increase and people may become sleepy.

**Light** - There should be enough light to perform tasks. However, glare, especially on computer monitors often gives people headaches.

**Noise** - Excessive noise causes people to be distracted.

**Relative Humidity (RH)** - Moderate relative humidity is the most comfortable for people. High humidity may aid in the growth of microorganisms.

**Temperature** - Most people are comfortable in a temperature range of 68-74°F. High and low temperatures often cause discomfort and complaints.

**Building/HVAC (Heating, Ventilation and Air Conditioning)**

**Air Duct Condition** - Air ducts often become dirty. Ducts are a good place for microorganisms to grow.

**Air Exchange Rate** - The rate at which the air in a room or building is replaced.

**Air Flow** - The speed at which air is circulating in a building. People do not like it to be too drafty or too stuffy.

**Building Pressure** - If there is a slight positive pressure, it is less likely that air pollutants from outside will enter the building through windows and doors.

**Filtration** - HVAC systems should include filtration. Filters must be maintained and/or replaced on a regular schedule.

**Location of Air Intakes** - Pollution or bad odors may enter a building if air is taken in from locations where garbage or chemicals are stored or where vehicles stand idling.

**O&M** - Operation and maintenance of the HVAC system. A routine maintenance schedule should be followed.

**Percent Outdoor Air** - Outdoor air is brought into the building and mixed (generally) with air that has been recirculated. A higher percentage of outdoor air may increase energy costs as the air must be heated or cooled or have moisture reduced. However, people generally prefer at least some outdoor air, unless it is very polluted.

**Water Damage** - Water damaged areas generally provide both food and moisture for fungi to grow. Wet areas should be dried immediately.

**Contaminants**

**Asbestos** - Asbestos was used in insulation and flooring. Long-term exposure to asbestos fibers is associated with a risk of chest and abdominal cancers and lung diseases.

**Bacteria** - Environmental and disease-causing single-celled microorganisms. Environmental bacteria are isolated from dirt, soil, water and other sources and may be measured as indicators of cleanliness. Environmental bacteria are also monitored as surrogates or representatives of the disease-causing organisms. Infectious diseases are caused by bacteria and viruses, such as flu, measles, chicken pox, and tuberculosis, and may be spread indoors. Most infectious diseases pass from person to person through physical contact.

**1,3 Glucans** - 1,3 Glucans are components of the cell walls of plants, fungi and certain bacteria and can be used to monitor for molds even when the organism is dead. An association between the amount of airborne 1,3 glucans and the extent of nasal and throat irritation and hoarseness has been demonstrated.

**Endotoxins** - Endotoxin is a lipopolysaccharide component of gram-negative bacteria cell walls. Endotoxins may serve as a marker or indicator of bacterial contamination but are also responsible for adverse health effects. When inhaled, endotoxins cause inflammation; they have been associated with aggravation of asthma and the clinical severity of asthma.

**Formaldehyde** - Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products. Sources of formaldehyde in the home include building materials, smoking, household products, and the use of unvented, fuel-burning appliances, like gas stoves or kerosene space heaters. At low levels, formaldehyde may cause eye and respiratory irritation. High concentrations may trigger attacks in people with asthma. Because of health concerns, many wood products, materials, and glues have reduced or eliminated the formaldehyde used.

**Fungi** - Mold and mildew are often problems in building. They may grow on building materials and furnishings if there is sufficient moisture. Exposure to fungi have been associated with allergies, hypersensitivity pneumonitis and asthma. Some fungi produce mycotoxins that are very harmful.

**Lead** - Old lead-based paint is the most significant source of lead exposure in the U.S. today. Lead affects practically all systems within the body. At high levels it can cause convulsions, coma, and even death. Lower levels of lead can adversely affect the brain, central nervous system, blood cells, and kidneys.

**Mite and Cockroach Antigen** - Many people are sensitive or allergic to dust mite and/or cockroach antigen. Respiratory symptoms are common with these allergies. It is thought that exposure to these antigens is one of the primary causes of the recently documented increase in asthma among children.

**Particle Counts** - Particles are solid or liquid substances that are light enough to be suspended in the air, the largest of which may be visible in sunbeams streaming into a

room. However, smaller particles that you cannot see are likely to be more harmful to health. Particles of dust, dirt, or other substances may be drawn into the building from outside and can also be produced by activities that occur in buildings, like sanding wood or drywall, printing, photocopying, operating equipment, and smoking.

**Pesticides** - Both the active and the inert ingredients in pesticides can be organic compounds; therefore, both could add to the levels of airborne organics inside buildings. Exposure to high levels of cyclodiene pesticides, commonly associated with misapplication, has produced adverse health effects including nausea.

**$PM_{10}$ and $PM_{2.5}$** - These refer to measurements of the mass of particles with sizes below 10 micrometers and below 2.5 micrometers. The smaller particles will get further into the lungs. Small (respirable) particles cause eye, nose, and throat irritation; respiratory infections; and bronchitis. Extended exposure may lead to lung cancer.

**TVOCs** - The ability of organic chemicals to cause adverse health effects varies greatly from those with no known health effects to those causing extreme illness. Measuring the total volatile organic compounds (TVOCs) is a way to easily determine chemicals in the air. These chemicals come from cleaning products, art supplies, color printers, and other products. At low levels, they may cause eye irritation, light-headiness, fatigue, or perceived poor air quality.

**Building Management and Cleaning**

Cleaning is the process of locating, identify, containing, removing, and properly disposing of an unwanted substance from a surface or environment. Cleaning is the most fundamental indoor environment management strategy. Cleaning, especially as it is applied to school environments, should be organized, scheduled, and focused on achieving specific objectives, especially those related to health protection and maintenance or restoration of valuable property. The cleaning process should be coordinated with other basic environmental management strategies: source control, activity management, dilution, and design intervention.

Prior to any possible benefits from an organized cleaning process, the built environment must be in such condition that cleaning will reduce exposures. The first step of an effective cleaning program is to configure the school environment so it can be cleaned effectively. Schools must identify and prioritize environmental management and restoration needs. Examples include HVAC, roof leaks, toxic substances such as lead, asbestos, organics, standing water, ambient sources.

Schools must assess the contributions of current cleaning and maintenance practices to include over all cleaning (extraction) effectiveness, barriers such as walk off mats, supplies, equipment and condition, and custodial training and competency.

An organized school cleaning program based upon environmental management principles and fundamental environmental protection guidelines will contribute to a significant improvement in indoor environmental quality through the general reduction of biological pollutants, total suspended particulate matter, and total volatile organic compounds.

**Principles of Cleaning Effectiveness in School Environments**

(Based on ***Protecting the Built Environment Cleaning for Health***, by Michael A. Berry, Ph.D.

**Cleaning should always follow fundamental environmental management and protection guidelines:**

- Provide for safety
- Clean for health first and appearance second
- Clean in relation to improving the total environment
- Maximize the sanitation of surfaces and the extraction for pollutants (particles, gas, and biopollutants) from the building envelope
- Minimize chemical, particle, and moisture residue
- Minimize human exposure to pollutants
- Dispose of cleaning wastes properly.

The following indicates how environmental protection guidelines should be applied to school environments as part of an improved cleaning program. These actions and considerations, where they currently do not exist, should be integrated into the school building operating and maintenance procedures.

**Provide for Safety**

- Cleaning should be conducted in unoccupied environments.
- All toxic materials related to cleaning should be kept away from adult occupants and children.
- All physical hazards must be removed.
- Blood-borne pathogens should be treated separately from other managed wastes in the building, following universal precautions.

**Clean for Health First**

- The primary objective of all cleaning conducted in a school building is to guard the health of the occupants. All school cleaning programs should be designed and implemented with this basic principle in mind.
- Cleaning should complement, not replace, basic hygiene practices such as frequent hand washing, surface disinfecting, effective waste disposal, management of communicable diseases, and adherence to universal precautions.
- Effective disinfectants should be used regardless, for example, of their bleaching effect on fabrics.
- When contaminants—fungi, for example—are observed, they should be removed to the maximum extent possible.

**Clean in Relation to Improving the Total Environment**

- Cleaning frequency and intensity should be in proportion to the level of human activity in the various parts of the building.
- The ventilation system should be kept clean and balanced to improve air quality and circulation through the building.
- The proper management and storage of food in the building must be guaranteed.
- Water-damaged areas of the building should be identified and repaired as soon as possible.

**Maximize the Sanitation of Surfaces and the Extraction of Pollutants from the Building Envelope**

- Desk tops, tables, lunch counters, lavatories, water fountains, light switches, keyboards, and phones should be sanitized daily.
- Maintenance staff should be equipped with state-of-the-art vacuums to remove particles.
- Vacuum bags with high collection efficiencies should be used.
- High-temperature hot water extraction cleaning should be used to clean all carpets in the building, followed by rapid drying through improved ventilation and/or fans.
- Routine dust collection should done with damp dust cloth. Dust cloths should be disposable or laundered frequently. For hard surface floors, a damp dust mop should be used and either replaced or washed often.

- School staff should be equipped with special wet-process cleaning machines to immediately clean up after accidents. Universal precautions should be used for cleaning up blood or human wastes.

**Minimize Chemical Particle and Moisture Residue**

- Rapid drying must be achieved through improved ventilation and, in some cases, fans. This applies to carpet cleaning, water spills, or other water damage.
- Dry cleaning powders, such as those used on widespread surfaces such as carpet, should be avoided.
- Many volatile organic compound (VOC)-based cleaning agents can be replaced with water-based solutions.
- Extraction chemicals, particles, and moisture residue can be improved with more efficient equipment and cleaning systems.

**Minimize Human Exposure to Pollutants**

- Walk-off mats should be placed at all entrances to trap pollutants. These should be cleaned or replaced often.
- High-efficiency filters should be used in vacuums to achieve maximum extraction to reduce human exposure during cleaning.
- Accidents involving body fluids should be cleaned up immediately, following universal precautions.
- Nontoxic cleaning agents should always be used. All maintenance and cleaning staff should be trained in their proper use.

**Properly Dispose of Cleaning Wastes**

- All cleaning wastes should be disposed of in the sewage treatment or solid waste management system.
- Human wastes must be managed separately from other wastes.

**U.S. Department of Education**
*Office of Educational Research and Improvement (OERI)*
*National Library of Education (NLE)*
*Educational Resources Information Center (ERIC)*

# REPRODUCTION RELEASE

(Specific Document)

## I. DOCUMENT IDENTIFICATION:

| | |
|---|---|
| Title: Educational Performance, Environmental Management, and Cleaning Effectiveness in School Environments | |
| Author(s): Berry, Michael A. | |
| Corporate Source: | Publication Date: 2001 |

## II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

*I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.*

**Sign here, → please**

| | |
|---|---|
| Signature: Michael A. Berry | Printed Name/Position/Title: MICHAEL A. BERRY |
| Organization/Address: | Telephone: 919-493-7409 FAX: 919-403-8921 |
| | E-Mail Address: MABERRY@NC.RR.COM Date: 6/18/2001 |

(over)

## III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

| |
|---|
| Publisher/Distributor: |
| Address: |
| Price: |

## IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

| |
|---|
| Name: |
| Address: |

## V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

National Clearinghouse for Educational Facilities
National Institute of Building Sciences
1090 Vermont Ave., N.W., Suite 700
Washington, DC 20005-4905

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

**ERIC Processing and Reference Facility**
**4483-A Forbes Boulevard**
**Lanham, Maryland 20706**

**Telephone: 301-552-4200**
**Toll Free: 800-799-3742**
**FAX: 301-552-4700**
**e-mail: ericfac@inet.ed.gov**
**WWW: http://ericfac.piccard.csc.com**

EFF-088 (Rev. 2/2000)