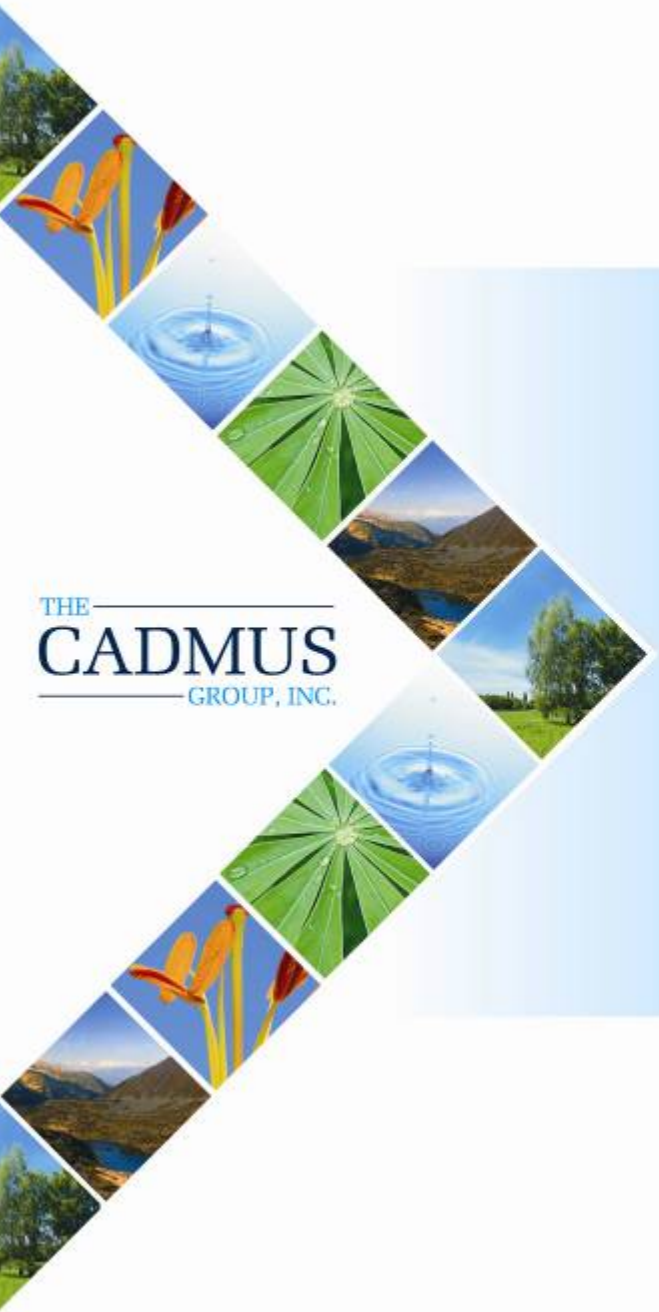


THE CADMUS GROUP, INC.

Third Annual State of High Performance Schools in Virginia Conference

Indoor Air Quality in Schools

Matthew S. Hiester

May 8, 2008

Goals and Objectives

- Define Indoor Air Quality
- Identify Major Causes of IAQ Problems
- Recognize Major IAQ Health Impacts
- Discuss Economic Costs of IAQ
- Hear About Cutting-Edge Research on IAQ and Student Performance
- Discuss links between IAQ and “Green”
- Learn Ways to Manage IAQ Issues

What is Indoor Air Quality?

- The temperature, humidity, ventilation, and chemical or biological contaminants of the air inside a building
- The indoor environment is a result of the interaction between the site, climate, building system, construction techniques, contaminant sources, and building occupants

Why Should We Care about the Indoor Environment?

- Most Americans spend about 90% of the their day indoors
- 53 million children and 6 million adults spend their days in the U.S. 120,000 school buildings
- ~1.2 million students and 96,000 teachers in 2,100 Virginia schools
- Indoor air pollutant concentrations can be many times greater than pollutants found in the outdoors and are unregulated
- Indoor air pollutants are consistently ranked among the top 4 greatest risks to human health

Scope of the Problem

- Poor IAQ is a major health, performance & facility maintenance issue for schools.
- Mold and other asthma triggers, chemicals (e.g., mercury), ventilation issues, etc. are commonly found in school buildings.
- Asthma is the leading cause of school absenteeism due to a chronic condition, accounting for 14,000,000 missed school days per year.

Scope of the Problem

- 75% of schools report needing to spend money on repairs, renovations, and modernizations to put schools' onsite buildings in overall good condition.
- The average public school building is 42 years old. School buildings typically begin rapid deterioration after 40 years, if not properly maintained.

Factors Contributing to Poor IAQ in Schools

- Inadequate Ventilation
- Building Materials and Furnishings
- Deferred (versus preventative) maintenance
- Varied Pollution sources
- Building occupants and their activities

Sources of Indoor Contaminants

- Outdoor Air Contaminants:
  - Emissions
  - Biologicals (e.g. mold, dust, pollen)
  - Soil Gases (e.g. radon)
- Equipment:
  - HVAC System
  - Office Equipment
  - Supplies
  - Special Use Areas

Sources of Indoor Contaminants

- Human Activities
  - Personal Activities
  - Housekeeping Activities
  - Maintenance Activities
- Building Components and Furnishings
  - Locations
  - Unsanitary Conditions
  - Water Damage/Uncontrolled Moisture
  - Chemicals

Consequences of Poor IAQ

- Health Impacts
- Reduced Learning and Productivity
- Higher Costs for Fixing Problems
- Poor Public Relations
- Liability

Potential Health Impacts

- Headache
- Fatigue
- Shortness of Breath
- Sinus Congestion
- Cough
- Sneezing
- Eye, nose, throat irritation
- Skin irritation
- Dizziness
- Nausea
- Infectious Disease
- Asthma Episodes
- Allergic reaction
- Death

“Sick Buildings” vs. Building Related Illness

- Sick Building Syndrome
  - Acute symptoms and comfort issue
  - Linked to time spent in building
  - Generalized symptoms
- Building Related Illness:
  - Symptoms linked to diagnosable illness
  - Direct attribution to environmental agents in the air

Economic Costs of Poor IAQ

- Decreased productivity
- Increased absenteeism
- Lower operating efficiency of equipment
- Emergency equipment
- Consultants during an IAQ “Event”
- Closing buildings/relocating occupants
- Negative impacts on student performance

EFFECTS OF THE PHYSICAL ENVIRONMENT ON STUDENT LEARNING

Glen I. Earthman
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
540-231-9715
earthman@vt.edu

PHYSICAL ENVIRONMENT & STUDENT ACHIEVEMENT

- Research on how school buildings influence student/teacher performance.
- A Decade and a Half of Work.
- So Many of School Buildings in Unsatisfactory Condition in US.
- Particularly Interested in Adverse Conditions and Student Achievement.
- In the Hopes School Authorities Would Act.

GREEN SCHOOL MEASURES

- Instrument Completed before Emphasis upon Green Schools or Sustainability.
- Included Green School Measures of AC, Lighting, Daylighting, Acoustics, Site.
- Other Measures – Condition of ceilings, furniture, lockers, science equipment.
- Wall colors, graffiti evidence, Auxiliary Buildings.

ASSESSMENT OF BUILDINGS

- Commonwealth Appraisal of Physical Environments (CAPE).
- Completed by Principals & Verified by Researcher for Accuracy.
- Were able to Determine Standard and Sub-Standard School Buildings Based upon CAPE.
- Compared Achievement of Students in Both Types of Buildings.

FINDINGS

- Students in Sub-standard Buildings Scored Below Students in Standard Buildings consistently.
- Differences ranged from 2% to 17% Depending upon the Sub-test.
- All Studies Found Significant Differences in Mathematics.
- Most Studies Found Significant differences in English, Science, & Social Studies

- Lanham (2000) – Elementary Students Grades 3 & 5.
- Different Statistical Methodology-Regression analysis.
- SES was Major Contributor to Student Learning.
- Found AC was the Next Contributing Factor in Student Learning.

FINDINGS

- This Means that Students in Sub-standard Buildings are Falling Behind Students in Standard Buildings.
- Do Students Fall Behind Year by Year?
- No Longitudinal Studies of Influence of Building on Student Achievement.
- Area of needed Research.

AC LONGEVITY & STUDENT ACHIEVEMENT

AC LONGEVITY & STUDENT ACHIEVEMENT

- Control of the Thermal Environment is VERY important to student learning and teacher productivity.
- Previous studies measured bodily functions -

  Blood Pressure, Cavities, Breathing, etc.
- Few studies used academic measures directly.
- No study has Looked at Longevity of AC

AC LONGEVITY & STUDENT ACHIEVEMENT

- How does AC Affect Student Performance and is there an Influence over a Period of Years?

- Two purposes of the study:

  1. How much influence does AC have upon student learning?

  2. Is there a long term effect of AC on student achievement?

AC LONGEVITY & STUDENT ACHIEVEMENT

- Surveyed principals – Find out if AC in the classrooms. Mailed survey to high schools.
- Principals asked if AC was in the classrooms.
- School Visitation.
- Result of Survey – 10 schools – 5 with AC and 5 without AC in Classrooms.
- Population of the study 10 small schools.

AC LONGEVITY & STUDENT ACHIEVEMENT

- Each school was small – R = 500-900 students.
- Each school located in a small community.
- Schools not subject to much immigration or emigration – Key to the population.
- Population was for most purposes same over six years of schooling.
- Schools were demographically similar- drop-outs, teacher preparation, minority, SES, pupil-teacher ratio.

AC LONGEVITY & STUDENT ACHIEVEMENT

- Mean scaled scores on Stanford Achievement Test used as Measures of Achievement.
- Ten sub-tests – Among them: English, Math, Science, Social Studies.
- Obtained scores for 4^{th}, 6^{th} , and 9^{th} grades.
- Same students over 6 years of learning.

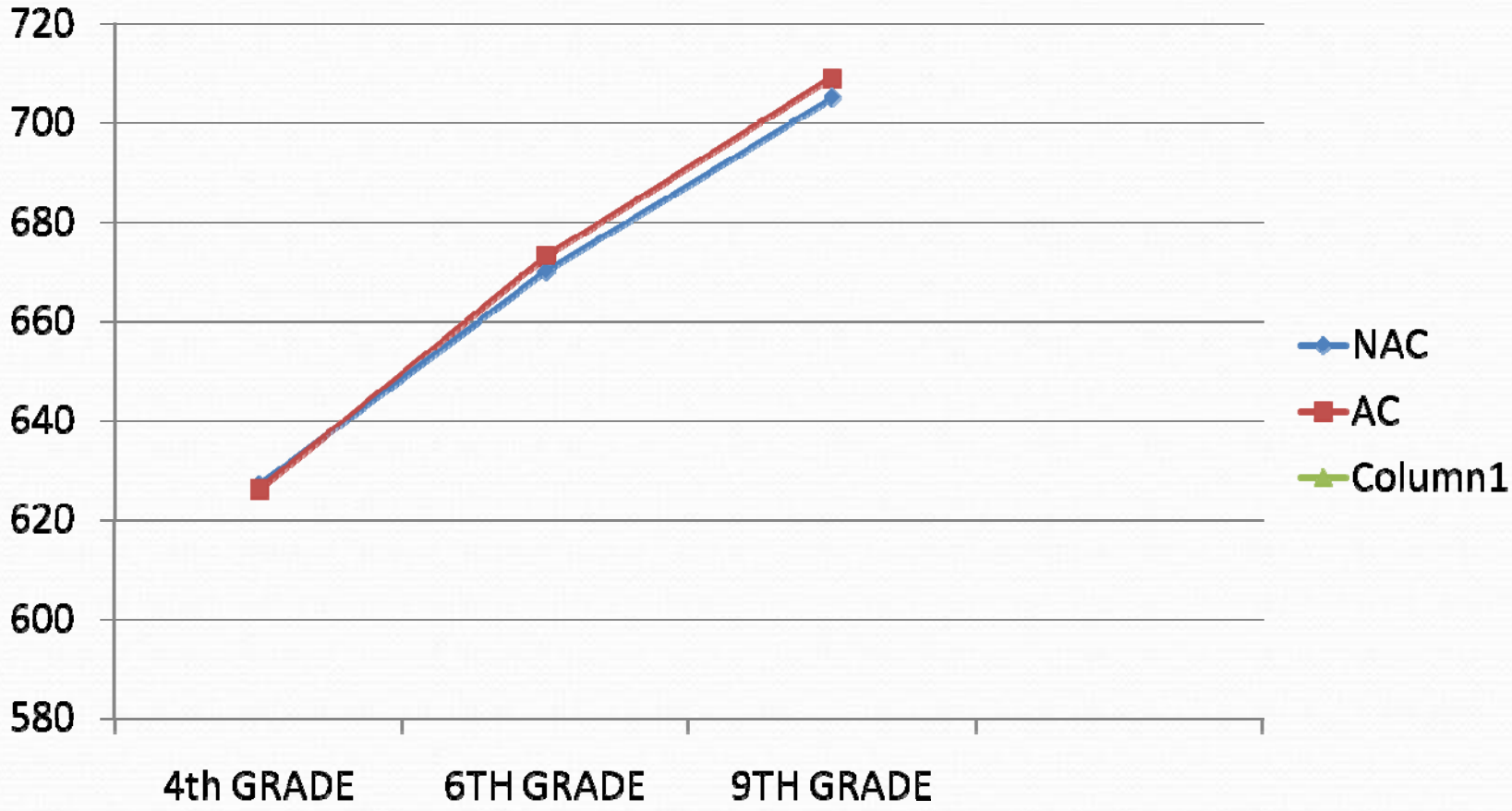
FINDINGS

- Time 1 was comparison between the scores of students in AC and Non-AC schools for each grade.
- Mean scores were higher in AC schools in all sub-tests, but not statistically significant.
- Some Mean scores in 4th grade not higher in AC schools.

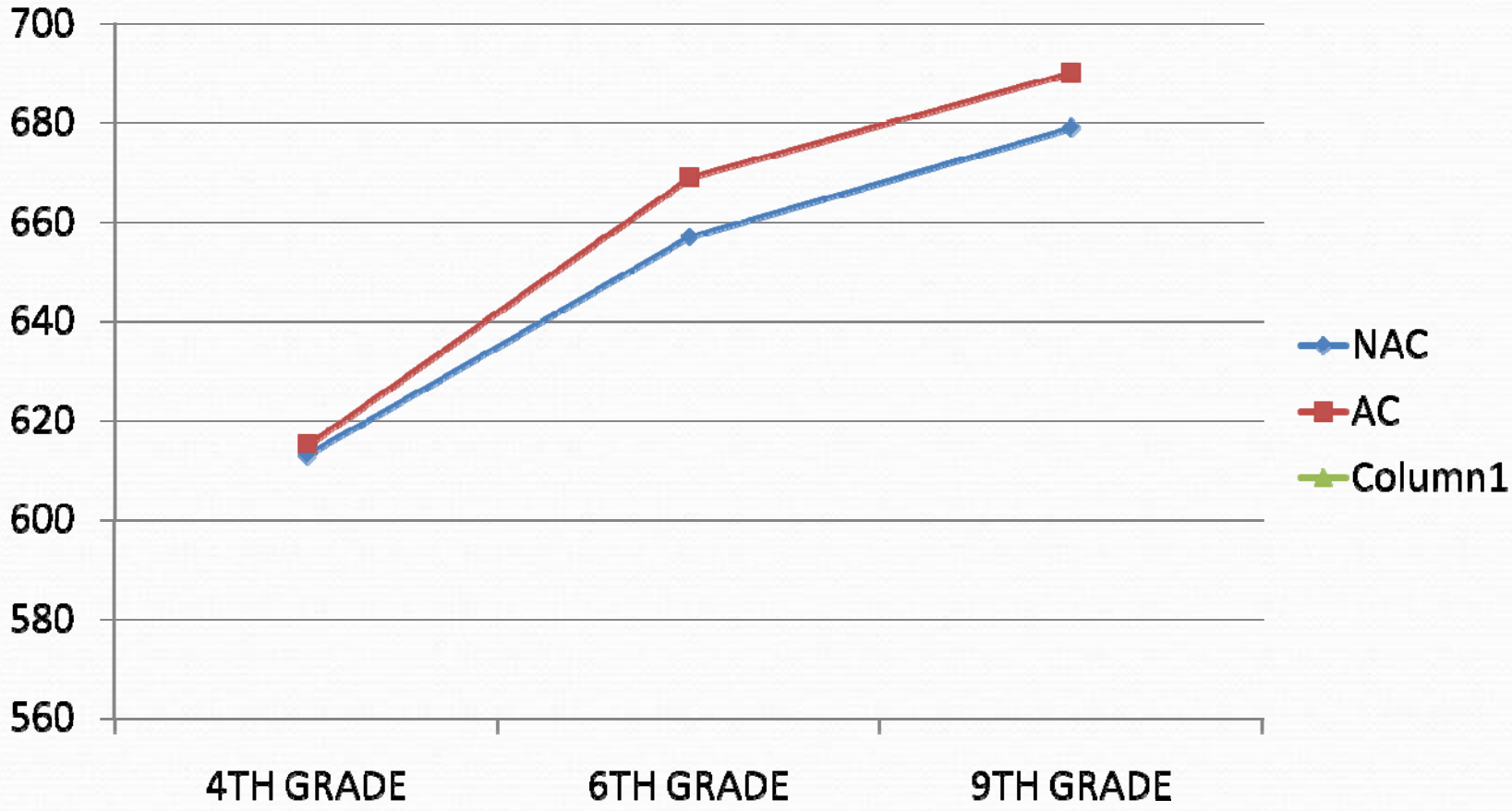
AC LONGEVITY & STUDENT ACHIEVEMENT

- Time 2 – comparison of scores between:
  - 4^{th} Grade & 6^{th} Grade
  - 6^{th} Grade & 9^{th} Grade
  - 4^{th} Grade & 9^{th} Grade
  - Plotted on Graph for better viewing.
  - Provides a better comparison over several years.

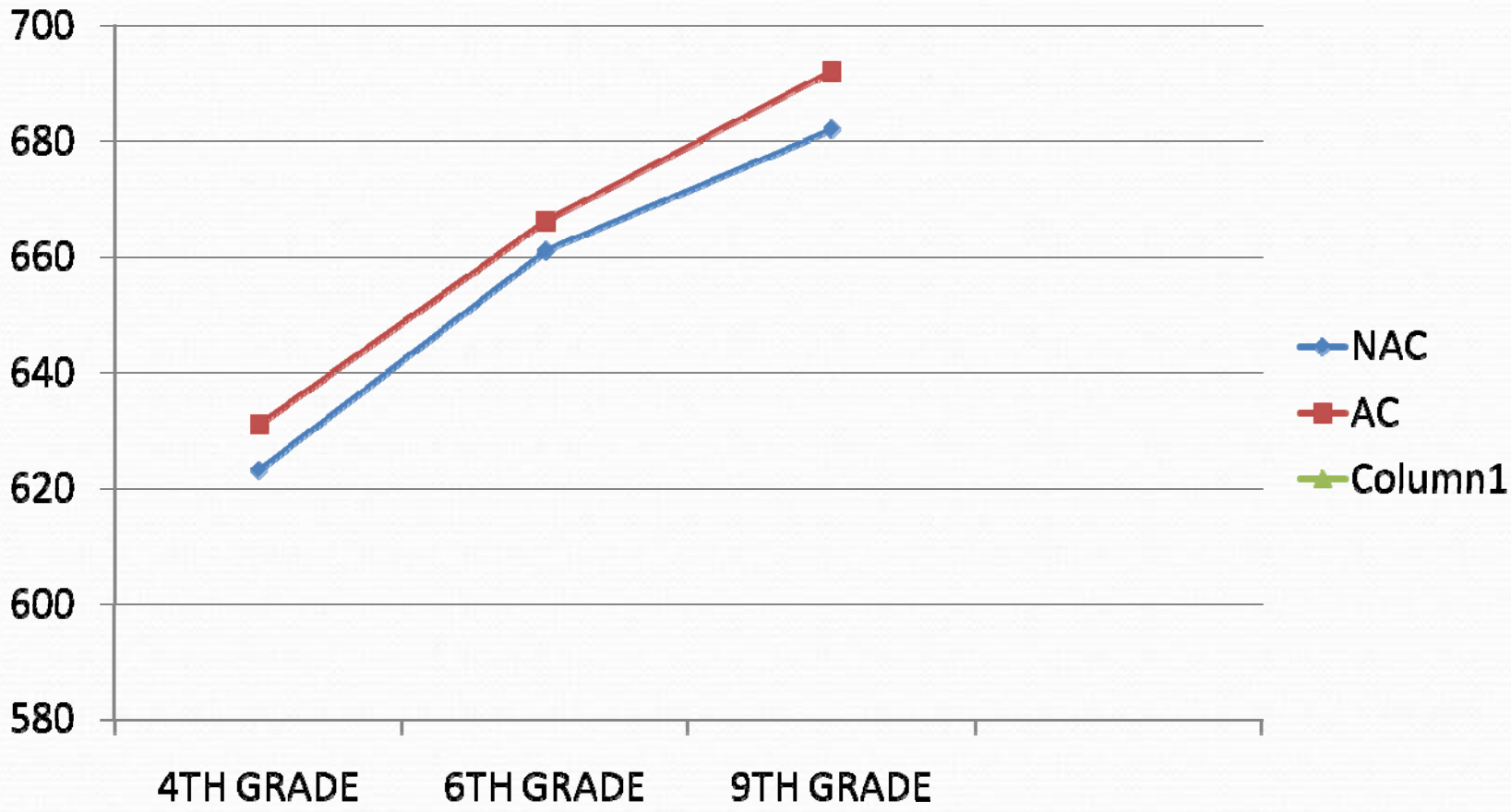
Reading Vocabulary



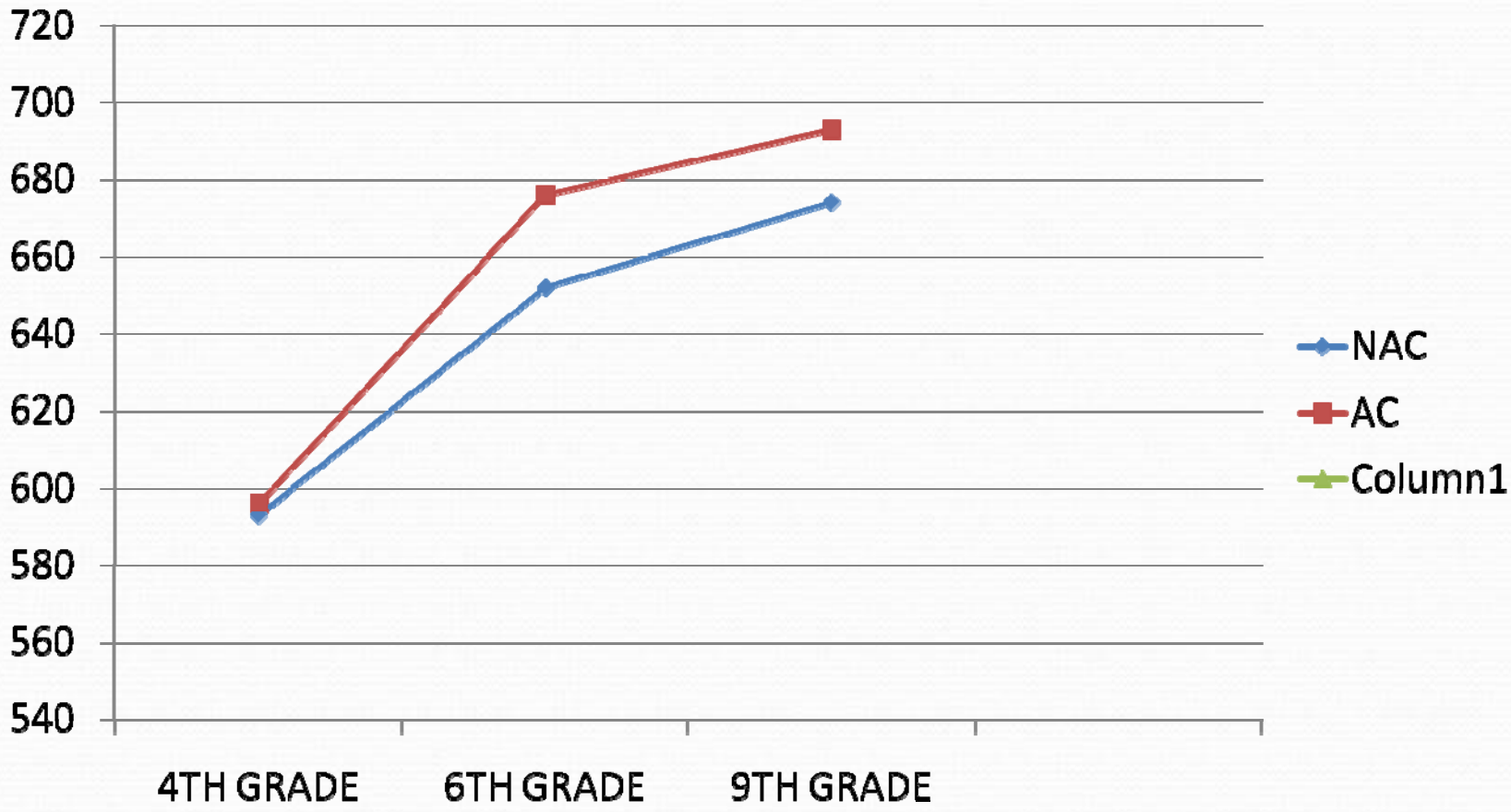
TOTAL MATH


700
680
660
640
620
600
580
560
4TH GRADE
6TH GRADE
9TH GRADE
NAC
AC
Column1

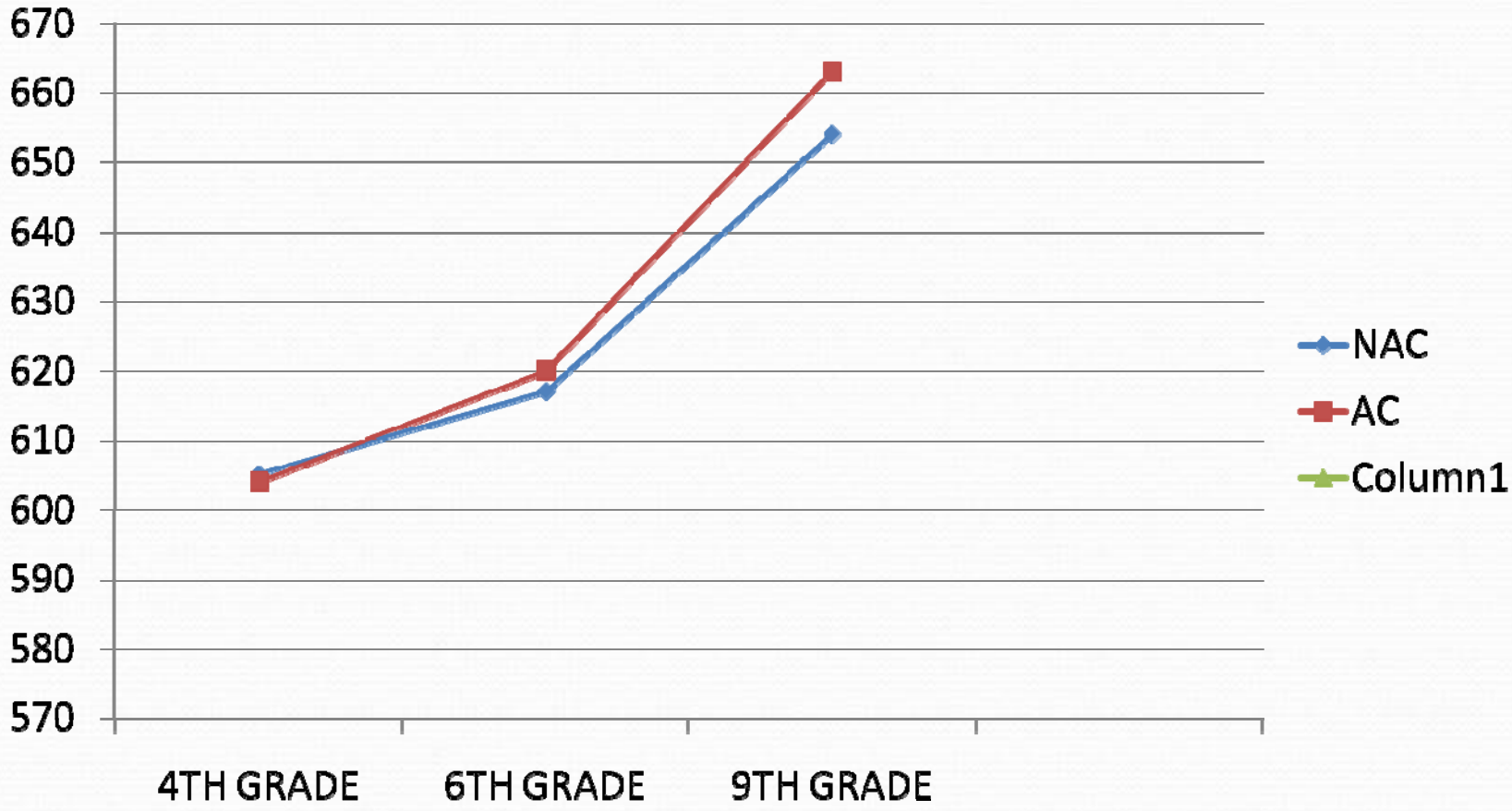
PROBLEM SOLVING



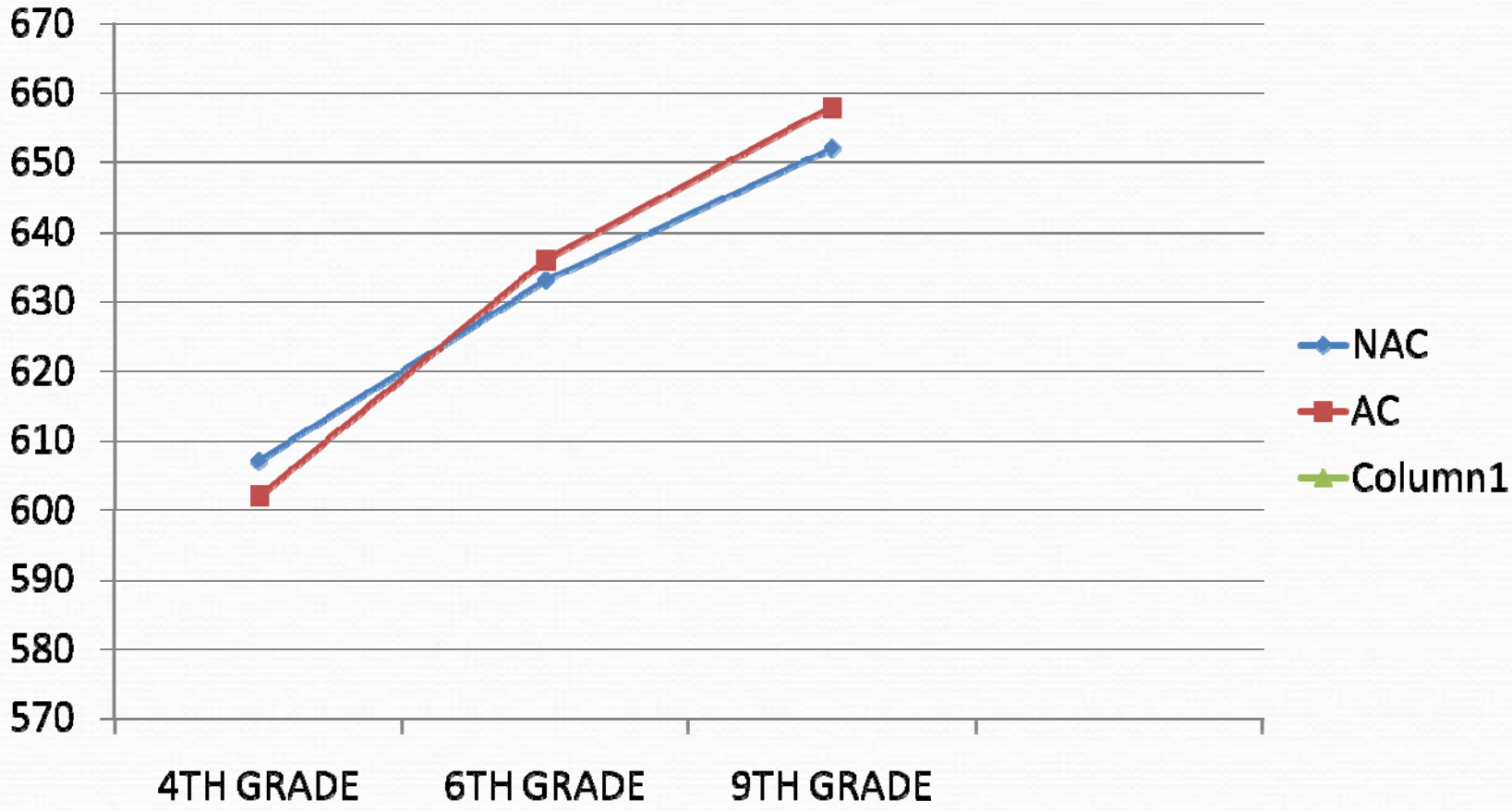
MATH PROCEDURES



PRE-WRITING


670
660
650
640
630
620
610
600
590
580
570
4TH GRADE
6TH GRADE
9TH GRADE
NAC
AC
Column1

EDITING


670
660
650
640
630
620
610
600
590
580
570
4TH GRADE
6TH GRADE
9TH GRADE
NAC
AC
Column1

AC LONGEVITY & STUDENT ACHIEVEMENT

- Statistical Analysis resulted in a Significant Difference in Scores in Sub-tests of Total Mathematics and Mathematics Procedures.
- Indicating AC did make a Significant Difference between the Two Scores.
- There were Important Trends Indicating a Difference in Scores between AC and NAC School Buildings.

LIMITATIONS

- Not able to Measure Quality of AC in Classrooms. No IAQ Test Made. Funding Problem.
- Was not able to Measure Degree Temperature Days in All School Divisions.
- Small Schools have Particular Characteristics that help Students.

AC LONGEVITY & STUDENT ACHIEVEMENT

- What can be Concluded?

  -AC does have a Positive Affect upon Students?

  -The Longer a Student is Exposed to AC the Better the Student Performance.

  -Conversely, Longer Students do not have AC the Less They will Score on Achievement Tests.

  -This Study Supported Previous Research.

What Does IAQ Have to do With a "Green" School?

- Green, healthy, sustainable, high-performance
- A building is only as healthy or sustainable as its occupants
- IAQ/IEQ is a major component of LEED and CHPS Certification for Schools
- Decisions about site selection, construction, materials, and furnishings can all impact IAQ

Key Components to IAQ Management

- Communication and information exchange is critical
- All staff play a critical role in identifying problem situations
- There is a balance between energy efficiency and ventilation
- Complaints merit responses
- Actions have consequences
- There is a time to bring in the experts
- Different buildings require different approaches

Framework for Effective School IAQ Programs

THE CADMUS GROUP, INC.

IAQ Tools for Schools Action Kit

- **Low Cost**
- **Adaptable to Individual School/School District Needs**
- **No Specialized Training Required**
- **Voluntary**
- **Common Sense Approach**

Key Messages

- Good Indoor Air Quality:
  - Enhances occupant health
  - Enhances occupant comfort
  - Enhances productivity and performance
  - Enhances sustainability
- Failure to respond promptly and effectively to IAQ problems can have serious consequences
- IAQ is a “whole building” issue and requires a commitment to address and correct problems

Resources

- U.S. Environmental Protection Agency
  - www.epa.gov/iaq/schools
- U.S. Green Building Council
  - www.usgbc.org
- Collaborative for High Performance Schools
  - www.chps.net

Questions?

Matthew Hiester

The Cadmus Group, Inc.

703.247.6118

mhiester@cadmusgroup.com