Longitudinal Study of a Green School as a Learning Laboratory

Steve Kerlin, Ph.D. – NKU

Billy Bennett – Doctoral Student and Director of EKU Center for Environmental Education

Rosie Santos – NKU Undergraduate Honors Student

Joe Chavez – Kenton County School District STEM Consultant/Science Coordinator

Green Schools Literature

- Emerging area of research.
- Preliminary reports have indicated that many aspects of green schools produce dramatic results in
  - student academic performance on standardized tests
  - student behavior as indicated by increased student attendance and a reduction in office referrals.
  - Also – possible connection with increased teacher satisfaction with teaching and a lower instance of absences for both students and faculty.

(Gordon 2010) (Air Quality Sciences 2009) (Duffin, Murphy & Johnson 2008) (Schneider, 2002)(Olson & Kellum, 2002)

Green Schools Literature

- Few rigorous empirical studies on the effect of a green school learning laboratory on student achievement
- In 2006 the National Academies Committee to Review and Assess the Health and Productivity Benefits of Green Schools reported that there were no well designed, evidence based studies that assessed the impact of green schools on health and productivity of students or teachers.

General Research Questions

- Does a "green school learning laboratory" produce improvements in middle school **students' academic performance, behaviors, attitudes, and environmental literacy**? How?

- Does a "green school learning laboratory" **influence teachers' instructional methods, attitudes and behaviors**? How?

TURKEY FOOT MIDDLE SCHOOL

Net Zero Design

Natural Day Light Harvesting
Advanced Geothermal HVAC
Insulated Concrete Forms (ICF)
Solar Light Tubes
CO_2 Monitoring System
Energy Efficient Kitchen Design
LED Parking Lot Lights
Domestic Hot Water
Security Lighting
LED Task Lamps
Water Bottle Refill Feature
Electric Meters
Rainwater Catchment System

Green Infrastructure

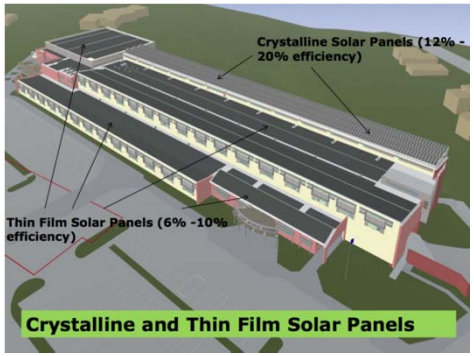
Stained Concrete Floors
Marmoleum Flooring
Ground Faced Block Walls
Long Span Concrete Decking
Vegetative Roof
Rain Barrels
Rain Garden
Vital Sign Screen
Low Energy Drinking Fountains
Thin film & Monocrystalline Solar

TURKEY FOOT
MIDDLE SCHOOL

Total Cost of Construction w/Solar
$26,570,432, $200.84/sq. ft.
With Federal Grant Assistance
$185.72/sq. ft.

TURKEY FOOT MIDDLE SCHOOL

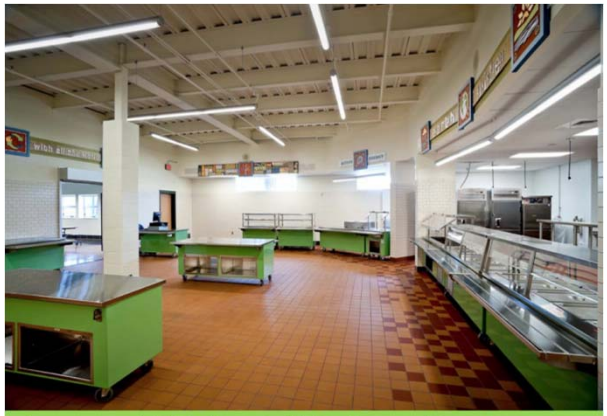
Green Features



Crystalline and Thin Film Solar Panels

133,00 sq. ft. compared to 66,523 sq. ft.

22.6 kBtu/sq. ft. compared to 82.78 kBtu/sq. ft.


Energy Efficient Kitchen Design

Rainwater Catchment Tank – 20,000 gallons

Solar Light Tubes

Solar Panel Installation

Example of School District Commitment to Use School as a Learning Tool : Daylight Harvesting Study

- Site-based study of Caywood Elementary Daylight Harvesting.
- Resulted in 50% less daylight glass in new middle school.
- Study conducted by students at Caywood Elementary.
- Construction 101 middle school class involved in school design, construction, tours, energy monitoring…

Expected Student Outcomes

from literature and hypothesizing

- Increased attendance among students – health and attitude
- Decreased office referrals
- Increased academic performance on standardized tests
- Environmental literacy scores above that of their peers at a similar traditionally constructed school & national baseline

Expected Teacher Outcomes

from literature and hypothesizing

- Increased teacher attendance
- Increased teacher understanding of green technologies (content knowledge) and environmental issues
- Green features of the building embedded into normal classroom instruction (pedagogy)
- Use of school specific scientific data
- Increased job satisfaction
- Increased teacher collaboration across disciplines

Research Timeline

- Six year longitudinal study
  - 3 last years of old traditional building – archival data
  - 3 first years of new high performance green building
- Status – currently in year 3 of new building (2012-2013).

Research Population

- Approximately 4500 current and past middle school students in the Kenton County School District will be studied.
- Grades 6-8 students at prior Turkey Foot Middle School, current Turkey Foot Middle School, and Summit View Middle School. Students of both genders and largely Caucasian, due to the racial makeup of the school district (94%)
- Approximately 60 teacher participants from 2 middle schools in the district will be observed and interviewed over the span of the project.

Research Data

- Student achievement – all middle school standardized test scores within district.
  - MAPP, KATS, EPAS (Explore), etc.
- Student attitudes – Middle School Environmental Literacy Survey (MSELI), student attendance records, and student behavior using office referrals resulting in disciplinary action.
- Teacher attitudes, behavior, & instructional strategies - audio recorded focus group discussions, attendance records, lesson artifacts, lesson observations, and professional development workshops.

Research Methods

- A mixed methods research approach (Creswell & Plano Clark, 2007) implemented to triangulate quantitative and qualitative research measures.

- Quantitative measures include:

  1. Statistical analysis of responses to the Middle School Environmental Literacy Survey

  2. Statistical analysis of standardized tests given district wide in the middle grades

  3. Student office referrals that require corrective action

  4. Student, and teacher attendance records provided to the researchers by the school district

Research Methods

- Qualitative measures - emergent thematic analyses
  - 1) field notes of classroom observations
  - 2) teacher focus group discussions, audio recorded and transcribed. Focus group discussions around topics of:
    - How teachers are using the green building in their instruction
    - Noticeable differences in student performance, behavior, or attitudes of students
    - Teacher attitudes toward working in a green school environment

Teacher Focus Groups – Analysis

- All teachers attend as job embedded training as grade level and specials classes groups
- 11 focus groups audio recorded & transcribed to date
- Turn of talk as the unit of analysis
- 1st set of transcripts coded independently by 3 researchers, conversations for coder consensus and to refine the framework, recode, repeat coder consensus
- Apply framework to remaining transcripts using inter-coder reliability measures

Teacher Focus Groups – Emergent Coding Framework

- Student Awareness
- Student Behavior
- Green Infrastructure
- Curriculum Implemented
- Curriculum Ideas
- Teachers' Health
- Students' Health
- Professional Development Feedback
- Professional Development Requested
- Teacher Awareness

Throughout these coding categories teachers' attitude is being noted with a +/- value measure.

Subcategories Example

Green Infrastructure
Subcategories
Lighting
Bathroom (Rain water catchment system, air dryers)
Data Display (Vital screens or online)
Sound Insulation
Outdoor Classroom
HVAC (temperature, odor, humidity, oxygen)
Vegetated roof
Solar
Layout

Rating Description	
Mentioned it is there and working/helpful	1
Mentioned it is there and not working or distraction	-1
Not present	0

Subcategories Example 2

Student Behavior	
Subcategories	
Discipline (behavior that requires office referral)	
Engagement ("on-task" behavior)	
Attendance	
Rating Description	
Positive Change	1
Negative Change	-1
No Change	N

Subcategories Example 3

Teacher Awareness & Student Awareness	
Subcategories	
Knowledge of Infrastructure	
Knowledge of Environmental Issues	
Inquiry (Teacher or student asks question about green feature)	
Rating Description	
Teachers or students express knowledge or ask questions about green features	1
Teachers do not express correct knowledge or ask questions about green features	-1
Not present	0

Preliminary Findings – Year 1

- Complaints about the green building infrastructure (HVAC, temperature of water fountains, time to bring systems online, lighting, loud hand dryers, ...) - all systems not working from start, time for adjustment to change
- Lack of knowledge by all teachers about the green features of the building, requests for professional development
- Some modified lessons and ideas of how to use the building as a teaching tool, mostly in science. Belief that instruction about or using green infrastructure is for science teachers
- Mixed interpretation of students' knowledge and attitudes toward the green building

Preliminary Findings: Curriculum

Data from teacher focus groups (Spring 2011 and Fall 2011)

Light Meter Data Collection	Geothermal and layers of the earth	Rain water harvesting
Light Meter Data Analysis	Primary and secondary resources	Energy transformation
Graphing	Geography	Economics: will the school pay for itself
Angle of the sun, seasons	Writing contest on energy usage	Green Energy Day
Natural winds	Persuasive essay on renewable energy sources	Renewable resources
Informational writing pieces on facility and functions	Green Roof Research	Recycling
Rotating Cells	Monitor rain barrels and analyze water quality	Technology in the context of the building features
Geographical implications on green energy use	Comparing line and bar graphs	Architecture
Solar power	Comparing infrastructure	
Geothermal data analysis	Comparing energy usage	

Preliminary Conclusions – Year 1 Focus Groups

- Awareness of Infrastructure by teachers and students but not consistent among teachers and students
- Teachers acknowledge lack of complete understanding of green infrastructure and how to utilize it to enhance instruction - Teachers should be provided with continued professional development, specific to different subjects and green systems and tied to standards
- Adjustment period should be expected, mixed attitudes about green building
- Possible positive affects on health, attendance and behaviors

Next Steps

- Finish collection of qualitative and quantitative data
- Apply coding framework to remaining teacher focus groups (years 2 & 3)
- Analyze archival data from last three years of traditional school
- Score and analyze MSELI year 1 and 3
- Report findings/disseminate research

Selected References

- Creswell, J. W. (1998). Qualitative inquiry and research design: Choosing among five traditions. Thousand Oaks, CA: Sage Publications, Inc.
- Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications, Inc.
- Air Quality Sciences. (2009). Green, High Performance Schools.
- Duffin, M., Murphy, M., & Johnson, B. (2008). *Quantifing a Relationship Between Place-Based Education and Environmental Quality: Final Report.* Woodstock, VT: NPS Conservation Study Institute in Cooperation with The Environmental Protection Agency and Shelburne Farms.
- Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). *Writing ethnographic fieldnotes*. Chicago & London: The University of Chicago Press.
- Gordon, D. (2010). *Green schools as high performance learning facilities.* Washington, DC: National Clearinghouse for Educational Facilities.
- Olson, S., & Kellum, S. (2003). *The impact of Sustainable Buildings on Educational Achievement in K-12 Schools.* Madison, WI: Leonardo Academy Inc.
- Schneider, M. (2002). *Do School Facilities Affect Academic Outcomes.* Washington, DC: National Clearinghouse for Educational Facilities.
- Van Manen, M. (1990). Researching lived experience: Human science for an action sensitive pedagogy. London, Ontario, Canada: State University of New York Press.

Thank You!

Steve Kerlin, Ph.D. – NKU
kerlins1@nku.edu

Billy Bennett – EKU
william.bennett@eku.edu

Rosie Santos
santosr1@nku.edu