

Informing Green School Design and Construction Projects Through Graduate Student Research

Brian H. Dunbar, MArch, LEED AP and Josette M. Plaut, MS, LEED AP
Colorado State University
Fort Collins, Colorado

A small group of construction and facilities managers within a local school district encouraged the district superintendent to develop policy for the integration of green building practices. The school district established a long-term partnership with a green building research institute in the Construction Management Department that has benefitted graduate students, the university, the school district and the community. Through a series of agreements and research projects, the university performs applied research into aspects of school building such as applying the LEED rating system, benchmarking other green schools, studying effects of cleaning on indoor air quality, and investigating sustainable finish materials. The school district, thanks in part to the university partnership, is now nationally recognized by government entities and the U.S. Green Building Council. The school district-university partnership is one that could be replicated throughout North America, creating programs that provide on-going benefits to students, the school district, the university, building professionals, and the faculty and students who inhabit the schools. This paper illustrates the process used to establish the partnership, the specific research projects performed by the graduate students and the outcomes of the program, both in terms of the school buildings and the multiple benefits derived by the students, the university, and the community.

Keywords: Sustainable Construction, Green Schools, LEED, Service Learning, Graduate Research

Introduction

The benefits of green buildings and, specifically, green schools are increasingly understood by building users as well as design and construction professionals. In many regions of North America, citizens, government agencies, corporations, and school boards have established mandates for green design and construction.

The roots of the current movement of sustainable, 'green' building can be traced back to modest beginnings in the 1970's and 1980's, when certain builders and architects experimented with natural building, energy conservation in buildings, solar architecture and related technologies. However, it was not until the introduction of guidance systems, especially the Leadership in Energy and Environmental Design (LEED) rating system that the movement grew to be recognized as a major facet of the construction industry.

LEED projects, according to McGraw-Hill Construction (2005), now comprise over 5% of all new commercial construction in the United States. In addition, another significant percentage, although harder to quantify, are the many projects that do not register their intent to certify with the U.S. Green Building Council, yet have goals to be built equivalent to LEED standards. Since its official release in 2000, LEED has been adopted

by a growing number of federal, state, and municipal governments. More recently, many non-profit and for-profit corporations have instituted policies requiring LEED certification for all new construction.

Certain regions of the country have been quick to implement LEED into projects, especially the Northwest and the Northeast. As of 2007, every state in the U.S. can claim a LEED certified building. California has a higher number of LEED certified projects, 148 as of January 2008, than any other state (USGBC, 2008). A growing number of school districts have adopted policies requiring LEED and/or similar green building guidance systems. The largest reasons, as cited in a 2007 study of school administrators (Ferraro & Inatsuka, 2007), are operational savings, improved learning and that the building serves as a teaching tool to students, faculty and visitors. Numerous research studies (Franta, Deshmurh, & Maurer, 2007; Heschong, 2003; Kat, 2006) have concluded that the typical components of a green school such as daylighting, health, materials, good ventilation and IAQ, and thermal comfort have positive impacts on student learning and performance along with staff health and retention. In 2006, a research team surveyed twelve high-performance schools in various regions of the United States to determine the occupant, environmental, and economic benefits of high-performing, green schools (Franta, Deshmurh, & Maurer, 2007). The survey results were consistent across the study group. Design efforts and goals were most often prioritized around daylighting and efficient electric lighting, indoor air quality, use of finishes with low volatile organic compounds (VOCs), and water efficiency. Officials at all twelve green schools believed that the operational savings, the energy efficiency, and the use of sustainable building techniques outweighed any additional upfront costs that may have been necessary to build the high-performing school (Ferraro & Inatsuka, 2007).

Research studies focused on costs and benefits of high-performing, green schools have identified better test performance, reduced absenteeism, energy savings, and water savings among the benefits of designing and constructing green schools. For example, elementary school students in classrooms with the most daylighting showed a 21 percent improvement in learning rates compared to students in classrooms with the least daylight in a robust study funded by the California Energy Commission (Heschong, 2003). According to the findings of a national review of 30 green schools (Kats, 2006), green schools cost less than two percent more than conventional schools and provide enhanced student learning, reduce health and operational costs, reduce insured and uninsured risks, and increase school quality. School administrators often echo the findings of the various studies. For example, Randy Overton, school facilities engineer in Hawaii elaborates on what he has seen at a green school in his district, "The health benefits we gain, the resources we save, the conducive learning environments, and the sustainable education our faculty and students experience everyday and begin the view as a way of life are priceless" (Franta, et. al., 2007).

Method

A team of construction and facility managers in the Poudre School District, a medium-sized school district in northern Colorado used early results of the green schools studies to inform the local school board in 2000. The board considered, and subsequently passed, policy to require each new and remodeled school building to implement current green building methods, materials, and technologies. As part of the policy, the construction and facilities group agreed to create ‘Sustainable Design Guidelines’, a living document to be used by every school project team. Due to the relatively limited understanding and experience with green building techniques, the school district sought to help regional building professionals acquire the knowledge and tools to successfully design and construct sustainable, green schools (Bradley, Dunbar, & Plaut, 2006).

During the same timeframe, the Construction Management Program at Colorado State University was instrumental in establishing an interdisciplinary institute focused on a mission of “fostering stewardship and sustainability of the built environment”. The faculty involved in forming the Institute for the Built Environment (IBE) envisioned training programs for regional professionals, a graduate program which could attract quality students who would be involved in advancing the emerging sustainable building research, and assisting regional project teams with applied research and project assistance, such as coordinating LEED certification documentation.

The school district engaged the university institute faculty and students in a variety of ways including sustainable materials investigation, assistance with the creation of the Sustainable Design Guidelines, LEED system training and coordination, and green school case study development. The IBE and the Poudre School District have found each of the activities (trainings, research projects, service-learning projects) to be mutually beneficial. For instance, having a willing and encouraging client and funding source (the school district) has proven to be a substantial attraction for potential graduate students considering enrollment in the university.

Research Program Process

At the beginning of new school projects, the school district construction and facilities group determines whether there is research potential and accompanying funding to contract with the IBE. If the research potential and the funding are not identified, there may still be opportunities to offer appropriate projects to a graduate class and/or engage a graduate student in smaller research projects.

If funding can be identified, a scope of services is determined which may include materials research, project monitoring, LEED coordination and documentation, and other activities. Based on the agreed upon scope, the institute engages selected graduate students to work on various aspects of the scope. The students are assigned various tasks and are invited to attend project design and construction site meetings, as appropriate.

Applied Research

Specific projects performed by the students since the partnership began include:

- Insulation product research and evaluation,
- Finish material research,
- Low-toxicity adhesive, paint, and sealant research,
- Construction IAQ best practices research,
- Daylighting quantity calculations,
- Acoustics in classrooms standards research,
- Recycled content materials research,
- Plumbing fixture water conservation calculations,
- Forest Stewardship Council sustainable wood and maintenance research,
- Building commissioning assistance,
- Energy modeling assistance,
- LEED system version comparisons,
- LEED for Schools drafted system investigation,
- Construction waste management specifications research,
- Landscape material reflectance ratings study,
- LEED certified high school case study documentation.

Service Learning

A portion of the potential projects conceived by the school district, especially remodels and additions, have proven to be excellent subject matter for university classes. The integration of ‘service-learning’ projects into university coursework is acknowledged as a successful teaching strategy to enhance classroom learning for students in many disciplines, including construction management (RMC Research Corp., 2003; Sax & Astin, 1997; Clemons & Dunbar, 1994).

Results

The results of the partnership between the school district and the university have been far-reaching. The Poudre School District has created award-winning schools, has hosted on-going tours and conferences, has been included in numerous videos and, most significantly, are seeing the positive impacts on the children with lowered absenteeism, higher scores on statewide tests, high satisfaction among faculty and staff and substantially lowered operating costs. For example, the LEED certified high school, third public school in the United States to obtain that status, operated on \$105,000 less utility costs than the previously built high school in the district. Both schools were built to the same energy code – the LEED certified school exceeded the energy code by sixty percent. The notable savings were the result of an integrated effort between project team members which included input from the university faculty and graduate students (Bradley, et. al., 2006).

The Poudre School District has been recognized by the U.S. Green Building Council, the Governor's Office of Energy Management and Conservation, the U.S. EPA, and many other organizations for their green schools. In award ceremonies and presentations, the school district acknowledges the benefits of the established partnerships.

For graduate students, the tangible results are also substantial. Most of the students that have been involved in the green school research projects have achieved LEED accreditation, awarded by the U.S. Green Building Council to those that successfully pass a comprehensive accreditation exam. Knowledge gained through project work is considered one of the most important means to obtain necessary preparation to pass the exam (Moore, 2007). The students have gone on to work on green building projects throughout the construction industry. A number of students have been hired into positions such as Sustainability Coordinator or Sustainability Director for companies such as Swinerton Builders, DPR Construction, Perkins and Will Architects, CT Energetics, PCL Construction, and others.

Graduate students that have been given the opportunity to work on the school projects through service-learning processes within a course have also learned important information and project methodology to take with them into their careers. For example, a class of twenty students participated in a six hour green school design charrette in collaboration with twenty junior high school students and teachers, ten local building professionals and other community members. The charrette was co-facilitated by a graduate student who was completing her thesis research focused on the integration of the charrette process into LEED certified buildings. The charrette participants brainstormed sustainable energy, materials, site, water, and classroom design goals.

Discussion

How other universities can institute a similar program

While the partnership between the Poudre School District and the Institute for the Built Environment and Construction Management Program is unique, the process to establish such a beneficial program can be replicated by other universities. Where built environment programs such as construction management, architecture, interior design, engineering, and/or landscape architecture exist, a loose or formal faculty collaboration can be formed. Once a common vision and goals are agreed upon, the group can meet with the facilities services group of a local school district to discuss the benefits of green schools, the expertise of the faculty and students, and the potential work that can be performed by the university.

Beginning activities could include assisting with the writing of Sustainable Design Guidelines, analysis of existing schools (energy, water, indoor air, sustainability of materials studies), analysis of current construction standards, and participation in school design meetings. In addition, the university program may find that certain aspects of a

school remodel project could be integrated into existing graduate or undergraduate coursework.

Summary

Through a series of agreements, training programs and graduate student research projects, a university construction management program and research institute, the Institute for the Built Environment, created a partnership with a local school district that has proven to be beneficial to the school district, graduate students, the university, and the community. Through collaborative agreement, faculty and students have been engaged in various research and service-learning projects that have informed green school design, construction, remodeling, and operations. The results have been positive for the Poudre School District in the form of awards, recognition, lowered operating costs and scholastic performance. Results for the university have been equally positive – students have gained unique experience which has led to successful preparations for LEED accreditation as well as quality jobs with industry. Also, faculty have been equipped with pertinent subject matter to bring into the classroom, thus enhancing teaching and learning.

The documented process can be replicated by other university programs. By establishing similar partnerships with regional school districts, the potential exists for similar, significant results that are beneficial to various groups and individuals.

References

Bradley, C., Dunbar, B., Plaut, J. (2006) Fossil Ridge High School. *Journal of Green Building*. V1(1)

Clemons, S., & Dunbar, B. (1994). Community linkages: Multiple studio projects, multiple rewards. *Design: A multi-cultural experience, IDEC International Conference Proceedings*. San Antonio, TX

Ferraro, J., Inatsuka, S. (2007). LEED cost benefit study for Hawaii D.O.E. Schools (WWW document) URL <http://www.hawaii.gov/dbedt/info/energy/efficiency/bbg/may9-b-4-inatsuka.pdf>

Franta, G., Deshmukh, A, Maurer, E. (2007). The little green schoolhouse. *RMI Solutions*. Rocky Mountain Institute. Spring.

Heschong, L. (2003). *Windows and classrooms: A study of student performance and the indoor environment*. (Report No. P500-03-082-A-7). Fair Oaks, California. California

Kats, G. (2006). *Greening America's schools: Costs and benefits*. A Capital E Report based on and drawn from the *National review of green schools: Costs, benefits, and implications for Massachusetts*. www.cap-e.com .

McGraw-Hill Construction (2005). *Green building smartmarket report: 2006*. McGraw-Hill.

Moore, T. (2007). *LEED professional accreditation study guide and practice exam*. USGBC Colorado chapter. Denver.

RMC Research Corporation. (2003). *Why districts, schools, and classrooms should practice service learning*. (WWW document) URL www.rmcresearchcorporation.com

Sax, L.J. and A.W. Astin (1997). "The Benefits of Service: Evidence from Undergraduates," *Educational Record*, Summer-Fall, 25-33.

U. S. Green Building Council (2008). *LEED projects directory*. (WWW document) URL <http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx>