



GREEN SCHOOLS AS AN INTERACTIVE LEARNING SOURCE

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ملخص البحث

تعتبر المباني و المسطحات الخضراء في المدارس النموذجية مكان للتعلم و ليست كمصدر للتعلم في حد ذاتها. بدلا من أن تكون المدرسة تعليمية تم تصميمها لتكون مريحة ، فعالة ، و مبهجة. و لذلك فإن التعليم نفسه يمكن أن يحدث في أي مكان و أي بلد. و لكن في الحقيقة المبني التعليمي و المساحات الخضراء تعكس منهج ضمني يؤثر بقوة في العملية التعليمية. للمدارس الخضراء العديد من المميزات لكل من الطلاب ، العاملين، و البيئة. و إلى جانب هذه المميزات فإن لديها القدرة على أن تكون بمثابة أداة تعليمية للتعليم البيئي. و هكذا فإن البيئة المبنية للمدرسة – تشمل مبنى المدرسة و الفناء- تزيد من الوعي البيئي للطلاب من خلال التعلم العملي و عناصر التصميم المستدام المرئية. تهدف الورقة البحثية إلى تسليط الضوء على الدور الفعال للمدارس الخضراء في التعليم البيئي و ذلك من خلال بحث استقصائي للوقوف على الجوانب المختلفة للاستفادة من المدرسة كأداة تعليمية مع توضيح أثر المدرسة الخضراء على العملية التعليمية. بالإضافة إلى التوصل لعدد من التوصيات كاتجاه رئيسي لتحسين المدارس الحكومية في مصر.

كلمات مفتاحية: المدارس الخضراء – المدارس الخضراء كأداة تعليمية – التعليم البيئي

ABSTRACT

Building and landscape the typical school from are considered mostly as place where learning occurs but not as source of learning itself. Instead of being instructional, the campus is designed to be convenient, efficient, or aesthetically pleasing. Thus the same education could happen anywhere in any country with no difference. But in fact school building and landscape reflect a hidden curriculum that powerfully influences the learning process. Green schools offer tremendous benefits for students, staff, and the environment. Besides these benefits they have the potential to serve as a teaching tool for Environmental Education (EE). Thus the school's physical environment – including buildings and ground - increases the environmental awareness for students through hands-on learning opportunities, and a visible element of sustainability values. The purpose of this paper is to highlight the role of green school buildings in environmental education in order to investigate the different aspects of utilizing green school as a teaching tool and illustrating the educational implication of green school. A number of recommendations are drawn as key direction to improve public school buildings in Egypt.

Key words: Green schools – Green school as a teaching tool- Environmental Education.

1 INTRODUCTION AND RESEARCH PROBLEM:

Many architectural programs or plans for public school don't support of curriculum, or sustainability. (TAYLOR AND ENGGASS, 2009) Several studies showed that many of our public school buildings in Egypt are unhealthy and confirmed many problems in the environmental aspect. (GADO AND MOHAMED 2009; MOHAMED 2009) While over the years, strong evidence and studies have shown that school building affects students' health and ability to learn. (KATS

[2006; \(WORLDGBC\) 2013](#)). Furthermore, we are ignoring the powerful effect of the physical learning environment on teaching. The environment is indeed a “silent curriculum” that can provide positive (or negative) learning experiences. [\(TAYLOR AND ENGGASS, 2009\)](#)

A new movement underway in school design around the world is to design schools that provide healthy, comfortable and productive learning environments. [\(YUDELSON 2008; STONE 2009\)](#). Beside the major benefits of green schools, green schools that is used as a teaching tool for environmental education, educates new generation with the skills to face the environmental challenges of the coming decades and preserve our natural resources and environment. Thus the building itself can be utilized as a tool to manifest and shape teaching and learning values

Schools that tie sustainability and education into a way of inhabiting the campus support both the running of the facility and the educational activities. For a school to continue as a sustainable facility for its entire life, it must be maintained and operated in a sustainable way sustainability must become as much part of the school culture as the traditional of order and cleanliness. Visible demonstration of sustainable behavior is part of teaching sustainability as a value children will respect. [\(GELFAND AND FREED 2010\)](#) Sustainability needs to be integrated actively into the community. One of the main barriers towards the adoption of green buildings is the public awareness thus greening school is the way of educating students, sharing information beyond the school and effectively raising the awareness in the community.

2 Aim & Objectives:

The paper main aim is to investigate the role of green school building in environmental education when the building itself designed to be an interactive learning source. This will be fulfilled through achieving the following objectives:

- 1- Defining the green school and identifying its benefits
- 2- Highlighting the link between environmental education and architecture
- 3- The implication of green schools on education

3 RESEARCH METHODOLOGY:

The current paper uses inductive study in order to define the green school, and introduce the benefits of using it as a teaching tool. In addition to state the important role of green schools that serve as a teaching tool as a key factor to prepare students for the environmental challenges.

4 BACKGROUND:

5 GREEN SCHOOL DEFINITION:

While sustainable school is based on a deep understanding of biology, on the creation of a habitat for learning instead of a machine for learning. [\(GELFAND AND FREED 2010\)](#) Green schools are education buildings that operate in harmony with the natural environment. They are built to reduce energy costs and conserve natural resources, make use of recyclable materials, and operate in a sustainable manner. [\(SPAKE AND \(AFT\) 2008\)](#).

The U.S Green Building Council has defined green school as a facility that creates a healthy environment conducive to learning during saving energy, resources and money [\(\(USGBC\) 2015\)](#). An effective green school has successfully integrated the concept into school day and serve as a laboratory for practicing conservation where distinct aspects of green design are used as subject area [\(CHAN 2014\)](#). On the other hand Green schools contribute to making communities more sustainable, explore solutions to environmental problems, and serve as models of responsible action. [CENTER FOR ECO LITERACY](#)

5.1 Green School Benefits:

Research clearly shows that there are a large number of benefits from building green, which are received by different stakeholders throughout the building life cycle [\(\(WORLDGBC\) 2013\)](#). There's a growing body of research showed that Green schools reduce the environmental impact of buildings and grounds, have a positive effect on student and teacher health, and increase environmental literacy among students and graduates [\(KATS 2006; YUDELSON 2008; GELFAND AND FREED 2010; \(WORLDGBC\) 2013; \(USGBC\) 2015\)](#)

In 2006 Gregory Kats broke a new ground by demonstrating that green schools are extremely cost effective. The study concluded that green schools cost less 2% more than conventional schools. [\(KATS 2006\)](#). The research conducted by BRE and Sweet Group supports Kat's

findings when concluded that sustainability strategies add some additional cost but this is typically less than 2%. Though, any additional cost can be paid back within 2–5 years through utility savings. As well as, some projects are built on the same budget with no additional cost. ([ABDUL AND QUARTERMAINE 2014](#))

Other studies show that "daylighting" better indoor air quality, and hands-on, experiential environmental curricula are linked to higher test scores. We have solid evidence that the classroom environment can affect a child's academic progress over a year by as much as 25 per cent. ([WORLDGBC](#)) A recent review by Carnegie Mellon of five separate studies evaluating the impact of improved indoor air quality on asthma found an average reduction of 38.5% in asthma in buildings with improved air quality. ([O'DONNELL WICKLUND PIGOZZI AND PETERSON 2010](#)) Many studies have shown that the holistic effect of natural light correlates with greater health and productivity. In 1999, a landmark study by the Heschong Mahone Group on daylighting in schools showed student performance ranging up to 20% better in daylit classrooms than in nondaylit classrooms. ([GELFAND AND FREED 2010](#))

Outdoor signs, interior displays, guided tours, and the presence of unusual building features pique the curiosity of the public and expand their understanding of our relationship and responsibility to the natural environment. As a result Individuals who learn about green building principles and sustainable behaviors apply these practices to their lives, spreading the impact of a single green development project through other communities. ([UCA 2005](#))

School buildings can be utilized as a 3D-text book to practically teach the students the importance of sustainability. Green schools empower kids to make a difference, and teach them environmental and health values that will stay with them for life. ([TAYLOR AND ENGGASS. 2009](#)) Green schools provide hands-on educational opportunities that conventional schools do not. For example, on site renewable energy generation, water conservation features that provide very valuable opportunities for hands-on learning. ([KATS 2006](#))

6 ENVIRONMENTAL EDUCATION AND ARCHITECTURE:

Environmental education: a Learning process that increase knowledge and awareness about the environment, including challenges and opportunities for the environment. ([CHAN 2014](#))

"learning by doing," This approach is especially applicable to the study of sustainability issues in that it requires students to interact with and respond to the real world. Such methods give students a sense of how environments around them could be different, and how they themselves could contribute to such change. ([TAYLOR AND ENGGASS. 2009](#))

Within the design, construction, and operation of buildings is a curriculum in applied ecology. Buildings and landscapes can extend our ecological imagination. The design and operation of buildings is an opportunity to teach students the basics of architecture, landscape architecture, ecological engineering for cleaning wastewater, aquaculture, gardening, and solar engineering. Buildings that invite participation can help students acquire knowledge, discipline, and useful skills that cannot be acquired other than by doing. ([ORR 2004](#)) Green schools promote environmental awareness among students.

7 GREEN SCHOOL AS A TEACHING TOOL:

Our natural ability to learn is directly linked to constant interaction with the environment. There is no better way to teach than to show children through example. When educators learn to view the environment as a source of meaning, they begin to use the world of physical objects as a teaching tool to help students understand the underlying laws and principles that govern our complex, universe. The key is to view the physical environment and its ambient quality as active and indispensable parts of the learning process. ([TAYLOR AND ENGGASS. 2009](#))

Rotraut Walden defines the school as "A school is not just a place for instruction but a living venue for learning and play, as well as a meeting place for users from the surrounding community". ([WALDEN 2015](#)) While Anne Taylor has defined the learning environment as "**a carefully designed physical location composed of natural, built, and cultural parts that work together to accommodate active learning across body, mind, and spirit**". The qualities of the environment must be clearly outlined by educators to provide a guideline or "academic blueprint" for architects and community members as they think of school facilities design. Table 7-1 illustrates the informed learning environment that merges learning goals with architectural design. ([TAYLOR AND ENGGASS. 2009](#))

Table 7-1 the Informed Learning Environment: Combining Architecture and Education to Create a Model for School Design. Adapted from (TAYLOR AND ENGGASS. 2009)P.32

	Natural	Built	Cultural
Architecture	School playgrounds function as community parks, nature trails, fitness courses, gardens, zoos, habitats, weather stations, and places for experimentation	Building systems teach through structural clarity, or “legibility” . The curriculum determines the design of the architecture.	Design ideas from cultural institutions are applied to school design: museums, galleries, plazas, health centers, local ethnicity and style, the workplace, families, and homes.
Education	Students perform site analysis as curriculum for understanding the life zone: climate, topography, plant and animal life, water, etc. Landscape architecture of the playground becomes a learning tool. Students collect data for the architect.	Behind every object is an idea or concept. Learners “read” physical objects and translate them into ideas. Thus, architecture is pedagogy. Physical elements or manifestations in the environment act as visual cues or prompts for learning.	The studio learning model, experiential learning, and design education are borrowed from architecture as teaching tools. The entire process of learning is visually and verbally documented. Performance is critiqued and assessed in more depth than testing alone can provide.
Summary of Unifying Concept	The Learning Landscape	The Three-Dimensional Textbook	The Design Studio for Project-Based Learning

7.1.1 The 3D-Textbook School building:

David Orr has defined Academic architecture as "a kind of crystallized pedagogy and those buildings have their own hidden curriculum that teaches as effectively as any course taught in them". Also he has coined the term Architecture as Pedagogy to refer to the educational potentials in architecture. (ORR 2004). Taylor has also defined the Learning Environment: A Silent Curriculum that is active and indispensable parts of the learning process (TAYLOR AND ENGGASS. 2009). The building should be designed to make the curriculum hidden in architecture and operations art of the formal curriculum. School environments should be understood not only as places that are flexible and integrated but, most importantly, as places that encourage, support, and allow the learners to acquire knowledge and develop practical skills while engaged with their social and physical environments. (LIPPMAN 2010)

The typical school from building and landscape is considered mostly as place where learning occurs but not as source of learning itself. But in fact the building and landscape reflect a hidden curriculum that powerfully influences the learning process. (ORR 2002). A learning building is where an active learner is supported within an active social and physical learning environment. (NAIR 2014) Steven Bingler, Bonnie Sherk, and Ann Taylor coined the term manifestations to refer to the physical objects that make up the three-dimensional textbook from which we learn. Students interact with and use these manifestations in the environment as experiential guides or learning tools. (TAYLOR AND ENGGASS. 2009)

7.1.2 The learning landscape:

Many urban sites are so highly built up that they leave little room green areas and restful outdoor zones. However, underutilized areas can be converted at minimal expense to serve outdoor learning activities. As several studies have identified that connections to nature help relieve cognitive fatigue and improve a student's ability to concentrate, while outdoor learning in nature develop powers of observation and creativity and a sense of being at one with the world (NAIR 2014) the outdoor environments provides multisensory learning possibilities for educators. (TAYLOR AND ENGGASS. 2009) The best learning often occurs when children spend unplanned and uncounted hours outdoors investigating, experimenting, exploring, and playing which is to say spontaneously and delightfully designing their own curriculum. (O'DONNELL WICKLUND PIGOZZI AND PETERSON 2010)

Thus designers should not only translate educational concepts into the learning environment but also setting those buildings in thoughtfully transformed playgrounds called "learning

landscape" (TAYLOR AND ENGGASS, 2009). Natural elements and existing structures offer a concrete focal point and readily available materials for high-quality lessons in many subject areas (DUNBAR 1994) There are many areas in the school where sustainable features are tied directly to the curriculum at various grade levels Such as school gardens. School gardens decrease impervious paving, provide habitat, absorb carbon, and provide wonderful resources for a wide variety of classes.(GELFAND AND FREED 2010)

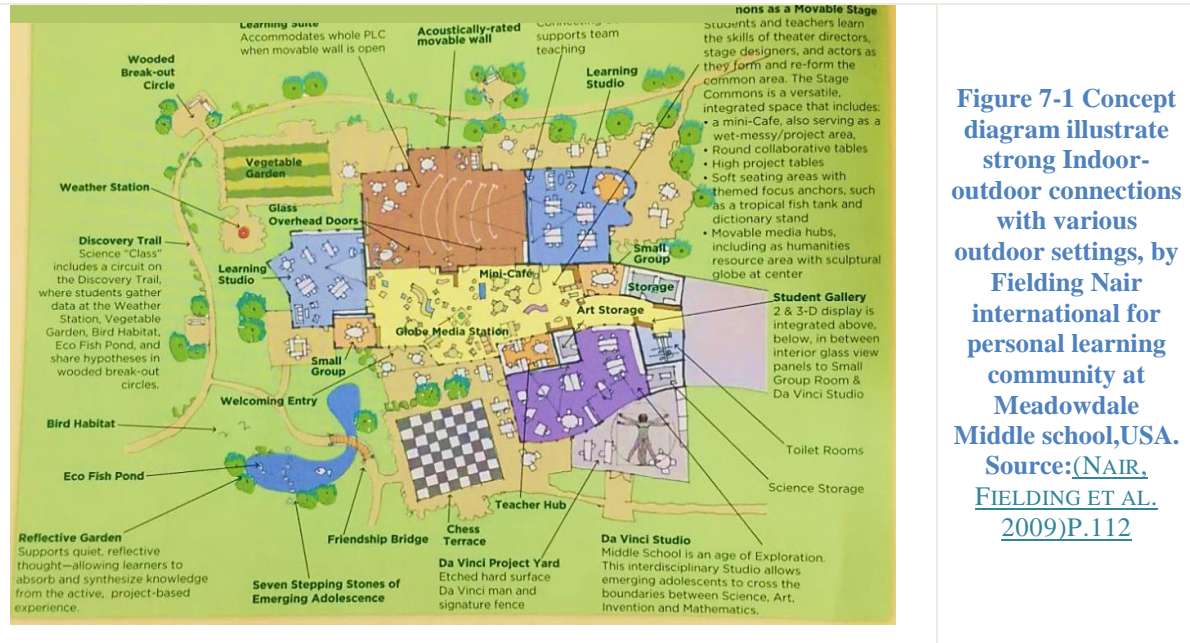


Figure 7-1 Concept diagram illustrate strong Indoor-outdoor connections with various outdoor settings, by Fielding Nair international for personal learning community at Meadowdale Middle school,USA. Source:(NAIR, FIELDING ET AL. 2009)P.112

The following few examples illustrate the potential for designers while designing the school ground, in order to transform our neglected school grounds into learning landscapes:

- Provide space and irrigation/water for garden environments to teach science concepts, including health and nutrition as shown in figures 6-2,6-3



Figure 7-2 garden classes at outdoor classroom. Derived from <http://edibleschoolyard.org/garden/2016/02/18/food-club-adelante-spanish-immersion-school>



Figure 7-3 integrate garden activities for young children into their regular classroom curriculum. Source: <http://edibleschoolyardpgh.org/>

- Utilizing the environmental pond as an integrated curriculum manifestation was intended to involve the students in multiple learning experiences and reinforce their different learning styles through a strategy as illustrated in figure 6-4.

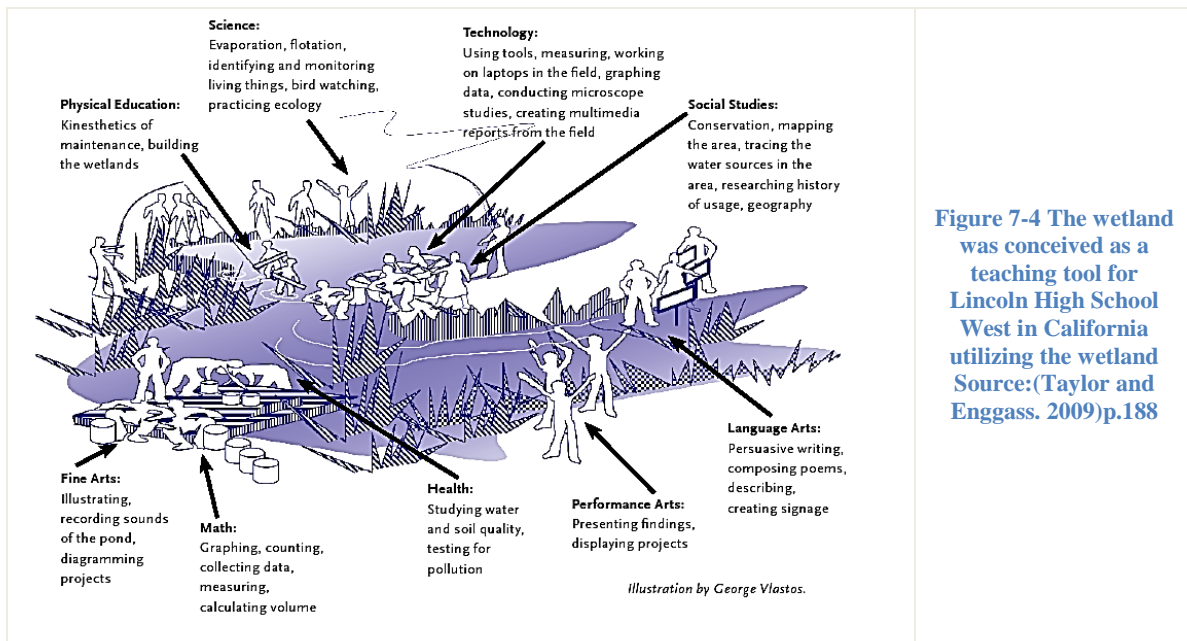


Figure 7-4 The wetland was conceived as a teaching tool for Lincoln High School West in California utilizing the wetland Source:(Taylor and Enggass. 2009)p.188


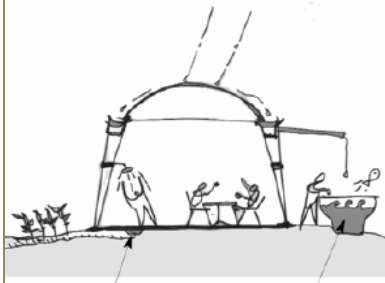
- Provide biology concepts through landscape architecture. Every plant selected for school grounds can become a teaching tool (TAYLOR AND ENGGASS. 2009)

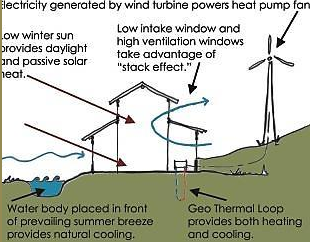
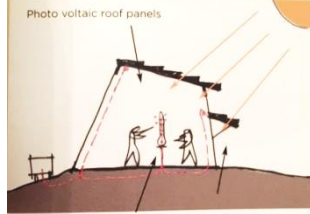
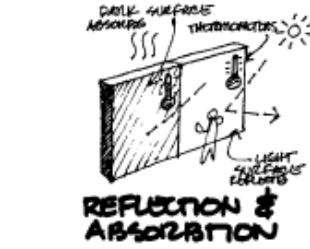
8 Learning from Green school-wide systems

The problem of sustainability is a culture issue. It is something that needs to be integrated very actively into the community and the purpose for Greening the schools is that children are exposed to these principles. It's a way of sharing the information beyond the school and effectively raising the awareness in the community. (LIPPMAN 2010) Green architectural elements can be designed for their maximum potential as learning manifestations. The following table highlights Green school-wide systems (lighting, heating, ventilation, and so on) as three-dimensional textbooks for learning. Furthermore, it demonstrates outdoor learning zones, which are conceived as part of the total academic picture for school design. (TAYLOR AND ENGGASS. 2009) The following table show how learning opportunities can emerge from carefully designed places and objects.

- Identifies the architectural element or system (manifestation) and Describes ways to enhance the design potential of the element
- Lists educational implications or concepts embedded in the Green architecture
- Demonstrate examples of designing the learning environment as a teaching tool

Table 8-1 Architectural Element: Green Architecture source: compiled from Anne Taylor's book Linking architecture and education: sustainable design for learning environments (Taylor and Engass. 2009)p.198-215

	Enhanced Design Potential	Educational Implications (Concepts)	Examples
Site, Outdoor learning zones , and Learning landscape	<p>Native Landscape, Xeriscape in dry climates</p> <p>Vary types of gardens for learning: vegetable, herb, insect, flower, butterfly, historical</p> <p>Preserve, restore, or create habitat for native creatures.</p> <p>use indigenous materials and building technique</p> <p>Outdoor classrooms</p> <p>Ecosystem Restoration</p> <p>water irrigation systems</p> <p>water recycling systems, cisterns for rain collection canals</p> <p>build for energy plays(solar collector, sundial, windmill, weather stations)</p> <p>consider access for the community</p> <p>include connections to local agriculture or landforms to emphasize individualized sense of place</p> <p>include signage about life zone as a learning tool</p>	<p>Natural resources</p> <p>Earth science</p> <p>Ecology</p> <p>Environment</p> <p>Cycles</p> <p>Agriculture</p> <p>Irrigation</p> <p>Biology</p> <p>Community</p> <p>Culture</p> <p>solar cycles,</p> <p>weather</p> <p>climate</p> <p>Energy</p> <p>preservation</p> <p>conservation</p> <p>Stewardship</p>	<p>A nature trail, while supporting studies in biology, ecology, botany, and animal behavior, can also serve as a running track, becoming a vital part of a physical education program.</p>  <p>Paths and site development can be oriented to animal habits, encouraging existing species to remain and additional ones to return.</p> <p>Figure 8-1 demonstrates indoor-outdoor connection and outdoor settings that support studies in biology, ecology, botany and animal behavior. Source: (NAIR, FIELDING ET AL. 2009) P.111</p>
Water	<p>Set up gray water recycling systems</p> <p>Design water or wetlands habitat on site</p> <p>A cooling tower with adjacent ponds, usually located under a ramada or shade structure, can lower temperatures forty degrees.</p> <p>decrease water consumption</p> <p>Use signage and labeling for any water systems (work stations act as museums for learning)</p> <p>Use transparent pipes (system open to visibility)</p> <p>provide a diagram of the entire water system from the water fountain to the sewage treatment plant</p> <p>investigate water recycling system</p>	<p>Water cycle</p> <p>Erosion, flooding</p> <p>climate, weather</p> <p>precipitation</p> <p>temperature</p> <p>Drainage and irrigation systems</p> <p>water conservation, pollution, quality, chemistry of water</p> <p>flow, cohesion (properties of water)</p> <p>mechanics</p>	 <p>"Gray" water from showers and sinks used for sub-surface irrigation of gardens. Rain water harvested from roof stored in cisterns</p> <p>Figure 8-2 demonstrates gray water recycling system and the use of harvested rain water at school (systems visible for student as a learning/teaching tool) source:(NAIR, FIELDING ET AL. 2009)P.163</p>

<p>Energy</p>	<p>Solar panel/photovoltaic</p> <p>Windmill on playground</p> <p>Use the power of natural light to increase efficiency: add photovoltaic capacity to existing building components such as awnings, canopies, rooftop arrays.</p> <p>Monitoring systems</p> <p>Green house</p> <p>clear plate over light switch to show circuitry or other exposed systems (electricity museum)</p> <p>Ground cooling systems</p> <p>Solar heating</p> <p>Multiple lighting systems flexible for use by students</p> <p>leave part of system open to visibility to act as a museum. Label parts.</p> <p>paint exposed portion of duct system, color-coded to show intake and return.</p> <p>map the duct systems</p> <p>HVAC monitoring systems accessible to students</p>	<p>Electricity sources and systems</p> <p>photovoltaic alternative energy, conservation</p> <p>Climate/microclimate</p> <p>Heat flow, conduction</p> <p>Mechanics</p> <p>Stewardship</p> <p>Convection (air)</p> <p>Radiation (radiator)</p> <p>Conduction (electric stove)</p> <p>HVAC (heating, ventilation, cooling)</p> <p>Color/spectrum</p> <p>Light</p>	 <p>Electricity generated by wind turbine powers heat pump fan</p> <p>Low winter sun provides daylight and passive solar heat.</p> <p>Low intake window and high ventilation windows take advantage of "stack effect."</p> <p>Water body placed in front of prevailing summer breeze provides natural cooling.</p> <p>Geo Thermal Loop provides both heating and cooling.</p> <p>Figure 8-3 Several strategies for cooling and heating are visible and accessible to students. Source: (NAIR, FIELDING ET AL. 2009)P.155</p>  <p>Photo voltaic roof panels</p> <p>Voltage meter allows students to monitor energy transferred from photo voltaic cells.</p> <p>Rather than hiding photo voltaic cells, they may be placed in highly visible locations, such as on an entry canopy, making the building a 3-dimensional text book.</p> <p>Figure 8-4 enable students to monitor energy transferred from photovoltaic Source: (Nair, Fielding et al. 2009)P.153</p>
<p>Material and Resources</p>	<p>Use nonpolluting materials for high air quality</p> <p>Provide museum quality displays of wall structure, insulation and materials.</p> <p>use green and biobased materials</p> <p>local material</p> <p>recycled, salvaged, reused, degradable materials</p>	<p>Materials</p> <p>Waste management</p> <p>Structure</p> <p>Products</p> <p>Resources</p> <p>Texture</p> <p>Health</p> <p>measurement</p> <p>R-value</p>	 <p>Figure 8-5 exposed building's materials allow students to study their heat absorbing and reflecting qualities. Source: (TAYLOR AND ENGGASS. 2009)P.217</p>

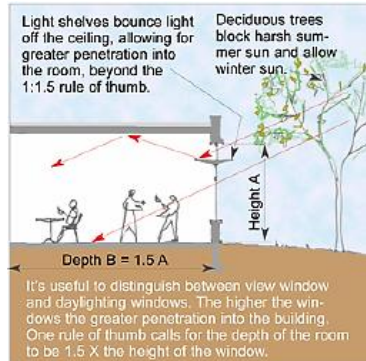
Indoor Environmental Quality	Natural lighting	Shadows, light	
	Natural ventilation	Solar system	
Operable windows	Reflection, refraction, absorption	Cardinal direction	
Orientation and siting of building	Seasons	Physics (light and sound)	
Skylights	Physics (light and sound)	Mechanics(window, solar design)	
controls for natural light (shades, louvers, remote control blinds, etc.)	Temperature	Weather	
use of courtyards	Health(air quality)		
Acoustics			

Figure 8-6 illustrates daylighting that enhance the quality of the learning environment.
 source:(NAIR, FIELDING ET AL. 2009)P.151

CONCLUSION:

Conceiving the learning environment as an active learning source that reflects a hidden curriculum will significantly affect the learning process and inform decisions about shaping the learning environment. The following conclusions from this work can be drawn as follows:

1. Utilizing the green school as a teaching tool through integrating pedagogy into school design, will:
 - Encourage environmental stewardship among students.
 - Spread the awareness of sustainable issues in the whole community through different ways such as (signage, interior displays, guided tours, etc.).
2. Educational concepts and strategies inform the design decisions of Green school that teach.
3. Architects should design green school elements for their maximum potential as learning manifestations for sustainability.
4. Educators should maximize the use of green school that teaches through writing a new integrated curriculum based on themes from environmental manifestations of buildings and landscape.
5. Engage students through hands-on learning opportunities provided by green school, as well as in the operation of their schools, will allow them to acquire knowledge and develop practical skills.

Consequently, it is recommended to green our public school buildings in Egypt in order to enhance our student's health and performance while preserving our natural resources and environment. Furthermore, designing these schools to act as a pedagogical tool will enable the government to foster a deep understanding of sustainability within students and share this information with the whole community.

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