



# A Review of Green School Design Guidelines

Nur Hidayatuljamilah Ramli, Mawar Masri,  
Mohd. Zafrullah Mohd. Taib, Norhazarina Abd Hamid

Faculty of Architecture, Planning & Surveying,  
Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia

hidayahjamilah@yahoo.com

## Abstract

The purpose of this paper is to execute a comparative study of green school guidelines with the review of the current literature. The method of this study is to use secondary data regarding green school design elements in foreign countries' school. The data assembled from various countries will be discussed with regards to the applications of its elements into Malaysian green school design. The result of the comparative study will be used to identify the design elements of Malaysian school designs towards a green and sustainable building. Therefore, finding from this research is expected to encourage the Malaysian government to develop and create a guideline for green school design in Malaysia.

Keywords: School Environment; Green Design Components; Green School Design Guideline; Students' Outcome

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## 1.0 Introduction

Schools are institutional spaces for communities of learners, including both students and teachers. The green school design is looked upon as one of the elements that influence the students' outcome. Previous study shows that the school environment affected the students' achievement (Rudd, et. al, 2008 and Schneider, 2002). There are many factors that contribute to achieving the quality of education and increasing students' outcome. The literature review shows that the student's achievement was contributed to the quality of education as well as the quality of life. Hence, to achieve the objective of positive school environment, the green school design should be adapted into school design in Malaysia. There are many elements and components that contribute to green school design. Some of the important components are building envelop, building orientation and indoor environment quality (National Research Council, 2006).

Since the school environment contributes to this phenomenon, the purpose of this paper is to execute a comparative study of green school guidelines with the review of the current literature. This study reviews the literature on the green school guidelines and benefits of green school design. The method of this study is to use secondary data regarding green school guidelines in foreign countries' school. The data assembled from various countries will be discussed regarding the applications of its elements into Malaysian green school design. The result of comparative study will be used to identify the design elements of Malaysian school design towards a green and sustainable building.

Definition of sustainability is varied and possibly need to be framed within a specific context to hold specific meaning, although there is extensive agreement that it is about balancing and integrating environmental, social and economic elements (Beyer, 2002). There is no consistent definition on what it means to be sustainable in terms of building and construction and human settlements.

Sustainable Building is a fully integrated; "whole building" approach to design, construction, and operation. Sustainable buildings are also referred to as *green* or *high performance* buildings designed to: provide optimal environmental and economic performance; increase efficiencies thereby saving energy, water, and other resources; furnish satisfying, productive, and quality indoor spaces; use environmentally preferable materials; and educate building occupants about efficiency and conservation (Olson & Kellum, 2003).

Dick (2007) stated that a '*green*' building also known as '*sustainable*' building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment.

## 2.0 Green School

### 2.1 Green School Definition

The U.S. Green Building Council (USGBC) had defined a green school as a school building or facilities that create a healthy environment that is conducive to learning as well as saving

energy, resources and money. Gordon (2010) states that green school is the physical result of the consensus process of planning, design, and construction that takes into account a building's performance over its entire 60 year life cycle. Gordon further pointed out that green school is such a building that it can provide clean fresh air, a comfortable temperature range, abundant light, and low distraction from unwanted noise while also maximizing resource efficiency, minimizing pollution, and teaching students the importance of innovation in the built environment.

## **2.2 Green School Benefits**

Kats et.al (2005), had underlined the benefits of green schools as in the Capital E. Report which are energy cost saving, emissions reduction benefits, water and wastewater benefits, health and learning benefits and financial benefits. According to Kats (2006), green schools provide financial benefits that are 20 times larger than conventional schools. The report review that green schools cost less than 2% more than conventional schools in America. Greening school design provides an extraordinarily cost-effective way to enhance student learning, reduce health and operational costs and, ultimately, increase school quality and competitiveness. Gordon (2010) agreed that green schools will more than pay for the occupants in healthier indoor environments and saving in energy and water. Gordon (2010) further pointed out that green school also saves money in operational cost. Saving money in operations and maintenance of green school building is beneficial to the school community because it frees up those operational funds for more teachers, equipment and activities.

In a survey by Turner Construction Company, one of the leading general builders in the U.S., the results show that green building costs less than the general public thinks, but this misconception is still the primary obstacle for people to accept the construction of green building. Turner Green Building Survey on 2005 emphasized that the benefits of green school design can be divided into three. There are financial benefits, environmental benefits and student, teacher and societal benefits.

Similarly to Kats et.al (2005), green schools use an average of 33% less energy than conventionally designed schools. It is saving the cost of the school building as well as reduced pollution and decreased infrastructure and maintenance costs to deliver water and to transport and treat wastewater.

Furthermore, green schools design provide additional benefits that are not quantified such as reduced teacher sick days, reduced operations and maintenance costs, reduced insured and uninsured risks, improved power quality and reliability, increased state competitiveness, reduced social inequity, and educational enrichment as reported by Kats (2006).

The USGBC researched the benefits of sustainable or green schools. The benefits were broad, ranging from the impact on student health, test scores, and teacher retention to reduce operational costs (USGBC, 2008). Facility improvements directly related to student performance improvements is additional daylight, improved indoor air quality, enhanced classroom acoustics, and comfortable and consistent indoor temperatures (USGBC, 2008). The green school itself also serves as a teaching tool – demonstrating to students, faculty,

and parent's practical ways that it can turn back the clock on global warming while creating healthier, more efficient, and less costly learning environments.

### 2.3 Green School Guidelines

According to Gordon (2010), the U.S. Green Building Council initially developed the LEED rating system to address all buildings. The project checklist for LEED for schools has seven categories, five of which have requisite goals and all of which have additional goals that award a school project various points. The seven categories are sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation in design, and regional priority.

The criteria of green school guideline in Collaborative for High Performance Schools (CHPS) are similar to USGBC LEED, but it was developed specifically for schools. The CHPS Web site defines green schools as having the following 13 attributes: "healthy, comfortable, energy efficient, material efficient, water efficient, easy to maintain and operate, commissioned, environmentally responsive site, a building that teaches, safe and secure, community resource, stimulating architecture, and adaptable to changing needs" (CHPS, 2004). The criterion for achieving green schools addresses seven main categories: Leadership, Education, and Innovation; Sustainable Sites; Water; Energy; Climate; Materials and Waste Management; and Indoor Environmental Quality.

As stated in the Green School attribute for Health and Learning report by U.S National Academy of Sciences (NRC, 2006), green school objectives are to be achieved through the guidelines. Green school design guidelines move well beyond design and engineering criteria for the buildings, addressing land use, processes for construction and equipment installation, and operation and maintenance practices. It includes design and engineering techniques to meet specific objectives which are:

- Locating schools near public transportation to reduce pollution
- Placing a building on a green site so as to minimize its environmental impact and make the most of available natural light and solar gain
- Designing irrigation systems and indoor plumbing systems to conserve water
- Designing energy and lighting systems to conserve fossil fuels and maximizing the use of renewable resources
- Selecting materials that are nontoxic, biodegradable, and easily recycled
- Creating an indoor environment that provides occupants with a comfortable temperature, good air quality, lighting, and acoustics.

The U.S. National Academy of Sciences report also recommend that green school design guidelines should include construction techniques to meet objectives such as the appropriate storage of materials on construction sites to avoid water damage, decrease the utilization of waste materials and appropriate disposal to reduce resource depletion, and the introduction of commissioning practices to ensure the performance of building systems. Operation and maintenance practices are to achieve good indoor environmental quality including using nontoxic materials, replacing air filters in ventilation systems regularly, and establishing a long-term indoor environmental management plan (NRC, 2006).

Green school guidelines differ for each authority in the country. However, there are still similarity in some aspects or criteria such as indoor air quality, day lighting, energy efficiency, acoustic element and water efficiency. Table 1 showed differences between green school design elements in three authorities which are the U.S. Environmental Protection Agency (U.S. EPA), Collaborative for High Performance Schools (CHPS) and U.S. Green Building Council – LEED For Schools (K-12: The Centre for Green Schools).

Table 1 showed common criteria for all the authorities and those criteria may be concluded to be the most important criteria. Almost all authorities agreed in order to design and build a green school building these criteria are essential. Therefore, it is essential that these criteria to be considered as very important in developing the Malaysian green school design guideline in future. The criteria are indoor air quality, thermal comfort, acoustic, day lighting, water efficiency and energy efficiency.

The second emphasize criteria that is also important in guideline is the lighting fittings and materials as well as site selection. These criteria are more emphasize on interior design elements for example the energy efficiency lighting, low emitting materials and material efficiency. It is observe that this criteria concerning and additional factors to maintaining occupant's health. However, site selection is vital criteria that should be considered in designing the green school building. Selection of the site is the most important criteria that should be consider before start to design the green school building in order to acquire the thermal comfort of the occupant and to optimize the green school design. Other optional criteria such as solar panels, green roof, mold prevention and recycling are guideline from US Building Council LEED which is parallel to the engineering of the school building. US EPA emphasize on the other optional which are ease in maintaining and operating with save and secure environment that is more in lined with the objectives for the environment. However, CHPS only highlighted the pollutant and chemical source control as the optional criteria in green school design guideline.

Table 1. Differences between green school design elements in three authorities.

| Criteria                            | Authorities  |   |   |
|-------------------------------------|--|---|---|
|                                     | US Environmental Protection Agency (US EPA) Design Tools for Schools | Collaborative for High Performance Schools (CHPS) | US Green Building Council LEED for Schools (The Center for Green School-K-12 Education) |
| Indoor air quality                  | √  | √   | √   |
| Thermal Comfort                     | √  | √   | √   |
| Acoustic                            | √  | √   | √   |
| Day lighting                        | √  | √   | √   |
| Solar panels                        |  |   | √   |
| Green roof                          |  |   | √   |
| Water Efficiency                    | √  | √   | √   |
| Energy Efficiency                   | √  | √   | √   |
| Energy Efficient Lighting           | √  |   | √   |
| Mold Prevention                     |  |   | √   |
| Join Use of Facilities              |  |   | √   |
| Recycling                           |  |   | √   |
| Low-Emitting Materials              |  | √   | √   |
| Alternative Transport Option        |  |   | √   |
| Material Efficient                  | √  | √   |   |
| Easy to Maintain & Operate          | √  |   |   |
| Save & Secure                       | √  |   |   |
| Commissioned                        | √  |   |   |
| Site Selection                      | √  | √   |   |
| Pollutant & Chemical Source Control |  | √   |   |

### **3.0 Conclusion**

In Malaysia, obviously the criteria that were concluded from Table 1 as very important to all authorities studied and should not be compromise in the effort of developing the Malaysian green school design guideline. Again listed here, there are indoor air quality, thermal comfort, acoustic, day lighting, water efficiency and energy efficiency. However, the reader should note that criteria in a green school guideline by CHPS on the environmentalist perspective, and approach is more towards the interior environment, while the criteria by US Green Building Council LEED were develop through the engineers' perspective, therefore it emphasize more towards the engineering aspect of the school building.

The literature reviews lead to conclusion that the Malaysian government should start taking action in designing and constructing the green school by referring to the general guideline, but molding at uniquely to suit to the Malaysian climate and culture. However, there are several criteria that can be adapted into Malaysia school building as the checklist from result of comparative study above. The criteria are good indoor air quality (IAQ), visual comfort, thermal comfort, acoustic comfort, energy, water and materials efficiency.

Nevertheless, the author would like to point out another perspective regarding the criteria discussed of green school design. Most of the criteria if the reader noticed, are also contributing factors of a school's physical environment, especially to the classroom.

#### **3.1 Good IAQ (Indoor Air Quality)**

In designing Malaysian school, first important thing is to prevent indoor air pollution. It can be done by using nontoxic interior finishes, cleaners, and school supplies. Moreover, in construct the schools building, it should be avoiding sites that are wet, have nearby hazards or fume from freeways and keep idling vehicles away from the school. Design and build school building with plenty of windows that operable.

#### **3.2 Visual Comfort**

Important to the designer to incorporate day lighting that can control as well as eliminate glare in designing school building in Malaysia. In addition, using high performance electric lighting such as energy efficient lighting system can also contribute to green school design. The designer should know to position windows and arrange the room layouts to maximize natural light.

#### **3.3 Thermal Comfort**

In order to gain thermal comfort in a school building interiors, designer should properly install mechanical ventilation, and air conditioning (HVAC) systems or in other hand, think how to maximize the natural ventilation since Malaysia have good natural air flow.

#### **3.4 Acoustic Comfort**

Acoustic comfort can be reduce from sound reverberations, including those from HVAC systems, electric appliances and TV/VCRs. Building the schools away from the main road or highways can limit the amount of "outside" noise from roads, also using good thermal materials can reduce noise form playgrounds, gyms or cafeterias.

### 3.5 Energy, Water, & Material Efficiency

Malaysian schools should use renewable energy when possible. First, reducing water use in school with water-conserving faucets and fixtures as well as using high efficiency equipment and automatic bathroom sink shutoffs. School community should use recycled materials, implement a recycling plan for the school and encourage school community to be active in reduce, reuse and recycle activities. Material efficiency and conservation promotes environmental responsibility and it will benefit in decreasing the operational costs to schools community.

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