

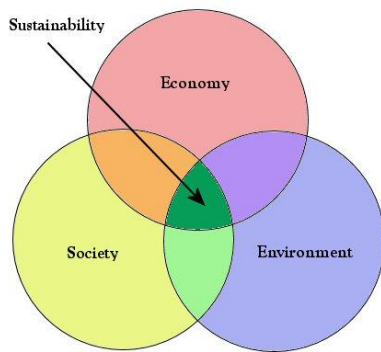
Sustainability in schools: an introduction to sustainable practices and design



Introduction

A sustainable system can last forever. To be sustainable, resources are not used faster than they can regenerate, and resources are recycled back into the system. For instance, in a sustainable forest, trees can be harvested, but only at the rate at which they are able to regenerate. More trees can be planted to replace the harvested trees, and the forest sustains itself on soil nutrients which are replenished as trees die.

Sustainability is often thought of as an ecological concept, but it is tied to social, economic, and cultural themes. Topics from overpopulation, poverty, over-consumption, and inequity are related to sustainability. Many cultures place deep value on the environment, and the very perpetuation of human life depends on using the Earth's resources sustainably. Sustainability can be achieved as a balance point between the economy, society, and environment.



Ecosystem services describe the many different goods and services that nature provides to humans. Examples of these include wetlands that filter and supply water, forests that sequester carbon, preserve the soil, and provide timber, and agricultural land which supplies food¹.

Ecosystem services can be classified into four categories relating to their value to humans – supporting services, regulating services, provisioning services, and cultural services (Figure 1). Supporting services are required for all other ecosystem services to exist – they include the creation of soil, plants, and nutrients. Regulating services exist as a result of the regulations of the ecosystem on certain things, such as insects, water, and waste. Provisioning services are related to good that the ecosystem produces, like food, timber, air, and water. Finally, cultural services relate to the intrinsic nature of the system to provide aesthetic or spiritual benefits to humans². If the ability of these systems to provide ecosystem services is compromised, humans suffer.

In general, sustainability can be thought of as an action that both improves conditions for humans (socially, politically, economically) and does not negatively impact the environment³. For sustainable initiatives to be successful, the needs of humans must be balanced.

Sustainability in the United States

The existence of environmental protection laws in the United States stems from the observation that unchecked human activity often leads to environmental disaster. Forests have been decimated by logging and soils have been degraded through negligent

farming operations. Overharvesting of game animals and fish have led to massive population declines. Industrialization resulted in pollution of the air and the water. These examples negatively affect living organisms and the environment, and humans are also harmed due to reductions in ecosystem services.

These factors led to the first law in the United States which protected the environment. This law was called the National Environmental Policy Act of 1969 (NEPA). Many other laws which restricted air and water pollution followed. In 1970, the Environmental Protection Agency (EPA) was created in order to enforce many of these laws, some of the most substantial being the Clean Water Act and the Clean Air Act⁴. These laws had the dual role of protecting the environment and benefitting humans.



Figure 1. The four components of ecosystem services provided by a forest system.

Sustainable Design and School Sustainability

The goal of ecologically-oriented sustainable design is to preserve ecosystem services, reduce nonrenewable resource use, and harmoniously connect humans to their environment. These principles are generally in agreement with basic design principles which emphasize durability and efficiency, and there is greater emphasis on low environmental impact construction.

Increasingly, schools are adopting sustainable practices and eco-friendly design. These sustainable practices have the dual goal of educating students about how to live sustainably and protecting the environment. This document serves as an introduction to considerations and design possibilities to make schools more sustainable in a variety of ways.

Transportation

The location of the school determines how students will travel – if it is located near the homes of many students, and sidewalks are accessible, biking and walking will be encouraged. To encourage biking, bicycle storage or bicycle racks should be available. If the school is distant, students will arrive by car or bus. Therefore, planning is required in the placement of schools and bus routes in order to service the most students.



If a vehicle must be used to travel to school, bus or carpool should be provided. This reduces a person's carbon footprint and also saves money^{5,6}. Private vehicles account for 55% of the carbon footprint of a household. By taking public transportation instead of a private vehicle, the vehicle-related carbon footprint of a household can be reduced by over 50%⁶. The fewer cars dropping off or picking up students, the less traffic and pedestrian safety issues will be encountered.



Follow the link to calculate the yearly cost of your commute, emissions, and benefits of carpooling:

<http://www.gmtma.org/pg-cost-calculator.php>.

Daily activities in the classroom

There are many small practices that can be accomplished on a daily basis to promote energy efficiency in the classroom. These activities can be performed by students and teachers, and may be best accomplished by assigning a classroom “Sustainability Monitor” that goes through a daily sustainability checklist.

1. Turn all lights and computers off when the classroom is unoccupied
2. Unplug electronics over holidays – avoid phantom energy draining, which occurs when devices are plugged up but not being used
3. Designate a classroom recycle monitor
4. Print on both sides of paper or go paperless



School-wide energy saving initiatives

Other energy-saving initiatives can be programmed into the school’s operating system or adopted as a school-wide policy. Most of these are best accomplished in a new building, where planning and initial purchasing can set the standard.

1. Limit heating and cooling – adjust school-wide temperature to be hotter in the summer and cooler in the winter
2. Install LED light bulbs (Figure 2)
3. Put lights on a motion sensor
4. Limit heating and cooling so that it is warmer in the summer and cooler in the winter
5. Install low-flow toilets and faucets on a timer
6. Limit the sale of bottled water, install bottle filling stations (Figure 3)
7. Install recycling bins in classrooms and in the halls
8. Purchase recycled paper for printers
9. Label where trash goes – what landfill or recycling center?
10. Reduce paper towel use and encourage electric hand dryers





LED is short for light-emitting diode

LEDs are efficient and environmentally friendly

LEDs can be up to 8x more efficient and can last up to 25x longer than incandescent lights.

Figure 2. Facts about LED lights show that they are more environmentally friendly and save money⁷.



On average, Americans use over 160 water bottles each year, but only recycle 23% of them.



Bottled water is not safer than tap water in the United States, and has less rigorous testing than municipal water (tap water).



Many bottled water companies fill their bottles with tap water, so drinking out of a water bottle is no different than drinking tap water



What can you do? Purchase a long-lasting water bottle and fill it with purified tap water

Figure 3. Facts about bottled water reveal the negative effects of using bottled water and possible solutions⁸.

School Garden

A school garden is one of the best ways to teach students about agriculture, organic food, and waste utilization. School gardens can come in many different forms, from small planter boxes to large plots of land.

In general, fertile, fluffy (not compacted), well-drained soil receives at least 6 hours of direct sunlight is ideal for most plants. In Georgia, the red clay typical of the Piedmont may serve as a challenge to growing plants due to its tendency to hold water and become very hard as it dries. Mixing organic matter or planter soil with the red clay and adding compost on a regular basis is recommended for growing plants.



Plant water requirements may vary, but most plants require 1-2 inches of water each week, or more water when the top inch of soil becomes dry. When starting a garden, it is crucial to consider the requirements of the selected plants – many can only survive after the last frost, and others are not adapted to the Georgia climate. Native plants or Georgia climate-specific cultivars are recommended⁹.

The benefits of a school garden are not just fresh organic food that can be used in a cafeteria or sold as a fundraiser. Students will also learn about the plant life cycle; as a



plant grows from seed to seedling, they can witness vegetative growth (asexual reproduction) and sexual reproduction. Students can examine flower parts and learn about plant care, weed management, and where their food comes from.

A large variety of fruits and vegetables can thrive in Georgia, including broccoli, carrots, lettuce, peppers, pumpkins, tomatoes, and watermelon.

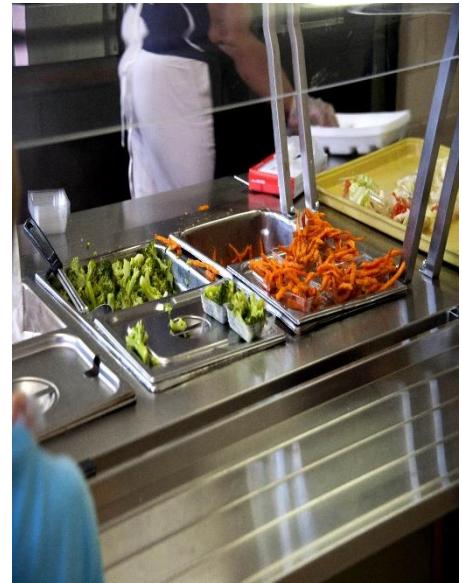
Recommended fruits and veggies, their cultivars, and their planting times:

http://www.webgrower.com/regional/pdf/GA_vegplantchart_cir963.pdf

Cafeteria

The school cafeteria showcases sustainability, as it can represent a contained system that can utilize waste. A school can grow its own food (or supplement meals with organic food), generate compost for a garden, and encourage limiting waste.

In the cafeteria, students and serving staff can reduce waste by controlling portions and practicing mindfulness about how overfilling plates wastes food¹⁰. One study of food waste by middle schoolers found that less than 85% of most meal components were consumed, equaling over \$1,200,000 in waste when extrapolated to school lunches across the country. The authors recommended focusing on creating more palatable meals, which may lead to less food waste and more nutrient uptake by students¹¹. Measuring the amount of food waste created after different meals and polling students on food choices may inform administrators of successful and unsuccessful meals. Similarly, encouraging students to bring lunches and snacks in reusable containers and carry reusable water bottles can reduce waste.



Reusable plates and silverware are more environmentally friendly than Styrofoam plates. Instead of purchasing disposable plates many times throughout the year, which leads to a larger carbon footprint due to the costs associated with manufacturing and transporting Styrofoam plates, reusable plates can be purchased once. Styrofoam plates cannot be recycled and contribute to landfills, where they will last for hundreds of years. Although washing reusable plates is more time consuming than using disposable plates, they are more environmentally friendly and have the possibility to be recycled¹². One recent alternative to this issue is compostable plates and eating utensils. Price for these compostable materials has been the barrier, but new advances and collective purchasing are reducing costs so that they are comparable to Styrofoam plates¹³.

One popular strategy to encourage eating locally and reducing energy costs associated with certain foods is to hold “Meatless Mondays” every week or once a month. In addition to health benefits such as reducing the chances of developing cancer, heart disease, or diabetes, going meatless is more sustainable. Over 1,800 gallons of water are required to produce a single pound of beef, whereas one pound of vegetables requires 98% less water¹⁴. Not only does going meatless reduce water use, but it also conserves energy spent raising livestock and transporting them cross-country or transnationally. “Zero Waste Day” is another popular cafeteria and school-wide activity where students attempt to generate no waste that reaches a landfill.

Energy Star Appliances

Schools can purchase Energy Star labeled appliances which save energy and are more environmentally friendly than their counterparts.

The Energy Star program was started by the Environmental Protection Agency (EPA) under the Clean Air Act. Its goal is to promote through labeling energy efficient products to be used by consumers – and around 85% of Americans recognize the Energy Star label. Through this program, the EPA is reducing carbon emissions and increasing efficiency¹⁵.



Waste

According to the EPA, Americans produce over 250 million tons of waste, and recycled less than 35% of it¹⁶. Once in a landfill, trash can take hundreds of years to decompose. It takes a glass bottle 1 million years to decompose and a plastic water bottle 450 years to decompose. However, these items can be recycled and used again^{16,17}.

What can we recycle? Check with who your recycling goes to because there may be additional restrictions. In general:

- Plastic grocery bags and other thin plastic bags
- Plastic food containers and lids; plastic with recycling symbols 1-6
- Most metal objects and appliances
- Paper that is mostly clean (not soiled with food)

What does the recycling symbol and code mean?¹⁸ You can find recycling symbols on various plastics, which identifies the type of plastic and how easily it can be turned into more plastic. Types 1 and 2 are the most easily recycled, whereas types 3-7 are more difficult to recycle.

- Type 1: polyethylene terephthalate
 - o Bottled drinks
- Type 2: high-density polyethylene
 - o Hard plastics like laundry detergent dispensers
- Type 3: polyvinyl chloride
 - o Durable plastic like shampoo bottles and credit cards
- Type 4: low-density polyethylene
 - o Thinner plastics, such as in plastic grocery bags, some clothing
- Type 5: polypropylene
 - o Reusable containers, textiles
- Type 6: polystyrene
 - o Plastic foam plates
- Type 7: all other plastics



Outdoors and Built Environment

The school's natural environment and building design can get students to think about sustainability and nature. Schools can take advantage of renewable resources, such as the sun in order to strategically building windows and skylights so that natural lighting can be used in the place of light fixtures (daylighting)¹⁹.

A school located next to green space, such as a forest or park, benefits the wellbeing of the students and staff. Fact about green spaces on grades and happiness. Not only is carbon being stored in these trees and plants, but they absorb carbon dioxide from the air. A forest can be used as a living laboratory where students can learn about plants, ecology, insects, ecosystems, and more.

Stormwater management

Cities are full of roads, parking lots, and roofs that alter the natural flow of stormwater. These are known as impervious surfaces, because they do not allow water to filter into the ground. Instead, these impervious surfaces rapidly move water into streams and may promote flooding. Similarly due to urbanization, this water can be polluted by chemicals (non-point pollution), such as fertilizers, car chemicals, and sediment before it enters water bodies²⁰.

There are several solutions involving green infrastructure that reduces flooding, slows stormwater, and are aesthetically pleasing²¹

Permeable Pavement

Permeable pavement allows rainwater to infiltrate into the soil, recommended for low traffic areas, parking lots, sports areas²²



Green Roofs

Green roofs are vegetated roofs that provide wildlife habitat and rainwater filtration²². Structural considerations must be made in order to install a green roof, and they can either be integrated into a roof as it is built or installed after construction. Because green roofs are heavy – soil and water are an added burden – the structural properties of the roof must be assessed. To protect the roof from water damage, additional insulation, waterproofing, and drainage is needed.



Benefits of a green roof include:

- Stormwater runoff reduction
- Reduce costs of heating and cooling
- Reduce “heat island effect”
- Aesthetics

Plants recommended are native grasses, succulents, and *Sedum*, which can withstand dry periods

For information about green roof design and benefits:

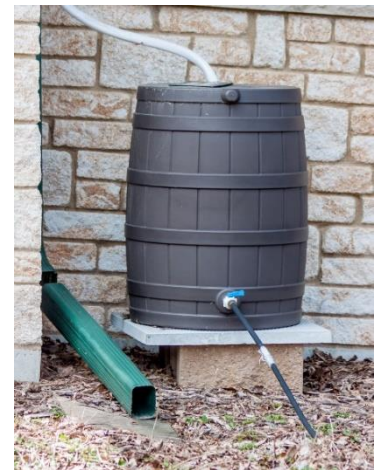
http://www.lid-stormwater.net/greenroofs_home.htm

http://news.nationalgeographic.com/news/2002/11/1115_021115_GreenRoofs.html

Rain Barrels

Rain barrels are rainwater storage containers that can be connected to roof drainage systems. When connecting a rain barrel system, it is important to elevate the barrel so that water can be easily drained from a tap at the bottom of the barrel. Depending on the amount of debris from the drainage pipes, filtering systems can also be installed.

The benefits of a rain barrel are to reduce runoff and flooding and to reduce the amount of potable water (drinking water) used unnecessarily. Water collected in a rain barrel is not potable, but is ideal for watering a garden or washing items²².



Rain Gardens

Rain Gardens are vegetated depressions in the ground which collect and filter rainwater. They are also known as bioretention ponds at a larger scale because they retain and filter stormwater, allowing plants and soil layers to filter out chemicals and absorb nutrients²¹.

The components of a rain garden are simple, but require soil excavation. The bottom layer, which should be at least 2 feet below the soil surface, consists of rocks or sand which act as a coarse filter. A rain garden soil mix can be placed on top of this layer, where an abundance of native plants can be grown. A variety of native trees, shrubs, and herbs are recommended for rain gardens, especially those associated with wetlands²².

Some recommended plants include bonesets (*Eupatorium* sp), turtlehead (*Chelone glabra*), many native ferns (NY fern, cinnamon fern, royal fern, lady fern), Virginia sweetspire (*Itea virginica*), and buttonbush (*Cephalanthus occidentalis*)²³.



Composting

Composting reduces the amount of waste that reaches the landfill and provides nutrients for plants when spread on a garden. A compost pile can be made on the ground near a garden or kept in a bin. To create a compost pile on the ground, first place a layer of sticks and straw, then begin layering your compost. Alternate between “wet” items (food) and “dry” items (sawdust, paper). A plant-based manure can be added as a source of nitrogen for the compost pile to aid in its breaking down. For the compost pile to decompose, it must be kept damp and enclosed to retain heat. This can be done with tarps or pieces of wood that form a box. At least once a month, the compost pile needs to be mixed up to aid in decomposition using a shovel²⁴.

What can be composted?

- Leaves, grass
- Fruit and food scraps (but do not compost fruits with rinds or peels such as oranges or bananas)
- Coffee and tea grounds
- Paper (shred first)
- Wood chips and cardboard (cut into small pieces)

What can't be composted?

- Meat
- Animal waste



Education

For school sustainability program to be successful, the faculty, staff, administration, and students must all be educated about the importance of sustainability and the school's commitment to certain practices. Developing a mission statement that describes sustainability goals for the school is the first step in this process²⁵.

The concept of sustainability and human accountability should be included in the curriculum. Students must be educated on the importance of sustainability and how the school is striving to reduce its impact on the environment. Students must be educated on why they should participate in recycling, Meatless Mondays, school garden, etc., or they will feel less motivation to do so.



Once a realistic goal has been determined, the school must plan for implementing ways to reach this goal and assessment. Some typical goals may include reducing energy costs, conserving a certain amount of water, or reducing cafeteria waste. Before implementing a sustainability goal, a baseline must be measured.

Student and Faculty-led Organizations

A student, faculty, staff, and administration-led group that focuses on sustainability issues would be well-equipped to make these measurements and recommendations to the school. This group can organize sustainability-focused events for the school, such as Zero Waste Days, Earth Day events, or garden work days, and can educate the student body. An afterschool organization could act as energy auditors which evaluate the cost and benefits of sustainable practices and determine where new initiatives are needed.

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