

## Educational sustainable Architecture Tools for Children

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### Abstract

In the present moment, our planet asks for changes in the human behaviour in order to face the atmosphere global warming, the acid rain, eminent radioactive risks, among others.

Consciousness can be attained on different levels, for example, by governmental policies and adequate legislation, research and by a responsible lifestyle of the people. People consciousness can be modified only by educational processes, which depends on theirs degree of knowledge, not forgetting that low degree of information delays this process.

Such as Brazil, countries in development have diverse social groups, consequently, with different opportunities and lifestyles. It is important to emphasise that educational programs are to be extended to everyone; this way also less privileged people will have enough information and the opportunity to change their condition. For that reason, it is necessary to carry out an extensive campaign with substantial information and educational programs, in particular for children and young people.

This paper suggests a simple educational tool to teach sustainable architecture concepts at the primary and the secondary schools, for brazilian students, with special care to tropical areas. This tool consists of family building prototype designed for saving energy with the application of efficient-energy technologies, that is, renewable energy sources, such as, solar-thermal-photovoltaic system, wind power and efficient building design principles, in order to achieve comfort conditions at minimal energy consumption, using natural procedures. The subject of this kit is to make the students assemble it by themselves and at low costs, using adequate materials. Besides, educational kits must stimulate the discussion about greenhouse effect and efficient energy consumption.

**Keywords:** Sustainable architecture, Buildings efficiency, Renewable energy source, Education

### 1. Introduction

The world energy sector demands a great investment; therefore, the rational use of energy is essential to the country development. In developing countries, such as Brazil, traditional energy resources are not enough to supply the increase in the demand without facing environmental consequences. Recently, due to the lack of investments in the electric energy sector, Brazil had energy ration problems which were caused by the rising in the demand of power and, particularly, also due to the long period of dryness during the last years. At that time, the reservoirs had reached theirs minimum level, affecting the power and water supplies.

Nowadays, in spite of the governmental efforts, the scenario is not normalised yet. In order to diversify the energetic matrix, emergency actions were undertaken, for example, the implementation of renewable energy alternatives supported by the Renewable Energy Incentive Program (PROINFA) and the Program for Energy Development in States and Municipalities (PRODEEM), involving the Government, the local communities "Municipal Administrations (City Halls), universities, federal technical schools etc.

The first steps towards the sustainable development have already been done by means of governmental policies and also by scientific community actions. Governmental directives are important, however, they are vertical decisions, which are imposed by legislation. In addition, the universities and technical schools play an important role training the technical staff for the implementation and maintenance of systems based on alternative energies. However, all these measures will not provide the intended results if a rational use of energy is not inserted into the people consciousness, modifying their lifestyle. The changing of lifestyle is as essential as it is the training of human resources. Education is the best and most efficient tool to achieve this purpose.

The concepts of efficient-renewable sources of energy in the national scenery must be incorporated in the global educational process, especially in the fundamental and secondary schools. Nowadays, these concepts are not discussed at these levels, principally at public institutes. Customs are modified by the educational process in which children play an important role as they spread their knowledge to their families. Neglecting these concepts at the educational basis means to miss the opportunity of bringing up people and to change the customs effectively. People well brought up and informed ask for their rights improving their condition of living.

This paper aims to discuss the basic idea of the efficient-renewable technologies for young people and, principally, for children, by means of an educational kit and, in this way, intending to change minds and customs. The concepts of comfort conditions saving the maximum energy will be spread into the local communities. In additional, this project will disseminate the importance of the sustainable development and its benefits applying these ideas to local realities. Brazil is a country situated between the line of Equator and the tropic of Capricorn, with many different climate regions, therefore, the educational house prototype must be sustainable for all these diversity of regions where it is to be installed.

## **2. Aspects of the educational kit**

The kit is proposed to teach the concepts in a nice, easy and funny way for children older than twelve years. At this age, the kids have sufficient knowledge to understand the basic ideas that will be discussed, since they have science classes in which the following concepts are taught: some physical and chemical phenomena by electric and heat transfer properties, material properties, irradiation, phases of the solid, liquid and gas states as well as the correspondent changing states and so on. At that time the students should have finished the first block of the fundamental school, when they have enough maturity to be able to:

- use the different sources of information and the technological resources to get knowledge;
- use the creativity, the intuition, the capacity of critical analysis and the logical thought to understand the reality and to solve problems for themselves;
- use the experiments to investigate the material properties and to indicate their applications for different forms of energy;

- make questions and assumptions on the subject in study;
- organise and to register information by means of drawings, pictures, projects, lists and small texts under instructor orientation;
- express their opinion in oral and written form and by means of drawings, questions, assumptions, data and conclusions, respecting the different opinions and also justifying their ideas.

The prototype consists of a residential building, scale 1:25 that can be entirely dismounted. It will be used to simulate buildings in hot-dry and warm-humid climate zones in Brazil, however, this idea can be also extended for other climate zones, for example, the cold zone at the south of Brazil. The correct use of the energy-efficient strategy provides a positive environmental impact.

The kit proposes some architectural design principles to reduce the energy consumption in buildings. This model was designed taking into account passive measures, like orientation of buildings, suitable use of colours, natural and zenith illumination, natural ventilation, cooling effect, external environment etc. The observance of these key topics assures a pleasant indoor climate at minimum waste of energy. Further, in the house prototype it will be added the models of wind: thermal solar and photovoltaic solar systems. In this way, the students can interact with the total prototype, understanding the basic notions of the operational renewable energy system.

This information is accessible among people with technical education – architects, engineers, ecologists and other expertise – and, in general, non-technician professionals do not have knowledge about these themes. The idea of the educational kit intends to diminish this gap.

### **3. Experiment “making – learning”**

The concepts of renewable energy and efficient-energy design will be transmitted in a simple, easy and funny way, according to the characteristics of the communities where the process will be implemented.

#### *3.1 Efficient-energy design*

First of all, children must assemble the building prototype, following the instructions presented in the kit. At this phase, the instructor must emphasize the details of the passive measures.

#### **Orientation of the building**

The orientation of the building must consider the position of the sun and the prevailing directions of the wind. The children must pay attention to the North-and South, to define the right position for the building. The north walls will receive more solar radiations according to the south latitude of the Equator. The students can verify these concepts observing their own shades. The wind orientation must be considered to maximize the natural ventilation around and inside the building.

#### **Suitable colours**

For warm regions, bright and light colours must be chosen for the external walls. The white colour is preferable due to its reflective properties. In contrast, dark colours are indicated to cold areas as they absorb heat. Newton's disk experience can be used to explain these ideas.

## **Natural/zenith illumination, natural ventilation and cooling effect**

The openings are the critical point as they absorb solar radiation (heat and direct and indirect sunlight), increase the ventilation and the cooling effect. The size, location and treatment of openings influence heat gains, air movements, the brightness and the quality of air.

- **Natural/zenith illumination**

Children must be informed about the different types of windows as well as the advantages and disadvantages of them, in order to attain the internal comfort accordingly to the climate zone. In Brazil, windows with shading devices must be focused, as they are versatile for assorted situations. Openings such as Zenith illumination (design of openings on the roof) and openings situated higher than the medium line of the walls improve the internal distribution of light, reducing the direct light and, consequently, also reducing the heat effects. It must be emphasised that the natural illumination saves the cost of using artificial lamps.

- **Natural ventilation (roof and opening design)**

Important concepts must be considered at natural ventilation: air movement due to wind and to temperature effects. Both of them are generated by differences of pressure.

For the first case, in order to make easy for children to understand the phenomenon of the air flow direction, fringes will be installed at each opening to indicate the path of the wind. Openings should be placed on opposing facades to facilitate cross-ventilation of the rooms. In general, they should have large dimensions at external and internal walls. The second case can be explained using illustrations or with the aid of a simple experiment, for example, the use of a plastic bottle to show the effect of temperature in the movement of the air. Openings will be made at the bottle and lighted incense will be inserted into it. The smoke will follow the movement of the air according to the different pressure lines generated by the temperature. This way, the concepts are easily understood and memorized by the children.

- **Cooling effect**

Using only wind and/or stack effect, the cooling effect can be created by openings for ventilation in order to remove the hot air stored inside the building (the openings for ventilation situated at different heights provide vertical ventilation – the stack effect). Small openings high located in the walls can be efficient for this purpose; cross-ventilation also contributes for the cooling effect. It is easy for the children to understand these ideas using simple schemes and also with lessons at the same time they are assembling the kit.

## **External environment**

The natural surrounding environment (trees, bushes and grass) contributes to the cooling effect inside the buildings. The presence of water in the air in its vapour form, the shading effects and the low reflection of heat that occurs in the natural surrounding contribute to the fresh air. Pavements should be avoided as they absorb and reflect heat. Children can experience this sensation by themselves.

### *3.2 Concepts of renewable energy for kids*

The information and fundamental concepts of renewable sources of energy will be applied to the children using simple experiments, that is, the most easy it's possible to imagine in order to assure the children real understanding.

### **Solar energy**

Solar energy can be converted directly or indirectly into other forms of energy, such as, heat and electricity. In the kit, two systems can be shown for the kids to explain the solar energy, which are, solar-thermal and photovoltaic system.

Other types of energy sources will be mentioned, in order to make clear the difference between non-polluted and polluted energy resource.

### **Solar energy for heating**

The application of solar energy for heating can be easily explained for children, as heating is usual in the domestic tasks and they already have notions about it. In this case, the innovation for them will be the demonstration that water heating systems work only with the solar energy, which is free and infinite. At the same time, it can be shown other applications, such as, buildings heating, drying agricultural products, solar cooker, among others. In order to simulate a flat-solar-energy collector, a black bottle will be placed on the roof of the house prototype. In the show room, this bottle with water will be heated by artificial light irradiation, instead of the sun lights. During this experiment, it will be stressed the importance of the building orientation in the performance of the solar thermal systems

### **Solar energy to generate electricity**

Before talking about solar energy to generate electricity, it will be shown the different kinds of energy, such as, fossil plants, nuclear plants, hydroelectric, biomass, solar wind energy and other. They will be classified as clean, pollute and dangerous.

In order to explain the use of the solar energy for electricity, a small PV system was built on the roof. This system consists of three panels, two batteries, threads and a small light bulb. For the children, it is important to explain that:

- the performance of a photovoltaic array is affected by sunlight and climate conditions (e.g., clouds, fog);
- the modular characteristic of photovoltaic energy admits arrays to be installed quickly and in which size is required or allowed;
- the environmental impact of a photovoltaic system is minimal.

### **Wind energy**

Some regions in Brazil have an enormous potential for wind power generation and, recently, some wind generators were built. A model of a wind generator is included into the education kit for the children in order to assure the understanding of the basic idea to transform kinetic wind energy into mechanical and electrical energy. In this model, the blades will be moved by the wind that will be simulated by a hairdryer. The directions of the hairdryer will be changed until achieve the best position. Aerodynamic concepts will be taught by some simple experiments with different profiles displaying their stiffness to the wind. For this purpose, it will be used profiles made of paper, a hairdryer to simulate the wind, a pendulum and a small frame structure as support. The movement of the pendulum will be associated to the stiffness of each profile. In addition, figures and schemes will show the aerodynamic forces along the rotor blades to explain how the wind generator works.

## **4. Conclusion**

Throughout the world, renewable energy educational focus is on the use of clean energy sources to improve the human conditions of living. For this purpose, the awareness of clean energy must be developed and the educational form is the most reliable way to achieve this

aim. Not only information of renewable energy must be incorporated at the daily life, but also changes in the lifestyle are important to ensure the success of the process. A socio-technical work must be developed in order to implement a new way of life. The community must be involved just in the beginning of the process.

Using the educational process, the idea of the kit intends to outspread the principal concepts of renewable energy and energy-efficient design technologies, such as architectural passive measures, to promote changes in the lifestyle of the families, by means of the knowledge acquired by the children.

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