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Sustainability-Infused Curriulum

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Sustainability Infused Curriculum (WIP)

Abstract

A recently established school-wide sustainability policy in 2015, explicitly states, “an experimentally integrated, environmentally and ethically sustainable system of science education and conservation practices based on the 2012 Jeju Declaration of the World Conservation Congress will be implemented through the school”.[1] Independent Schools Foundation Academy is a private Chinese bilingual school serving over 1500 students K-12 following the framework and curriculum of the International Baccalaureate Organization (IBO).

The strategy behind the implementation of this policy includes: development of a scientific, sustainable curriculum that is age appropriate; establish a culture of sustainability within the ISF community and beyond to the wider HK community; and install sustainable infrastructure that allows students to learn firsthand sustainable living practices. It is well understood that solutions to the environmental challenges facing Hong Kong and our planet will require multiple disciplines.

The current sustainability programs include: a) a whole school aerobic food waste composting system and organic farming, b) energy consumption monitoring of existing buildings, c) upcoming installation of an air pollution monitoring equipment that will correlate with the data collected by the Hong Kong government, d) a Center for Renewable Energy Education that will teach students about RE and also produce solar energy for classroom consumption, e) an underwater robotics program where students are designing and building ROVs for marine debris collection, and f) a student lead environmental group that manages the paper and used cooking oil recycling on campus. The above listed programs integrate the fundamental science and math concepts with opportunities for the students to design and engineer possible solutions.

The faculty works closely with classroom teachers (K-12) to ensure that the above mentioned projects are incorporated into the curriculum throughout the school. Interdisciplinary units (IDU) of study between the STEM subjects are being developed that encourage faculty and students to work across subject areas. Projects include Personal Projects, Extended Essays, bilingual roof-top farming for primary school students, and opportunities for students to work with outside researchers. There are also specific enrichment courses taught: green chemistry, earth systems, sustainability in a changing world, and natural water systems.

Introduction

The environmental challenges facing Hong Kong will require all stakeholders in the city to actively participate. As a K-12 school, ISF Academy is compelled to teach our students the scientific knowledge behind global warning, climate change and the impact this will have on their city when they are adults in decision making roles. However, more importantly, we are compelled to have all the students experientially design and build solutions in a safe school environment that will make a difference and inform their future. They need to know the fundamentals of both the problems and the engineering possibilities. The school is financially able to make significant investments in the projects listed in detail throughout this paper. Each program is well thought out and requires student involvement in problem definition,

possible solutions, design and build of the system, communication to the community, and ongoing monitoring of the progress made. As the students learn with their minds, hearts and hands; the sustainability problems facing Hong Kong will be more relevant and the solutions will be longer lasting. Essentially, we will have school home that is greener and more sustainable but we are aiming for that more significant multiplier effect that will impact the students' decisions throughout their lives.

Ongoing Projects

Classroom Monitoring of Energy Usage

In February 2016, 180 grade 5 students began monitoring their daily energy usage. The nine classrooms have been wired with energy tracking equipment that informs the students real-time as to their energy usage. They are analyzing the amount of energy used for air conditioners, lighting, and plugs. The nine classrooms are competing with each other to reduce their overall energy consumption over a 4 month period. A behavioral study has been set up to learn more about the students' long term motivation towards energy reduction. Several studies have been published in the past documenting this motivation for home energy use, and commercial applications; however, they are adult focused. This study will focus on how students, specifically primary school students, manage their energy usage when given information and control over the systems. Parents of these students will also be surveyed throughout the study; hoping to address the question: Are energy usage patterns changing at home as well?

Currently the school has an annual energy bill of over 4.5 million Hong Kong Dollars. The electricity used is produced by a mixture of coal, gas and nuclear energy. The students will also be learning about the Green House Gases (GHG) associated with this energy generation.

The older students in the IB higher physics classes have been in involved in the design of this experiment, the actual hardware installation, and will be making a key contribution towards monitoring the equipment and data. Classroom sets of the actual sensors are available for the students to learn firsthand both the theory behind the sensors and the engineering of both the hardware and software of the system. Figure 1 is an example of the real-time monitoring screen.

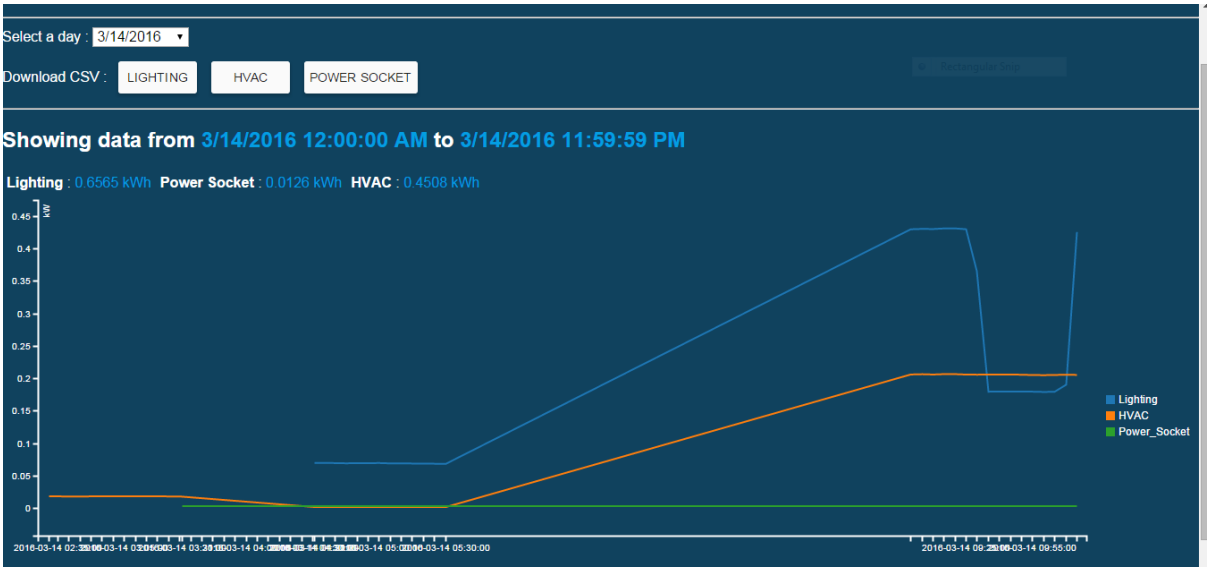

Figure 1: Grade 5 classroom example of energy tracking data

Food Waste Aerobic Composting and Organic Farming

In November 2015, a large scale aerobic food waste composting system was installed on campus. Currently the school serves a hot lunch to over 1500 students and faculty each day. Before the actual installation of this equipment, the students measured the amount of food waste/ per student/ per school day. The run rate for food waste generated at the school over an academic year is 27,000 kilograms. This is on average 90 grams per day per student. At this point, the school has the largest food waste composting system at an educational facility in Hong Kong.

The number one environmental problem facing Hong Kong in the short term is landfills are expected to be full by 2017 – 2018. Over 40 percent of the daily Hong Kong landfill waste is organic waste. The long term Green House Gas (GHG) implications and lack of land for additional landfills has required the Hong Kong to actively look for both long term and short solutions.[2]

The food waste composting system includes two different machines. The food waste is collected each day and macerated to a uniform size. At this point in the process, the food waste is also centrifuged to remove excess water. Figure 2 shows the macerator. The second machine is called the Rocket and is a large vessel measuring 1 meter in diameter and 4 meters long. Figure 3 shows the Rocket. Over a 14 day period, the food waste is aerobically digested and the final product is compost that can be used for roof-top farming on the school. The students have been involved in this project since the beginning and have most recently worked with technical experts to improve the process control of the Rocket. Initially the system was not stable and would periodically go anaerobic. This was noticed by the school

community because of the smell and the maturity of the compost at the exit of the Rocket. The students have been involved in the design and installation of a biofilter and the addition of coffee grounds (nitrogen source) to the mix.

Figure 2: Tidy Planet Dehydra installed in the ISF Academy kitchen [3]

Figure 3: Tidy Planet, Example of a Food Waste Rocket[3]

In addition to learning about food waste, aerobic processing, and environmental engineering; there are over 500 students during the academic year gardening on the roofs of the school, as shown in Figure 4.

Figure 4: Primary school children at ISF Academy gardening on the roof of the school.

A future project will be design and installation of soil gas measurement equipment for determining the Green House Gases (GHG) that are emitted from the Rocket. This system will be installed during the spring/early summer of 2016.

Underwater robotics and Marine Debris

Hong Kong is a city made up of many islands in the South China Sea and is connected to the People's Republic of China (PRC) on the Kowloon peninsula. The shore line of Hong Kong is over 733 kilometers long and the beaches and waters are polluted with marine debris and plastic pollution, as shown in Figure 5.

Figure 5: Photograph showing marine debris on Lamma Island, Hong Kong[4]

The school participates in the Hong Kong regional underwater robotics competition each April under the Marine Advanced Technology Education (MATE) organization.[5] This is a year-long course that emphasizes the engineering and building of Remote Operated Vehicles (ROV) that can be used for ocean research and underwater tasks. In April 2016, there will be 3 school teams entered in the level of competition that will be designing a basic robot with the mission of picking up marine debris and plastics off the ocean floor. This is a competition level that is specific to Hong Kong.[6]

The students learn how to build a basic ROV, design the water proof camera and lighting system, and learn how to operate an ROV under water. This competition also includes an engineering poster, technical report, and a presentation to IET chartered engineers over the course of a two day competition. Figure 6 shows ISF students building the ROVs in the Design Technology labs, and Figure 7 shows the students at the HK regional competition.

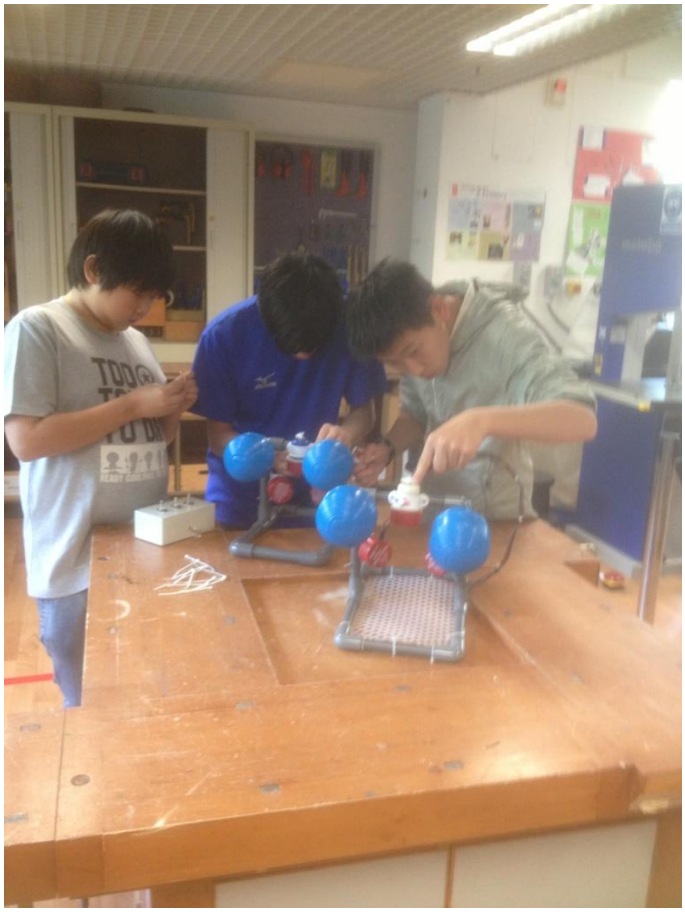

Figure 6: Students at ISF Academy building the basic underwater robot

Figure 7: ISF Students at the HK ROV competition

Air Pollution Monitoring Equipment Installation

One of the most severe environmental problems facing Hong Kong is the deteriorating air quality. Hong Kong air pollution, while not as severe as PRC is negatively impacting the health of Hong Kong citizens.[7] ISF Academy is located in the south west corner of Hong Kong Island. This region of Hong Kong does not have a dedicated air pollution monitoring station in the vicinity of the school. Currently the school is constructing two new buildings on the campus but once the building structure is complete, an air pollution monitoring station comparable to the systems used by the Hong Kong will be installed on the roof of the school. We anticipate this installation in the summer of 2016.

Students will be working alongside the Hong Kong University of Science and Technology environmental engineering group to help install the equipment, learn monitoring techniques and analytical skills required for data management. Data collected will include all major air pollutants and particulate measurements.

Center for Renewable Energy Education

A small scale photovoltaic energy system will be installed onto the roof of the school during the summer of 2016. This system will include two different projects. In an area

of the school that is not easily accessible to students, 67 solar panels will be permanently installed. These panels will produce approximately enough energy for 6 classrooms during the academic day. More importantly, a Center for Renewable Energy Education (CREE) will be installed on another roof that does allow for safe student access. The CREE will have different Renewable Energy technologies installed that can be used by the students for engineering based projects.

Students have been working on this project for several months. Over the summer of 2015, two students shadowed a structural engineering firm and learned how the weight load of the panels will impact the structural integrity of the buildings. By working alongside the engineers, they also learned firsthand the building requirements of Hong Kong. These same students have researched extensively the technologies they want to see in the CREE. These technologies include: battery storage, single axial rotation PV module, a small scale wind energy system and a form of mechanical energy storage (still to be determined). The CREE will be an active learning center for older students.

Student Led Initiatives

A student led secondary school group meets weekly after school to work on environmental and sustainability projects that are of importance to the students. These projects are varied and each year a signature project is selected. In the past the students have looked at recycling the used cooking oil (UCO) from the kitchen, convincing the school administration to purchase recycled paper for all copy machines, and the additional of bike racks onto the campus. The students also provide leadership for the whole school community by recycling used paper on campus and separating recyclable goods at the annual school fair.

For the past three years the students have also led out on a school beach cleanup in an area near the campus. This activity is a part of the International Coastal Cleanup effort and is head each autumn in Hong Kong, as seen in Figure 8.[8]

Figure8: ISF Academy students collecting beach rubbish and logging data

For the academic year 2015 – 2016, the students are looking at the large number of private cars that drop off and pick up students each day. This is a traffic engineering challenge that will require communicating with all stakeholders: parents, teachers, and students. The students hope to build awareness of the problems associated with the daily traffic congestion and suggest solutions to the school management that will reduce localized air pollution, traffic delays and improve the area surrounding their school.

Conclusion

As with all schools, ISF Academy is a bee-hive of activity and the multiple sustainability projects are ambitious. The ongoing projects are a result of several years of evaluation and careful curriculum development. Each project has involved students and other community stakeholders. The curriculum combines all of the STEM subjects in interdisciplinary units that allows students opportunities to learn the required background information and design solutions for their community. We know that the impact on these sustainability initiatives will continue to grow as more programs come on line and are fully incorporated into the school day for each child.

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