

Highlights

Project-Based Learning: Engaging Secondary School Students in Authentic Environmental Science Research

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In the past year (July 2014 to March 2015), 90 secondary school students participated in an Environmental Science themed Project-Based Learning (PBL) program designed by scientists at the National Institute of Education, Singapore. The authenticity of the PBL program was enhanced by partnership with NParks' Coastal Biomonitoring program. A total of 22 school teachers were also involved as facilitators of their students' project work. The strategic partnership of NIE scientists, secondary schools and NParks created a unique experience for students engaging in PBL.

Engaging in authentic research through Project Based Learning (PBL) has shown to be an effective pedagogical method for teaching 21st century skills in school students. In the past year (July 2014 to March 2015), 90 secondary school students participated in a PBL program conceived by scientists (Drs. Tan Lik Tong, Beverly Goh Pi Lee, and Mr. Nicholas Yap Wei Liang) at the National Institute of Education. The PBL program, in partnership with NParks, involved students being engaged in science research related to an Environmental Science theme. Within this theme, environmental toxicology was chosen due to its interdisciplinary nature. In addition to student participants, secondary school teachers were also involved in the PBL program, to assist as facilitators of students' project work. The partnership with NParks adds an authentic dimension to the program. Students were engaged in field trips to various coastal areas in Singapore assessing ecosystem health using the green-lipped mussels, *Perna viridis*, as a bioindicator organism and also conducted various bioassays related to ecotoxicology research. The main objective of the PBL program was to increase students' awareness of environmental

issues, both global and local, through the use of field-based Environmental Science. Moreover, the chosen theme was timely, due to the current Singapore Government emphasis and focus for schools to develop curricula related to the environment and water industries.



Poster Presentation Day (March 20, 2015) attended by students, teachers, and scientists

In the PBL program, secondary 2 and 3 students from 10 schools in Singapore participated in guided project work, with close mentoring by research scientists from NIE as well as their school teachers. Before embarking on their project work, both student and teacher participants received relevant content and skills training, e.g. performing bioassays related to ecotoxicology, at a 3-day workshop (June, 2014) held at NIE. This was followed by scheduled meetings with student groups for brainstorming of potential research questions within the confines and context of environmental ecotoxicology. After a period of data collection and analysis (July – November 2014), students presented research findings in both oral (e.g. poster presentations) and written formats. At every phase of the PBL exercise, students were guided primarily by scientists on concepts related to the nature of science and scientific inquiry, as well as cultivating critical thinking. The PBL model established by NIE scientists could potentially be used as a platform to introduce esoteric research topics, pursued by practicing scientists, to school students. Selected scientific abstracts from three projects undertaken by secondary school students are presented below.

Selected Scientific Abstracts

Bendemeer Secondary School

Green Mussels (*Perna viridis*) as Bioindicators: An Ecotoxicology Study of the Effects of Brackish Water on the Health of Farmed Green Mussels Using Behavioural and Cellular Bioassays

Chumphot Ngammekchay, Jeffrey, Linda Gan, Phan Shi Min, Pang Ching Teck, Sheri Sng, Carine Teo Meng Hwee, and Ng Kuan Wei

Polluted water, caused by anthropogenic activities, affects organisms that live in the waterway of Singapore's Sungei Buloh Wetland Reserve. This research study aims to obtain information on the health of the green mussels, *Perna viridis*, exposed to brackish water of Sungei Buloh Wetland Reserve. A pre-test and post-test experimental design was used for the research study. Health of the farmed green mussels, obtained from Lim Chu Kang, were measured by a series of bioassays. The results from the cellular (Zyosan A and Neutral Red) and behavioural (byssal thread counts and clearance rate) bioassays showed that green mussels that were less stressed had a higher byssal thread count, higher clearance rates, a higher neutral red retention time and a higher percentage of healthy cells, as compared to mussels that are more stressed by changes in the water quality. Water quality testing of the brackish water was also conducted using data loggers to analyse how changing abiotic factors (pH, temperature, turbidity, salinity, total dissolved oxygen) may have stressed the green mussels at the cellular and behavioural levels.

Raffles Institution

The Physiological, Cellular and Biochemical Effects of Water Exposure in Sungei Buloh Wetland Reserve and Raffles Marina on the Asian Green Mussel (*Perna viridis*)

Fong Khi Yung, Lim Hur, Jovan Lim Ming Han, James Ding Sinuo, and Joseph Chong

Asian green mussels (*Perna viridis*) were used as bioindicators of water quality and pollution levels in two locations. A total of 70 mussels were placed in Sungei Buloh Wetland Reserve and Raffles Marina for 5 days each. Mussel health relating to water quality were then determined using the clearance rate, neutral rate and FRAP assays. Analysis of results showed that mussels placed in Sungei Buloh fared better in all three assays and were thus on average healthier than those placed in Raffles Marina. However, statistical analysis showed that the difference in results between mussels placed in Sungei Buloh and Raffles Marina were not significant in the case of the clearance rate assay and neutral red retention assay. However, significant differences were seen between mussels at the two study sites in FRAP assay results, although data from the FRAP assay was highly variable. The fact that there was no significant differences in results from the clearance rate and neutral red retention assays between mussels placed at Sungei Buloh and Raffles Marina could be due to several environmental, manmade and

geographical factors. Results of the statistical analysis also demonstrated that the level of stress induced in the mussels placed in both locations was roughly equivalent and only slightly higher in Raffles Marina than in Sungei Buloh.

Ahmad Ibrahim Secondary School

Investigation on Water Quality in Sembawang and Sungei Buloh Wetland Reserve

Low Liong Leong, Shawn Goh, Vivian Quek, and Yan Kai Tao

Chemical pollution in aquatic environments and their effects on living organisms is a key issue in ecotoxicology. In this project, the local green-lipped mussel, *Perna viridis*, was used due to the ease of maintenance and its abundance in nature. We chose two ecotoxicology assays: the Neutral Red assay and the Comet Tail assay, to test how pollution in the marine environment may have cellular and molecular effects on the mussels. Environmental quality may be determined by assessing the health of the mussels at the cellular and molecular levels. Mussels are particularly suitable for biomonitoring as they are filter-feeders, and may also bioconcentrate substances from water, accumulating contaminants which are insoluble and absorbed onto food particles into their tissues. They are filter feeders, and are sensitive to changes in the environment.

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