Raining Frogs: An Education for Sustainability Project

By Elaine Lewis and Catherine Baudains

Introduction

Since 1995 the school education sector has been a dominant focus for education for sustainability (EfS) in Australia (Tilbury, Coleman, & Garlick, 2005, p. 1). The commencement of the Australian Sustainable Schools Initiative (AuSSI) in 2003, with its whole school approach, dramatically increased this focus (Department of Education and Training, 2005b). The pilot for the Western Australian Sustainable Schools Initiative (WA SSI) commenced in 2005 (Department of Education and Training, 2005b). A small independent school, located in the Perth metropolitan area, was one of the twenty schools that participated in the WA SSI pilot. This paper will report on one project that was conducted at this school as part of the WA SSI.

One of the EfS projects implemented by this school in 2005 involved a biological survey of the school grounds and adjacent land, including a nearby wetlands area. The biological survey is a longitudinal study that aims to develop students' attitudes, understandings and skills related to the conservation of their local environment with a systems thinking perspective. The idea for the project arose directly from the students' expressed interest in their local natural environment. Furthermore, the project was developed within an understanding that school students' appreciation of the natural environment can be enhanced by engagement in projects that focus on their local environment (Baudains, 2006; Bennett & Burton, 2006; Fisher & Campbell, 1998). The adoption of a systems thinking approach (Lewis & Baudains, 2007; Sterling, 2003; Tilbury et al., 2005), an understanding of scientific literacy (Rennie, Goodrum, & Hackling, 2001; Rennie & the Australian Science Teachers Association, 2003) and the SSI whole school framework (Department of Education and Training, 2005a, , 2005c) were also integral to the theoretical basis of the project.

Linked thinking, the recognition of interrelationships in our world and the interconnectedness of the natural and human environment are different expressions of a systems approach. Whole systems thinking is a framework for seeing the whole picture and understanding phenomena as part of an integrated whole, in contrast to viewing phenomena only in their separate components (Capra, 1996; Clayton, Clayton, & Radcliffe, 1996; Sterling, 2003; Tilbury et al., 2005). In an EfS context whole systems thinking means emphasizing the interconnectedness of all the systems in our world as they relate to the environment, economics and social development (Newman, 2005). For instance, rather than viewing high pollution levels in a wetlands ecosystem as an environmental problem unrelated to the local residents' health, whole systems thinking views the issues in the whole context rather than in isolation, therefore facilitating an understanding of the possible relationships between the phenomena. Another critical aspect underlying the application of whole systems thinking is scientific literacy.

Scientific literacy involves five components: being interested in and understanding the world around us; engaging in discourse of and about science, questioning claims made by others about scientific issues; being able to identify questions, investigate and draw evidence-based conclusions; and making informed decisions about the environment and people's health (Rennie et al., 2001). It will be suggested that to develop scientific literacy the inclusion of the systems thinking approach is essential. Taking a whole school approach is also a reflection of systems thinking in action (Tilbury et al., 2005). The purpose of this paper is to report on the initial findings of the biological survey project, that is, the first two years of its implementation, 2005 and 2006. Interim conclusions and implications for EfS will be discussed.

Biological Survey

Students at the school were interested in fauna and flora in their local area and some of the students expressed concern about the degree of biodiversity. A research project was subsequently developed with the students to investigate the extent of biodiversity around the school, with the goal of improving the biodiversity of local native fauna and flora species.

The biological survey is a longitudinal study, 2005-2010, that is divided into four phases: the development phase, data collection, conservation action and evaluation phases. The project commenced in 2005 with the development phase for the biological survey. The survey involved the whole school, from pre-primary children to senior primary students (3-12 years old). The junior (JP) and senior primary (SP) students actively participated in the research while the pre-primary children engaged in observations and discussions focusing on the pit trap specimens that the older children caught.

Development Phase

The development phase occurred during 2005. This involved students in a 'systems thinking' brainstorming activity, measuring, mapping and photographing the sites, the installation of pit traps, the purchase of equipment, liaison with *Ribbons of Blue* and obtaining relevant approvals for the research.

Data Collection Phase

During 2006 the students conducted the biological survey, collecting data from two sources: the school surrounds and an adjacent lake. Students collected fauna and flora data from the school surrounds over five days, during each of the four terms of the school year. The lake data was collected on one day each term. An initial analysis of the data was undertaken by the students.

Conservation Action Phase

The conservation action phase will be undertaken over a three year period, from 2007-2009. During this phase the students will evaluate the results of the biological survey drawing on a systems thinking approach. They will investigate fauna and flora native to the area, make recommendations and implement changes that will enhance the biodiversity of the area.

Evaluation Phase

During the evaluation phase, 2010, another detailed biological survey will be conducted by the students to determine if there have been any changes in the biodiversity of the local area. Students will report their findings utilizing a systems thinking perspective.

Development Phase

The initial task of the development phase involved students in a 'systems thinking' activity in which they brainstormed all the systems that may be relevant to the project. The children identified five systems: environmental, social, political, economic and the health system to be relevant to the biological survey. Each of these systems was seen as interlinked and impacting on each other. Also each system was divided into sub-systems, for example, the environmental system was divided into wetlands, native gardens, exotic gardens, waste, water, weather, built environs and recreation areas. Other tasks undertaken during this phase involved the students in measuring, mapping and photographing the school quadrats and the lake site. The senior primary students installed the pit traps, three per quadrat. The pit traps consist of 20 litre buckets, with fly wire and egg carton in the bottom, and 12 metre lengths of wire, as illustrated in Figure 1.

Approvals to conduct the fauna survey were obtained from class teachers for access to their gardens, the school grounds committee, and the Department of Environment and Conservation for a Licence to take fauna for educational or public purpose. Extensive liaison with a Ribbons of Blue education consultant supported the teachers at the school with expertise and the use of equipment.

Data Collection Phase

School Surrounds Data

During 2006 the students conducted fauna and flora surveys around the school grounds. The school surrounds were divided into four quadrats: frog pond, native garden, exotic garden and permaculture garden. For one week each term the children collected survey data for each quadrat on flora, pit trap catches and birds. Only the students' pit trap data on frogs will be reported here. All captured frogs were inspected to identify species and sex, then weighed and released into the quadrat in which they were captured.

At the end of the year a senior primary group working on the frog data reported:

Figure 1. Pit trap in native garden quadrat.

Figure 2. Students checking the pit traps.

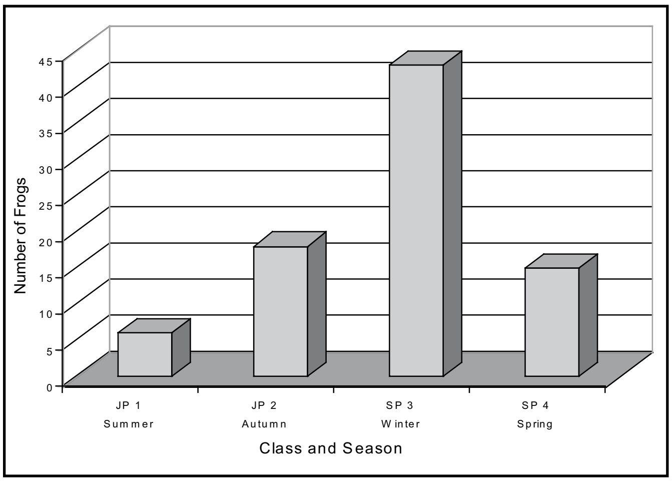

Figure 3. Number of frogs caught in the pit traps during 2006.

This graph [Figure 3 below] shows the number of frogs caught in the pit traps by the different classes. In first term, summer, [Junior Primary 1] only caught 6 frogs. In term 2, autumn, [Junior Primary 2] caught 18 frogs, a vast improvement on first term. In third term, winter, [Senior Primary 1] caught a massive 43 frogs because it was wet and the frogs were out and about and all the tadpoles had become frogs. One day it was absolutely raining frogs! In fourth term, spring, [Senior Primary 2] caught 15 frogs. As you can see there are big differences in frog catches during the different seasons.

We found that most of the frogs were found in the permaculture and native garden sites because the frogs liked the more natural habitat. We also found that most of the frogs we caught weighed less than 20 grams but we did catch a few frogs that were heavier than 60 grams. Only two species of frog were caught, 7 Motorbike frogs and 75 Western Banjo frogs.

Lake Data

The students conducted a range of investigations at the lake site including a visual site assessment, macroinvertebrate study, water quality testing and bird survey. Only the students' macroinvertebrate and water quality data will be reported here. The students examined water samples to determine the number and species of macroinvertebrates caught. They summarised their data in the table shown in Figure 4.

A small group of senior primary students working with the data concluded:

Looking at first term when [Junior Primary 1] did the study there were 30 macroinvertebrates found and they were spread over all the categories as you can see in the table. When [Junior Primary 2] did the research, during the winter months, they only found one species of macroinvertebrate, which was the water

Species Classes	Insecta	Crustacea	Arachnida	Mollusca	Nematoda	Anelida
Junior Primary 1 27/03/06	15 Water boatmen 10 Mosquito pupae 1 Soldier fly larvae 1 Non biting midge larvae 3	5 Fairy shrimp 5	1 Water spider 1	8 Mussel 2 Snail 6	0	1 Leech 1
Junior Primary 2 23/06/06	8 Water boatmen 8	0	0	0	0	0
Senior Primary 1 21/08/06	60 Water boatmen 59 Water scorpion 1	32 Fresh water prawns 32	0	1 Fresh water snail 1	1 Round worm 1	0
Senior Primary 2 27/10/06	0	11 Clam shrimp 3 Shield shrimp 1 Fairy shrimp 7	0	0	0	0

Figure 4. Macroinvertebrate data from the lake site in 2006.

boatmen (8 specimens). The water boatmen can withstand harsh conditions, meaning that the water they are living in may be in a polluted condition. When [Senior Primary 1] did the study they found 59 boatmen and, because it was coming into spring, they caught 35 other macroinvertebrates as well (4 other species). When [Senior Primary 2] did the macroinvertebrate search we found only crustacea. We caught 3 clam shrimp, 1 shield shrimp and 7 fairy shrimp, giving a total of 11 crustacea. We think it was because of the weather; it was pretty hot so they did not breed so much.

The students also collected surface water data from the lake site. They measured turbidity, pH, electrical conductivity (salt content) and temperature. The senior primary group analysing the turbidity data reported:

Turbidity measures the amount of debris that has been left in the water. [Junior Primary 1] measured 50 units which is high, indicating there may be a pollution problem. We think that this occurred because it was warm and sunny so the water got evaporated leaving the muck that was already there more densely in the water. [Junior Primary 2] scored 30, [Senior Primary 1] scored a low 19 and [Senior Primary 2] scored a very low 10. We think that as the seasons change and get colder, more rainfall comes, therefore making the water clearer because more fresh water comes, but in the hotter weather the water got dirtier as it evaporated.

The students presented their findings as shown in Figure 5.

The students working on the pH data stated:

The pH measures how acid or alkaline the water is. [Junior Primary 1] was a whopping 8.6 which was way beyond the other classes. This result meant the water may be polluted. [Junior Primary 2] obtained a pH reading of 7.6, [Senior Primary 1] scored 7.2 and [Senior Primary 2] 6.5, which means that it is completely normal for lake pH levels.

The students presented their findings as shown in Figure 6.

The senior primary group working on the electrical conductivity data concluded:

[Junior Primary 1] in saltiness testing got 1.2 meaning it was brackish because it was summer. Since it was hot and sunny the water in the lake was evaporating leaving more of the salt in it. We need to know how much salt there is to know what type of animals can survive in the lake. [Junior Primary 2], in autumn, had 0.8, which meant that it was a bit brackish, which meant that it was not very salty. [Senior Primary 1 and 2] obtained a reading of 0.7 which meant, like [Junior Primary 2], the water was fresh.

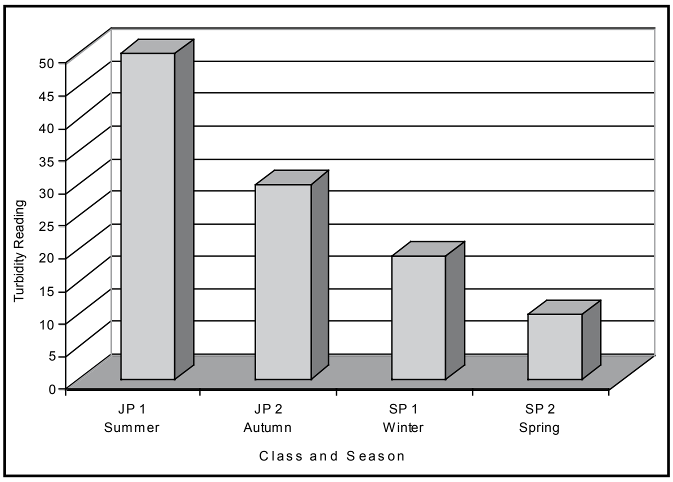

Figure 5. Turbidity of the lake site during the different seasons in 2006.

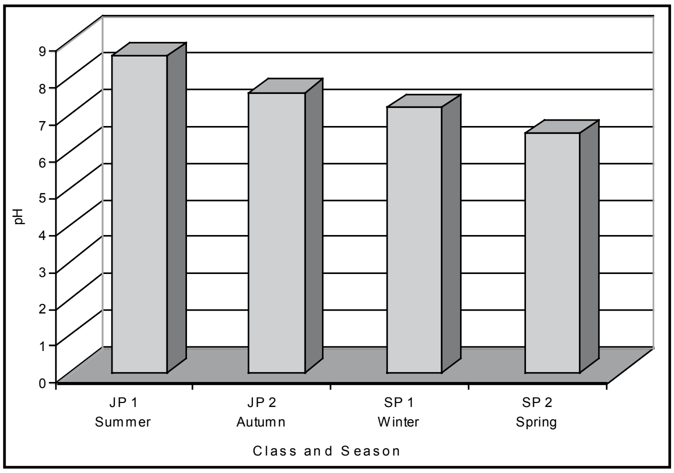

Figure 6. pH of the lake site during the different seasons in 2006.

The students presented their findings as shown in Figure 7.

The senior primary group analysing on the temperature data reported:

[Junior Primary 1] found an average temperature of 23 degrees C. Because it was summer there was more sun, therefore making the water hotter. [Junior Primary 2], in autumn, got an average temperature of 14 degrees meaning there was less sunlight over the lake, or that there was a lot of rainfall or cloud cover. [Senior Primary 1] obtained an average temperature reading of 17.8 degrees meaning there was not much rainfall and this year autumn had colder water than winter. A similar reading, 17.7 degrees C was found by [Senior Primary 2] in spring, before the weather got hot again.

The students presented their findings as shown in Figure 8.

After analysing all the surface water data the senior primary students concluded:

In summer the pH, salt, turbidity and temperature were high compared to the other readings in the other seasons. The temperature was lowest in autumn ... Doing the surface water data revealed lots of information.

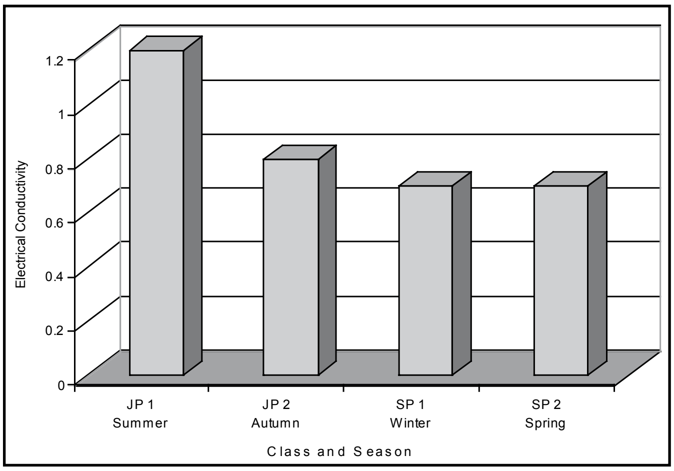

Figure 7. Electrical conductivity of the lake site during the different seasons in 2006.

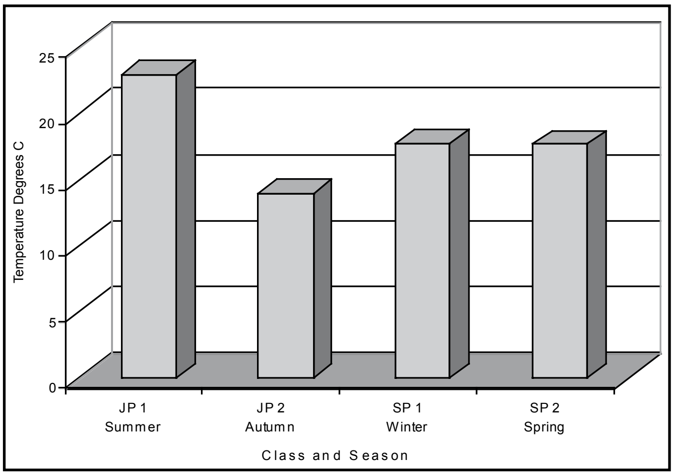

Figure 8. Temperature of the lake site during the different seasons in 2006.

Conclusions and Future Directions

Three conclusions may be drawn from the study at this interim stage. These conclusions relate to engagement, system thinking and scientific literacy. The students were extremely engaged in all aspects of the project, from enthusiastically digging holes for the pit trap buckets to the excited early morning ritual of checking the pit traps, and later preparing posters to aid the presentation of their findings. Clearly the children's hands-on experience in the investigation of local fauna and flora was engaging and they were able to link their data to the variations of the seasons.

However, when so closely focused on their data the children did not make many interconnections. The influence of the weather was the main relationship identified. The students' written comments indicate that further teaching on systems thinking is required. The children only focused on the narrow specialisation of their environmental data and did not make reference to other systems that may be impacting on the findings, even though these issues were raised in whole class and small group discussion. Furthermore, the students' assessment rubric did not explicitly mention 'systems thinking' and it would be worth experimenting with its inclusion in the future. The systems thinking approach is complex and demands repeated exposure to the understandings it entails. This is the case not only for the students, but the teachers involved as well.

During 2007 the students will examine the research findings in more depth and take action to improve the issues that concern them. This will involve the children in further exposure to system thinking activities. It is anticipated that the systems thinking approach will improve the scientific literacy of the students, through explicitly exploring its different components, such as, the previously mentioned aspect of making informed decisions about the environment and people's health. For instance, the children may investigate water pollution in summer and local health issues (the environment and health systems) or local fertilizer run-off and the growth of toxic algal blooms in the lake (the social and environmental systems).

The biological survey is a huge undertaking for a small school and reflects its commitment to EfS, the WA SSI, a whole school approach, systems thinking and enhanced scientific literacy. The final evaluation of the project will inform student and teacher learning outcomes, the sustainability of longitudinal studies in small schools and provide an example of the effectiveness of systems thinking based around a local environmental issue. It appears that this research may also have implications for understandings about scientific literacy and the development of national curricula.

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Abstract

This paper describes the teaching of education for sustainability at an independent primary school involved in the WA Sustainable Schools Initiative. The initial findings of a longitudinal biological survey are reported and implications for education for sustainability are discussed. Student engagement, whole systems thinking and scientific literacy are highlighted.