

Sustainable schools as pedagogical tools for environmental education

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Abstract: There has been extensive research about the association between school physical environment and children’s educational performance. However, the relationship between the sustainability of school physical environments and children’s environmental awareness via education has been rarely addressed in the literature. This paper evaluates the possible differences between the environmental attitudes and behaviours of children in schools designed for sustainability and conventional schools in Victoria, Australia. The New Environmental Paradigm (NEP) and General Ecological Behaviours (GEB) scales were employed to measure the environmental awareness of 275 grade 4-6 children in seven primary schools. Quantitative analysis was conducted to look for significant differences between the environmental attitudes and behaviours of two groups: children attending conventional schools and children attending schools assessed as being designed or refurbished with sustainability in mind. The results of the analysis indicated that there was a statistically significant difference between the two groups. Factor analysis revealed the NEP and GEB to be multidimensional scales. Considering the relationship between school design and the identified behaviour and attitude factors showed the presence of sustainability features had the greatest impact on the factor Children’s Attitudes via ESD (Environmentally Sustainable Design) at School. This result invites professionals in the built environment design disciplines to re-think the pedagogic importance of environmentally sustainable design in schools.

Keywords: Sustainably designed schools; conventional schools; children’s environmental awareness.

1. Background of the research

1.1. Environmental characteristics of school and children’s educational attainment

A large number of empirical studies have been conducted on the impact of environmental characteristics on school occupants (Colven *et al.*, 1990; Moore *et al.*, 1994; Hathaway, 1995; Dudek, 2000; Clark, 2002; Higgins *et al.*, 2005). These characteristics include thermal factors, lighting quality, natural ventilation, air quality and acoustics. It has been proven that keeping these elements at an

adequate level has a direct positive effect on children's concentration, mood, wellbeing and attainment (Woolner *et al.*, 2007).

The physical design characteristics of schools also have an educational impact, for "student's interaction with physical settings often becomes their primary medium for learning" (Tanner, 2000). It is believed that architecturally well-defined settings contribute to greater level of engagement of children in learning activities (Moore *et al.*, 1994). Schneider suggests that "those involved in school planning and design should see it as an opportunity to enhance outcomes by creating better learning environments" (Schneider and National Clearinghouse for Educational Facilities, 2002). Different architectural approaches can therefore be seen to facilitate and accommodate different education styles by shaping children's pedagogical engagement.

1.2. Sustainable school design as a pedagogical tool for environmental education

Children's environmental attitudes and behaviours are two of the main objectives of Environmental Education (Musser and Malkus, 1994; Leeming *et al.*, 1995; Stern *et al.*, 2008). Literature shows that the designed environment has the potential to shape its occupants' behaviour and also govern and support interactions between them (Weinstein, 1977). There is considerable evidence regarding the relationship between school physical settings and students' and teachers' behaviours and attitudes (Moore *et al.*, 1994; Day, 2007; Durán-Narucki, 2008). Implicit in the work of Ann Taylor is the idea that visual literacy ("knowing eye") can make the pedagogic link between sustainable design and environmental education. Designed artefacts, including buildings, are informed by an idea or concept. Occupants of a space can read these concepts and assimilate them if they are articulated. Thus, sustainable school design might have a pedagogic value, because "physical elements in the environment can act as visual cues or prompts for learning" (Wilks, 2010). Although there has been much research about the relationship between school physical environments and educational outcomes (Woolner *et al.*, 2007; Leiringer and Cardellino, 2011), few studies have considered the impact of the sustainable school design on children's environmental awareness (Newton *et al.*, 2009; Uzun, 2009; Cole, 2013). Cole believes that the school building is "the largest and most visible artefact of school sustainability and one that changes less often relative to other aspects of the school environment such as curriculum" (2013). Lyons also suggests that sustainable school buildings will positively affect the overall culture of sustainability (Lyons Higgs, 2006). As such, this study investigates the potential role of sustainable school design as a pedagogical tool for children's environmental awareness.

2. Method

Comparing the environmental attitudes and behaviours of children in schools designed for sustainability and conventional schools entailed a number of research considerations, including: differentiating sustainable schools from conventional schools, isolating the impact of extraneous variables other than school design¹, and developing appropriate scales for measuring children's environmental attitudes and behaviours. The following sections describe each these considerations in detail.

¹ This paper reports on a part of the findings of a far larger study that considered the impact of many extraneous variables other than school design, such as parents' environmental attitudes and behaviours, and teachers' environmental attitudes and behaviours.

2.1. Rationale for selecting sustainable schools versus conventional schools

In order to select sustainable schools, three of the possible environmental rating methods in Australia are discussed: Green Star, The Victorian Architecture Award, and ResourceSmart AuSSI Vic. To find out which of these approaches could be the best for the purpose of this study, the advantageous and disadvantageous of each is debated.

The Green Building Council of Australia developed a Green Star environmental rating system in 2003 to encourage and evaluate sustainable design and construction in Australia with consideration of occupant health and operational cost savings. Green Star evaluates environmental performance of buildings in terms of: management, energy, water, materials, indoor environment quality, emissions, transport, land use, and ecology innovation. Although this tool has the advantage of considering encompassing essential criteria for sustainability, this is not a very popular tool among primary schools in Victoria. As such this method does not seem the appropriate method for selecting schools designed for sustainability.

The Australian Institute of Architects has run a national annual award program since 1981. Prior to entering the national level, entries are submitted by architects to be refereed by state judges. The Victorian Architecture Awards go back to 1929. After passing the Victoria state stage, winners are entered to the national pool of entries. Sustainable Architecture is one of the categories for the Australian national awards, which identifies the projects demonstrating innovative approaches to and superiority in environmental sustainability. The award winners of the sustainable architecture category of Australian Institute of Architects Award are considered exemplars of sustainable design. Although this award is well-recognized and encompass comprehensive sustainable design strategies, it was not appropriate for this study, because only two primary schools in Victoria won the award, and therefore, this award program does not provide an appropriate pool of primary schools for the researcher to select the case studies from.

Unlike previous mentioned methods for evaluating sustainability which encompass a wide range of building types, AuSSI (Australian Sustainable Schools Initiative) is a program specifically addressing schools. This initiative considers not only schools' performance in terms of water, energy efficiency, waste and biodiversity, but also advocates a whole-school approach to sustainability from community and management points of view. ResourceSmart AuSSI Vic is a version of AuSSI contextualized for Victorian schools that aims to support schools and their communities to live sustainably. While the initiative does not directly focus on design, it helps schools embed sustainable resource consumption through a consideration of school performance in terms of water, energy, biodiversity and management; qualities that can be improved through design. Resource Smart AuSSI Vic defines the highest level of sustainability as 5stars and provides a 5star certificate for those schools that qualify (Sustainability Victoria, 2014). 5star gives schools the opportunity to show continuous improvement in their environmental performance through the five levels. This method was recognized as the most appropriate for this study, as it has lots of common criteria with the two previously described methods, which are more feasible for schools to meet. There are also large numbers of schools which have been awarded the 5Star sustainability certificate, and this makes it possible for the researcher to randomly select a few of them for the purpose of this study. Thus according to ResourceSmart AuSSI Vic, St Macartans, Epping View, and Gembrook primary schools were selected as sustainable schools. Geelong East, Rollin's, Belmont, and St Partick's primary schools were also selected as conventional primary

schools of this study since they did not have 5Star sustainability certificate, and consisted of old buildings constructed in the last 40 years.

2.2. Participants

Data for this study was collected from 275 students of grade four to six from seven primary schools. Of 275 children, 132 were from schools designed for sustainability and 143 from conventional schools. There were 15 children from School 1 (conventional), 31 children from School 2 (conventional), 31 children from School 3 (conventional), 69 children from School 4 (sustainable), 49 children from School 5 (sustainable), 14 children from School 6 (sustainable) and 66 children from School 7 (conventional).

2.3. Environmental attitudes and behaviours scales

In order to develop the NEP for children, which is called NEP (Children@school), the 10-item NEP for Children questionnaire developed by Manoli *et al.* (Manoli *et al.*, 2007) was employed. While the NEP for Children developed by Manoli *et al.* covers many aspects of environmental attitudes, it lacks items specifically related to school-based learning spaces. Therefore, six items were added to develop a scale which includes environmental attitudes that have the potential to be fostered in connection with the ecologically sustainable design of the school. Some existing items were also paraphrased to make them more comprehensible for Australian children. NEP (Children@school) was tested for content and face validity, and was a five-point Likert scale from strongly disagree to strongly agree with a neutral midpoint. This scale was also subjected to principal factor analysis to identify any potential underlying dimensions. Analysis indicated that NEP (Children@school) is constituted from three dimensions: Children's Environmental attitudes towards Human Intervention, Children's Environmental attitudes via ESD at school, and Children's Environmental Attitudes towards Eco-right. It is worth underlying that all of the items within 'Rights of Nature' factor in Manoli *et al.* (2007) study have fallen into 'Eco-right' factor in this study. Moreover, the items classified in 'Eco-crisis' and 'Human Exemptionalism' in Manoli *et al.* study have been classified within the 'Human Intervention' factor in this study with some deletions and modifications. The newly added items in NEP (Children@School) scale were grouped within the ESD at School factor. Estimate reliability of omega was calculated for all the three identified factors. Results showed that all the three factors had a respectable omega value. NEP (Children@school) could be found in appendix (Table 2).

The behaviours scale used in this thesis for measuring children's environmental behaviours was adapted from the 8-item Evans *et al.* jumping game (2007), and was called GEB (Children@school). Although the content of the GEB (Children@school) was adapted from Evans *et al.* study, the researcher used a questionnaire with 5-point Likert type answers rather than the jumping game format that Evans *et al.* used. The modification applied on the Evans *et al.* behaviour scale included: first, re-phrasing all items so to convey school-related ecological behaviours; and, second, adding two more items. Thus, the GEB (Children@school) asks students about their actual actions in school daily life in which environmental consideration can be an issue. This scale was initially tested for the content and face validity. It was also subjected to principal factor analysis, and the result suggested that GEB (Children@school) is constituted from two dimensions of: Children's Pro-active Eco-behaviours, and Children's Environmental Behaviours towards resource and energy Conservation. Omega, as the measure of reliability, was calculated for each of the two identified factors, and results indicated that both of the factors had a respectable reliability estimates. GEB (Children@school) could be found in the appendix (Table 3).

3. Analysis

Employing multivariate analysis of variance (MANOVA), this study investigates the possible significant differences in children's environmental attitudes and behaviours in schools designed for sustainability and conventional schools. This test was expected to answer the following questions:

- Do children in schools designed for sustainability differ with children in conventional schools in terms of their environmental attitudes and behaviours?;
- Are children in schools designed for sustainability better adjusted than children in conventional schools in terms of their Attitudes towards Human Intervention, ESD at School, and Eco-rights, their Pro-active Eco-behaviours, and Resource and Energy Conservation Behaviours?

In order to answer these questions, the impact of other probable influential variables such as curriculum needed to be isolated. Because of the 'centralization of control over curriculum through the National Curriculum in Australia (Palmer, 2002), the potential influences of contrasting curricula between the schools was discounted.

Preliminary analysis confirmed that no serious violation of the assumptions of normality, outliers, linearity, multicollinearity and singularity, and Homogeneity of variance-covariance matrices was noted. One-way between groups MANOVA was conducted to evaluate the impact of School-design on Children's Environmental Attitudes towards Human Intervention, Children's Environmental Attitudes via ESD at School, Children's Environmental Attitudes towards Eco-rights, Children's Pro-active Eco-behaviours, and Children's Environmental Behaviours towards Resource and Energy Conservation.

Analysis output indicated that there was a statistically significant difference between children in schools designed for sustainability and children in conventional schools on the combined dependent variables, $F(5, 269) = 28.14$, $p = .000$; Pillai's Trace = .343; partial $\eta^2 = .343$ (Figure). As the significant result was obtained in this stage, further investigations determined whether children in schools designed for sustainability and children in conventional schools differed on all of the dependent variables (Children's Environmental Attitudes towards Human Intervention, Children's Environmental Attitudes via ESD at School, Children's Environmental Attitudes towards Eco-rights, Children's Pro-active Eco-behaviours, and Children's Environmental Behaviours towards Resource and Energy Conservation), or only some of them. When the result for the dependent variables were considered separately, using Bonferroni adjusted alpha level of 0.01 (Pallant, 2013), all the dependent variables except Children's Attitudes towards Eco-right reached statistical significant difference: Attitudes towards Human Intervention, $F(1, 273) = 14.552$, $p = .000$, partial $\eta^2 = .051$; Attitudes via ESD at School, $F(1, 273) = 103.333$, $p = .000$, partial $\eta^2 = .275$; Pro-active Eco-behaviours, $F(1, 273) = 35.553$, $p = .000$, partial $\eta^2 = .115$; and Resource and Energy Conservation Behaviours, $F(1, 273) = 42.569$, $p = .000$, partial $\eta^2 = .135$. School-design appeared to be more associated with Children's Attitudes via ESD at School, representing 27.5% of the variance in this variable which is considered a large effect size (Cohen, 1988), compared to Attitudes towards Human Intervention (5.1%) with a medium effect size, Pro-active Eco-behaviours (11.5%) with a large effect size, and Resource and Energy Conservation Behaviours (13.5%) with a large effect size.

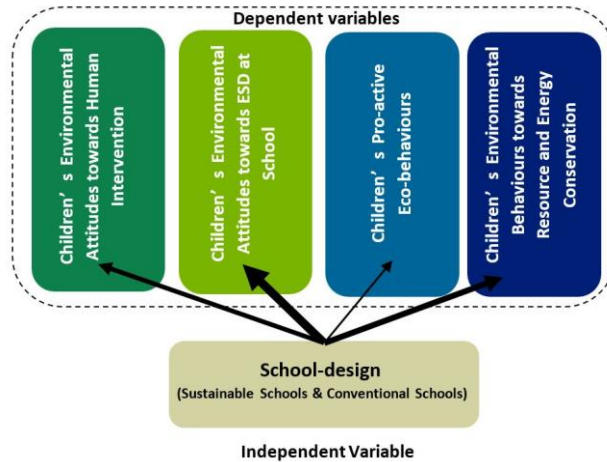


Figure 1: MANOVA for comparing the mean differences between children in sustainably designed schools and conventional schools (only the significant correlations are shown - the thicker arrows shows the stronger).

Although it was clear that children in schools designed for sustainability and children in conventional schools significantly differed in four variables of environmental attitudes and behaviours, the mean scores were compared to determine which type of school had higher scores and for which dependent variable. The results suggested that children in schools designed for sustainability reported higher levels of Environmental Attitudes and Behaviours in all of the significant dependent variables as summarized in Table 1:

Table 1: Mean differences of the dependent variables for children in two types of school-design

Dependent Variable	Schools designed for sustainability	Conventional schools
Children's Environmental Attitudes towards Human Intervention	M=3.544, SD=.725	M=3.17, SD=.884
Children's Environmental Attitudes via ESD at School	M=4.451, SD=.631	M=3.447, SD=.958
Children's Pro-active Eco-behaviours	M=3.355, SD=.951	M=2.673, SD=.943
Children's Environmental Behaviours towards Resource and Energy Conservation	M=4.322, SD=.617	M=3.771, SD=.768

4. Discussion and conclusion

Figure 2 illustrates that School-design is most associated with Children's Attitudes via ESD at School, and can explain 27.5% of the variance in this dependent variable, which is considered a large effect size (Cohen, 1988). This result invites professionals in design discipline to re-think the importance of environmentally sustainable design in schools.

Interestingly, the mean scores of Children's Environmental Attitudes towards Human Intervention, Children's Pro-active Eco-behaviours, and Children's Environmental Behaviours towards Resource and Energy Conservation were also significantly different in schools designed for sustainability and conventional schools. This implies that School-design have a determinant role in most of the identified

factors of children's environmental awareness, and thus, is worthy of attention if we are to educate children with pro-environmental inclinations. Further analysis to understand the differences between the two types of schools indicated that schools designed for sustainability outperformed the conventional schools in all of the significant dependent variables (Figure 3). In other words, children in schools designed for sustainability better adjusted than children in conventional schools in terms of their Attitudes towards Human Intervention, ESD at School, Pro-active Eco-behaviours, and Resource and Energy Conservation Behaviours.

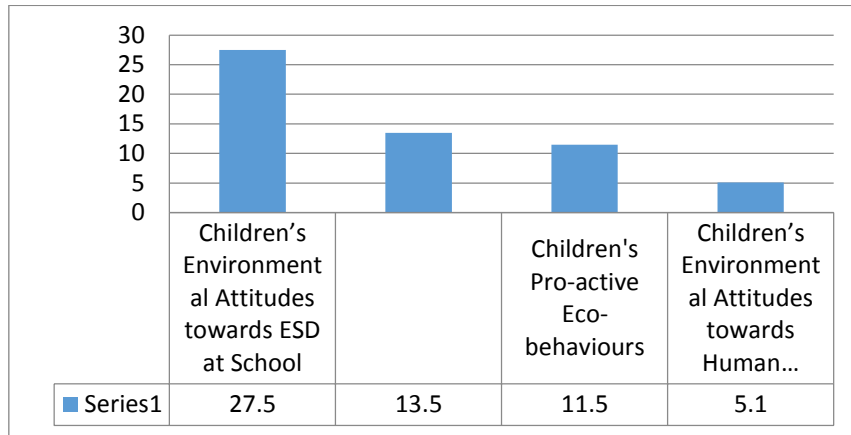


Figure 2: The percentage of the variance in dependent variables that could be explained by school-design.

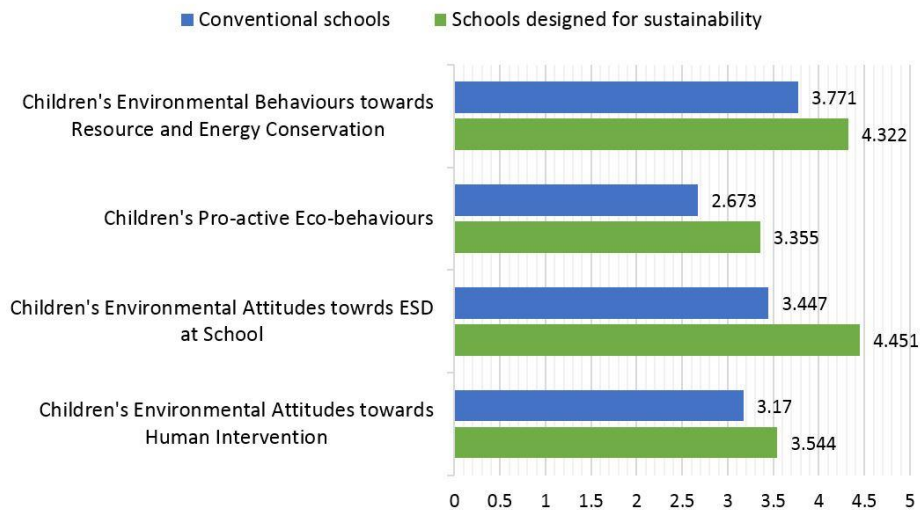


Figure 3: Mean differences of the dependent variables for children in two types of school-design.

The effectiveness of sustainably designed schools as teaching tools has been looked at from different discipline perspectives. Some educationalists, environmentalist, and architects believe that sustainable school buildings, also known as 'green' school buildings, will positively affect the overall culture of sustainability (Lyons Higgs, 2006). It is claimed that "sustainable architectural design of the schools can be an important aspect in raising educational standards or altering the perception of a school" (Edwards, 2006). It is also believed that buildings with a low environmental impact provide a unique teaching opportunity (Newton, Wilks, & Hes, 2009). Moreover, Cole suggests that the school building is "arguably the largest and most visible artefact of school sustainability and one that changes less often relative to other aspects of the school environment such as curriculum" (2013). Thus, the physical environment of a school has been referred to as a three-dimensional textbook (Taylor & Enggass, 2009), or silent curriculum, which might not be palpable but which can effectively lead to positive or negative environmental experiences.

Some departments have been directly involved in promoting school buildings and grounds as tools for sustainability education. The Department for Children, Schools and Families, UK, recommend a number of 'doorways' for change for schools to become sustainable by 2020. Alongside 'energy', 'water', 'travel and traffic', 'inclusion and participation', etc., there is a 'buildings and grounds' category that encourages schools to manage and design their buildings and grounds to visibly represent sustainability. Such design is intended to create a connectedness to the natural world for pupils, giving them 'the chance to contribute to sustainable living, and demonstrate good practices to others' (Department for Children, 2008). It can also "symbolize the school's commitment to sustainability in a unique way" (Cole, 2013).

It is worth underlying that this paper reports on the findings of a far larger study that not only considered the role of School-design, but also considered the influence that parents' and teachers' environmental attitudes and behaviours might have on children's environmental attitudes and behaviours. The results of this larger study suggest that School-design is the most powerful predictor of children's environmental attitudes and behaviours compared to parents' and teachers' environmental attitudes and behaviours. As such, and because an individual's environmental attitudes and behaviours is moulded by many variables, it is suggested that future researchers measure other potential influential variables such as the socio-economic situation of children's families, older sibling's role modelling, and the physical context of schools (such as proximity of natural environments and parks).

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Appendix:

Table 2: NEP (Children@School).

Scale item	Three identified factors for NEP (Children@School)
10. If things don't change; we will have a big disaster in the environment soon.	Human Intervention
9. People will someday know enough about how nature works to be able to control it.	
5. When people mess with nature it has bad results.	
3. People are clever enough to keep from ruining the earth.	
8. People are treating nature badly.	
2. There are too many people on earth.	ESD at School
11. I would be willing to go to a school which has a focus on nature.	
12. I believe that artificial light in classrooms should be generated by solar panels.	
14. I would be willing to grow food in the school garden.	
15. I feel more connected with nature when classes are held in outdoor spaces.	
16. It makes me feel better when we have natural day light rather than artificial light all day in classrooms.	Eco-Rights
13. It makes me feel bad to use recycled water for watering the garden.	
4. People must still obey the laws of nature.	
6. Nature will survive even with our bad habits on earth	
7. People are supposed to rule over the rest of nature.	
1. Plants and animals have as much right as people to live.	

Table 3: GEB (Children@school).

Scale item	Two identified factors for GEB (Children@School)
1-I participate in recycling activities at School.	Pro-active Eco-behaviours
2-I work in the school garden with teachers.	
7-I look at books about the environment (nature, trees, and animals).	
4-I pick up litter left behind by my friends during recess and lunch breaks.	
10-I don't turn on the classroom lights because there is always enough light in my classroom.	Resource and Energy Conservation
8-I leave the class window open while the heater is working.	
5-I forget to turn off water after washing my hands in the school toilets.	
6-I bring too much food to school and I have to throw away the extra food.	
9-I turn on the air conditioner rather than opening the glass window when it is warm inside.	
3-I forget to turn lights off when I leave a classroom.	