USING CONSTRUCTION OF SCHOOLS BUILDINGS AS A NOVEL APPROACH TO TEACH ABOUT SUSTAINABILITY

Dominique Hes
University of Melbourne, dhes@unimelb.edu.au

Philippa Howard
University of Melbourne, phoward@unimelb.edu.au

Students learn from being involved in the design and construction of their educational buildings. This paper reviews the outcomes of the Smart Green Schools ARC linkage project over 2007 to 2010, looking at how the design and construction of school buildings with the students was used as tools for teaching sustainability. The research, through a case study methodology using observation, interviews and surveys, shows that the teachers and students involved in the real world physical process of designing and constructing their buildings, led to an increased understanding: the development of the '*knowing eye'*.

The research also showed that not involving the school community in the design and construction of classrooms resulted in buildings not functioning as and their 'sustainability' aspects not understood.

Keywords: Smart Green Schools, impact of construction on outcomes, lessons

INTRODUCTION

Buildings are a significant part of the schools hardware, and together with books and computers they can be active educators *if* the students and teachers can see them as more than a roof over their heads. Particularly in the teaching of architecture, building and sustainability buildings can have a significant role to play. The Smart Green Schools (SGS) Linkage ARC project was in part interested in looking into this. That is, looking at the use of the buildings themselves as learning objects, or 3D textbooks. This is where this paper is situated, presenting how buildings from design to construction can be used as a teaching tool.

The SGS project investigated the influence of innovative and sustainable school building designs on the education of middle years students (Years 5-8) in four different school settings in Victoria, Australia. It focused on understanding how learning spaces supported new and future teaching and learning pedagogical approaches, including the integration of ICT and multimedia technologies.

The school environment is just one aspect of an interrelated system of cultural, economic, pedagogical, organisational and motivational factors. Research suggests that teachers do not perceive the physical environment as a major component of education and are therefore unlikely to fully explore the potential of the environment as a 3D textbook to facilitate learning (Nair & Randall 2005).

At the two case study schools written about in this paper, the students participated in building projects, helped to collect environmental data and through doing so learnt about materials, passive design, water, climate energy and comfort. In addition, the students participated within teams to further their problem solving, communication and organisational skills.

Sustainability and school buildings

Environmental sustainability issues are related to schools in two ways: the impact of the school on the environment and the impact of the environment on schools. Schools can minimise their impact on the environment by incorporating strategies that are applied to green buildings in general; for example, energy, water and waste efficiency, careful materials selection, design for durability, flexibility and minimisation of ongoing maintenance. Within a green building in a temperate area (e.g. Melbourne and Sydney), it is possible to reduce the amount of energy consumed by 70% or more through good envelope and lighting design (see projects such as Council House 2 and 40 Albert Road in Melbourne's CBD, Australia). Water can be reduced by 80-90% (Chanan et al. 2003) if efficiency is optimised, rainwater is collected and water reused. Waste in construction and renovation can be virtually eliminated (Hes 2007), and waste in operation can be reduced by 60% or more. Materials that are renewable, reusable and recyclable – when combined with design for durability, flexibility and maintenance minimisation – can

reduce their embodied environmental impact significantly. The environment has an impact on schools and consequently educational spaces need to be designed to suit these local conditions. To be effective educational spaces they also need to support the wellbeing of occupants and their ability to teach and learn. Both the way the building has been designed and how it responds to its environment can be used in teaching. Shum Miller (2008, p.913-920) described three schools in the United States where monitoring, technology and design of space were used not only for educational purposes but to engender responsibility and understanding for sustainability . This is where the challenge lies.

METHODOLOGY

As described above, this research sits within a broader framework of the Smart Green Schools ARC linkage project. The methodology is one of qualitative research centred on case studies (Yin 2003). Case studies were chosen as they allowed the investigation of the highly complex influences of built educational environments and their affect on teaching and learning. Observation and 'thick description', which enable judgments about making comparisons with, or the possible transferability of findings to other settings, were used (Bryman 2004).

Specifically, in looking at the potential for construction to support sustainability learning in high school students, the participants in the building of the three projects across two sites were interviewed, students surveyed and observations made over two years. The open-ended semi-structured interviews aimed to get an understanding of the building process undertaken and the rationale behind the approach. It also hoped to uncover the lessons learned, costs and benefits of the approached in construction taken.

RESULTS AND DISCUSSION

Two schools, provided here as case studies, demonstrate that not only is environmentally responsible design important, but that engagement of the teacher and a tailored curriculum are also integral to making the most of the varied educational opportunities. The two schools discussed below are Thornbury Secondary College and Woodleigh

School in Victoria, Australia, both with buildings designed by Luke Middleton a Melbourne based designer

Woodleigh School

Woodleigh commenced operation in 1856 as a coeducational school. It was one of the earliest schools in the State of Victoria and the first on the Mornington Peninsula. Apart from preparing students for tertiary study, it prides itself on equipping students for other less academic aspects of life in the twenty first century. This is done through creating:

> *Opportunities for self-discovery... providing the challenges that stimulate learning and by striving to be responsive to the needs of each student. Discipline at Woodleigh is based on three simple rules: Respect for self, Respect for others and Respect for the environment* (Middleton 2008).

The latter rule is taught through active participation in community events, clean up days, tree planting, active participation in the protection of school's native vegetation and agricultural activities based on permaculture principles. More recently their buildings have been part of the teaching of Environmental Sustainability.

The building was built out of straw bale and the roof was supported by reclaimed ironbark poles with cypress timber on the northern façade cut in a radial sawn pattern to use the timber efficiently. The floor is exposed concrete to assist with thermal mass. The concept of the roof allowed maximum indirect natural light into the space while facilitating cross and stack ventilation and night purging.

Internally teaching space is light, airy and spacious (Figure 1).

Figure 1 – Woodleigh internal spaces entry and work area (03 and 04) and main teaching space and teacher's area (01 and 02) (Photographer: Haskins, S 2009)

Figure 2 shows a designated space for the teacher for storage and preparation (01), a space for carrying out planting and other practical agricultural activities (03), with a generous internal (02) and external (04) teaching areas.

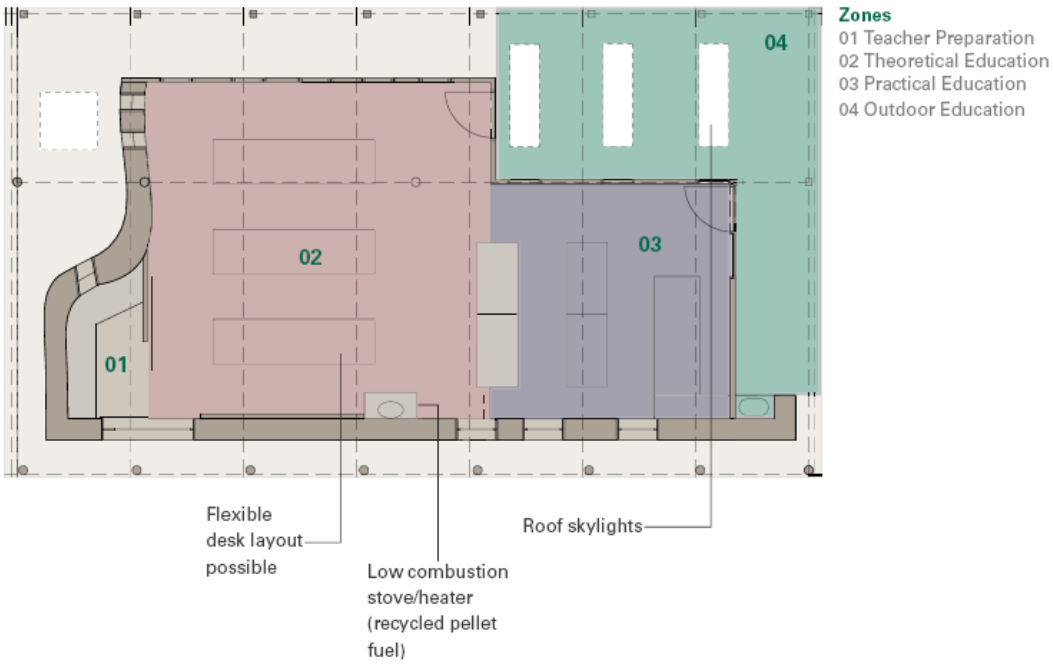

Figure 2 – Woodleigh space program (Middleton 2008)

Thornbury Secondary College

Thornbury is a public school located in the north-eastern suburbs of Melbourne. It opened first in 1962 with a school population of 126 students, accommodated in school buildings

that were typical of the ‘temporary’ structures the government was rushing to complete across Victoria at the time (Thornbury High School 2010). The ad-hoc typology of school buildings across the site are one interesting aspect of this case study, as research was carried out on two very different buildings. The first is a double general purpose classroom (GPC) which was going to be a standard ‘portable’. However, the design team was able to construct the GPC at a similar cost with a significant improvement in amenity, spatiality and performance; achieved with the constraints of the location and footprint of planned portable. The second building was a purpose-built recording studio where more time and fewer constraints produced a very different outcome.

OBSERVATIONS AND OUTCOMES

Woodleigh School

The design and construction of the AgHort Building (Agriculture & Horticulture) or Environmental Sustainability Centre, took two years. The scope of works changed significantly over the briefing period. Based initially on needs, the building was going to be only a shed before the school council decided to add power, make it a class room and provide full ICT. The teacher driving the project wanted to include students in the process. This was made possible through utilising the school’s activity program where middle year students elect to do an ‘activity’ three times a week for one 80minute period over eight weeks.

Over the two years, the tasks offered as part of the activity program differed from designing the form and function, to testing materials, construction options and actual construction. During the construction phase of the building, Middleton involved a builder who he had worked with previously and who he knew had the interest and skills to engage with the students. The builder would typically arrive in the morning set up the activity and then do a 15 minute briefing session with the students at noon. They would then work until 1:30pm after which the builder would complete the task. For example, leading up to the building’s slab was being poured, the builder set out and prepared the location, the students then helped tidy up the site, put in the plastic and reinforcement and

then the builder did the formwork in time for the next activity day, when the concrete was poured and the student could help vibrate the concrete. Figure 3 shows a Woodleigh student helping with the straw bale test wall.

Figure 3 – Woodleigh students constructing the straw bale walls (Woodleigh School 2008)

The outcome of the project has been a building that the students understand and have a connection with. The key, Middleton outlined, was that all activities should have a worthwhile outcome - be authentic. As such one of the major lessons in involving students was that there needed to be activities planned that could be undertaken if there was a downtime; examples given were the ability to research alternatives, work on surrounding projects such as landscaping, or conduct site visits to relevant projects to develop ideas.

One such activity was experimentation with straw bales as it was going to be the base building block for the project. Students were given a couple of weeks to play with the bales, design and construct their own buildings. The teachers were amazed that the structured demonstrated a tacit understanding of orientation, thermal chimneys, and so forth but also that the students were a lot more playful, innovative and creative that they had expected while still demonstrating these principles. The material also let the students create building at their scale which the teachers also found resonated with the student.

Apart from authentic activities this project also shows a significant use of scaffolding – providing support but not the answers – by the teachers. Teacher 2 gives an example of this process in the students' involvement in materials selection:

> *… the process of them doing this made them think about how sustainable solutions could be used in a building… but we made sure that we didn't give them the answers... **we gave them the groundwork**… concepts, tools, ideas but they needed to put these together to **form their own solutions** for the building.*
>
> *So, for example, they helped make the decision about the fly ash content of the concrete* [this lowers embodied energy and thus environmental impacts such as Climate Change] *and this gave them the practical understanding that you don't just use 'concrete' – there are choices you can make. This carried over to decisions on timber use, etc. and this led to the students questioning the materials chosen for the retaining wall and coming up with the used car tyre concept.*
>
> *So doing this with one material gave them the skills of questioning material use in other areas – it modelled a way of thinking about choosing more sustainable material* (Friedlander, M 2009 pers. comm., 6 October).

Lastly now that the building has been completed and is in use, it is crucial to continue its educational opportunities. This is done through transparency in the use of the building. The building is used and managed by the agriculture teacher. Doors and windows are opened by the teacher or the students when they think it is appropriate and the students help with the maintenance of the timber which needs regular repainting. The lights are only turned on 5 or so times a year because of the amount of natural light and there is. The researchers are continuing to be involved with the project, working with the students to monitor their building and using the activities elective to design and build a toilet for the building.

Thornbury Secondary College

As outlined above, the General Purpose Classroom (GPC) was originally intended to be a 'portable classroom' placed on the site which the designer, Middleton, was able to design and get built as a permanent classroom for the same budget. Thus, the major constraints

on the design of the GPC were the budget, the timeline and location. From an environmental outcomes perspective, it was the fixed location and footprint that limited what could be achieved. Adjoining the site was the existing year 7 centre which was built directly to the north, blocking most of the northern sunlight to the site. Middleton forced the roof of the GPC to be extremely high to access natural light and promote natural ventilation (Figure 4). In describing the construction, Middleton calls the GPC an 'Esky building design'. The GPC is a lightweight highly-insulated skin-supported structure using timber studs and trusses. The walls are independent of the roof allowing future flexibility. For additional flexibility the building is entirely screwed together so it can be moved if required.

Compared to a portable, the users of the GPC describe the space as having a similar quality of a permanent building. The teachers specifically comment on the high quality of the natural light that illuminates the space throughout the day.

> *The teachers LOVE the space, they think it is fantastic, particularly how the windows work and how the room leads the students to focus on the teacher and within the room even through they have the lots of light* (Parker, G 2009 pers. comm., 5 October).

Figure 4 – Thornbury High School GPC (Photographer: Haskins, S 2009)

However, this project had no involvement of the students and was built by a builder for a set fee. As a consequence those interviewed spoke of the school community having little understanding of the real quality and sustainability of the building. This lack of understanding resulted in an evaporative air-conditioning being installed at the start of the 2010 academic year. One teacher lamented over this, especially as the teaching staff now rely the mechanical system to cool the space, even on a mild summer day.

Feedback provided by teachers on the comfort of the space identify the GPC as being intolerably hot in summer which was an unfortunate result of glass specified to improve thermal performance, not being installed due to the high costs. In addition, windows needed to be opened and closed at the correct times of day to help keep conditions comfortable, but this did not occur. Firstly, due to security concerns low-level windows were closed at night, preventing night purging from taking place. Secondly of the users lacked a fundamental understanding of passive cooling and the need to open the windows for cross ventilation. Lastly, incorporating an air lock would have helped with the infiltration of unwanted hot or cold air.

The second project is a recording studio which was designed from first principles working with the teachers and students. A workshop where the teachers were asked what they needed was conducted. Their first response was “as big as we can get”. Middleton (2009 pers. comm., 2 October), worked with them to explain the consequences of this request in terms of materials, waste, energy use, cleaning, less acoustic control, and so forth. Further, by rationalising their needs, not necessarily going for a square box, but a more spatially efficient and acoustically effective fan shape, external spaces for teaching and performance were created. This then led to thinking about using this external space as part of a sustainability pathway which could lead visitors past other sustainability initiatives such as the vegetable gardens water tanks and potential future project.

Figure 5 – students working on the foundations of the recording studio (Thornbury High School 2009)

Students helped in the development of the design by making models, thinking about the site, context, the sun, shade and climate. Students were also involved in some of the construction (Figure 5) and they helped communicate the design intent through multimedia design, website development, writing and making. Thus the project intersected with a variety of subject content in the curriculum domains.

In the construction, again there was the limit of what the students were skilled enough to do and what was safe, but they helped with the stumps, they built the platform around the building and they worked on the foundations. It seemed that by engaging the students in physical labor helped to create a lived or actual understanding of what was going on. Also things were taken very slowly, so one thing would be done like the foundations built and then the project would sit idle for a while, this made the project quite visible and transparent. As one of the teachers said it developed a curiosity about what was going on:

> *In contrast to the general class room where we have had very little interest or questions from the users, the new recording studio which is more straightforward and outwardly green has resulted in a lot more questions: 'why straw bale, why the air lock, etcetera'… it is like being involved in the building is part of the learning itself… So even without there being a dedicated curriculum for sustainability linked to this building there is clear learning about*

sustainability happening by the fact it exists… and most importantly, from my perspective, it is leading to curiosity (Parker, G 2009 pers. comm., 5 October).

CONCLUSION

Involving students and teachers in the design construction and management of their buildings seems, from this research, to foster an understanding and engagement in sustainability in the built form. It helps students and teachers develop something which Anne Taylor (2008) calls the 'knowing eye', the ability to have a deeper level of understanding of the built environment and its impact.

The projects above show that if time is available then taking longer and involving the community of teachers and students to partake in the construction process benefits the students both by providing a real world activity but also by fostering ownership of the building. This ownership leads to better management and performance of the building.

ACKNOWLEDGEMENTS

This research has been funded by the Australian Government through the Australian Research Council Linkage Grant Scheme. The Chief Investigators applying were Clare Newton, Dr Dominique Hes, Dr Sue Wilks, Dr Kenn Fisher and Professor Kim Dovey respectively come from the diverse fields of architecture, sustainability, education, educational planning, and urban design. The industry Partners are the Victorian Department of Education and Early Childhood Development, the Victorian Government Architect's Office, Rubida Design, Mary Featherston Design, Hayball, H2o Architects, McGauran Giannini Soon Architects, McBride Charles Ryan Architects and SBE Melbourne. Teacher, Ben Cleveland and architect Ken Woodman received postgraduate scholarships to research in the area as part of the funding.

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