‘Once they have been there and have sat in it, they get it’

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Introduction
Many recent school designs incorporate sustainability features. This paper reflects on several school building projects where the potential was present for these features to be brought into the teaching practice. Using a building as a 3-D textbook means it can be incorporated into the curriculum and aid teaching about heating and cooling, temperature transfer, sun angles, lighting and so forth. A building can embody its philosophy overtly, hanging its green credentials on its sleeve, by providing access to electricity meters, control mechanisms, data and sustainable features.

This research fits within a broader framework of the Smart Green Schools ARC linkage project and sits within its qualitative research methodology centred on case studies.\(^1\) Case studies were chosen as they allowed the investigation of the highly complex influences of built educational environments and their effect on teaching and learning. Observation and ‘thick description’, which enable judgements about making comparisons with, or the possible transferability of findings to other settings\(^2\), were used.\(^3\)

The importance of real world, physical experiential case studies to support learning has been shown by others as crucial for developing tacit understanding (see for example

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Hes4). Our research hopes to illustrate how buildings could be used in learning about environmental sustainability within the middle years of schooling. The ultimate intention is to provide guidance on how schools can integrate buildings as effective 3-D textbooks to support their curricula.

This paper illustrates its arguments through the voices of three of the teachers at the case study schools and their experiences in using these buildings. This has inherent limitations in bias and attachment to their projects that need to be kept in mind when reading their reflections on using buildings as 3-D textbooks to teach environmental sustainability.

Environmental sustainability and schools

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, 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%5 if efficiency is optimised, rainwater is collected and water reused. Waste in construction and renovation can be virtually eliminated6, 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. Spaces need to be


designed to suit the local climate but can also 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\(^7\) 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:

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\text{The various elements of a sustainable school can be featured as part of the educational curriculum. For example, statistical data from the on-site photovoltaic system can be used for a mathematics exercise, or data about the sun movement can be incorporated into the science lesson. These bring home the message in a direct and effective manner.}^{8}\]  

Case studies
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 educational opportunity of the buildings. The two schools discussed below are Thornbury Secondary College and Woodleigh School in Victoria, Australia, both designed by Middleton, a Melbourne-based designer.

1. 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:

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\text{...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
- Respect for the environment.9

The latter rule is taught through active participation in community events, clean up days, tree planting, active participation in the protection of the 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 specifically looked at in this research is an agricultural teaching space. The design, led by Middleton, was driven by both the teachers and the students. The students had a significant input into the design, materials and construction of the space, adding their own ideas and even helping to construct the walls (Figure 1).

Figure 1: Woodleigh students constructing the straw bale walls
(Source: Woodleigh School)

This project, involving the students from Years 8 to 11, showed significant use of scaffolding 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 materials.  

In this same space, Teacher 2 suggested the use of a hand pump for the water collected in the rainwater tanks rather than an electric pump to create the tacit understanding of the energy required for pumping water (Figure 2).

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The building was built out of straw bales and the roof was supported by reclaimed ironbark poles with cypress timber on the northern façade cut in radially to use the timber efficiently. The concept of the roof allowed maximum indirect natural light into the space while facilitating cross and stack ventilation. The use of thick straw bale walls, insulation and concrete floors supported the passive design strategies of controlling infiltration, thermal mass and night purge. Internally, teaching space is light, airy and spacious (Figure 3).

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Figure 3: Woodleigh internal spaces entry and work area (03 and 04) and main teaching space and teachers’ area (01 and 02) (Photographer: Scott Haskins)

Figure 4 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 generous internal (02) and external (04) teaching areas.

Figure 4: Woodleigh space program

Teacher 1 who uses this building to teach agricultural studies said he feels that:

…it is a really pleasant building to be in, it is comfortable most of the time and has a natural feeling that fits into its setting and it is a working building perfect for teaching agriculture.

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The policy of the school is very much to teach through experience and application. Teacher 1 reflected:

...the thing about being in the building is that we...can use it as a case study. We are in it! They can look up and see the louvres and understand the cross ventilations strategies. They can see and touch the eco-timer. You can talk all you like about concepts but they remain abstract until you experience them. You can see and experience that these are the features that make a sustainable building.  

Teacher 2 built on the importance of learning by sitting in and experiencing a sustainable building by showing how the students were then able to apply their learning to a broader context:

At the end of the day we can sit the students down in the building and say:
This building has no lights...is it needed? ...they can answer 'no!'
This building has no heating...is it needed ? ...‘no!’
This building has no cooling...is it needed ? ...‘no!’
And now they can start questioning why all the other buildings do need these things...

An example of using the building as a teaching tool after its construction was given by Teacher 2 where he takes students into the agriculture building to experience it for 10 minutes and then takes them to a fully air-conditioned building and gets them to compare what they ‘felt’:

...they think it is really comfortable and has a ‘good’ feel and are surprised that they can affect that... On a good day they can even feel the change from hot and stuffy to cool and fresh when they open the building up to ventilate. As one exercise on a hot day we take them to an air-conditioned building and make them sit there for 10 minutes recording what they feel and then go to the ag building. We then discuss the differences between the two in air quality, comfort etc.

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14 Clarke, C. ibid.
16 Friedlander, M. Op cit.
2. Thornbury High School
The interesting aspect of this case study is that there are 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 the planned portable. The second building was a purpose-built recording studio where more time and fewer constraints produced a very different outcome.

The major constraints on this 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. A large building directly to the north meant that the roof needed to be extremely high to allow for the natural light and ventilation strategies (Figure 5). Using what Middleton called the ‘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.

Figure 5: Thornbury High School general purpose classroom (Photographer: Scott Haskins)
Unfortunately the glass specified to improve thermal performance was not installed. Consequently, the building did not perform thermally as expected. As well, there was a need for the windows to be opened and closed at the correct times of day to help keep conditions comfortable, but this did not occur. The reasons were firstly due to security concerns; low-level windows were closed at night. Secondly, 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 straw bale recording studio 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\textsuperscript{17} worked with them to explain the consequences of this request in terms of materials, waste, energy use, cleaning, acoustic control and so forth. Further, by rationalising their needs and not choosing the biggest square box possible but instead going for a design that was a more spatially efficient, 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 projects.

Students helped in the development of the design by making models, thinking about the site and its context, the sun, shade and climate. Students were also involved in some of the construction (Figure 6) 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.

\textsuperscript{17} Middleton, L. [designer of case study buildings, Thornbury High School] pers. comm., 2 October 2009.
Built out of straw bales, the studio raised more interest and entailed more tacit learning than the GPC. Teacher 3, a teacher and driver of the building projects, reflected:

In contrast to the general classroom 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 etc’...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 leads to curiosity.\(^{19}\)

In talking about the GPC, Teacher 3 reflected on those aspects of the space that are not directly attributed to sustainability but are related to good design:

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\(^{19}\) Parker, G. [teacher Thornbury High School] pers. comm., 5 October 2009.
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 though they have lots of light (Figure 7). It has many good environmental design features, though it would have been nice to have double glazed windows and an air lock so that the conditioned air did not escape every time someone came in the door.20

Figure 7: Thornbury High School general purpose centre
(Photographer: Scott Haskins)

As asked if there was any specific sustainability teaching that the GPC supported, Teacher 3 spoke of the challenges of secondary teaching where spaces are not owned by the users:

The Thornbury general classrooms are used by a number of teachers, the space isn’t owned and even though the opportunity is there to write aspects of the building into the curriculum, no one does it. For example, there are vegie patches outside the classroom and the idea was that each Year 7 group would own one and it would be part

20 Parker, G. ibid.
of their learning to grow food there, and this would lead to other aspects of sustainability and the classroom being considered, but the curriculum isn’t there, so it isn’t being done... It isn’t like a primary classroom where a teacher can integrate various aspects because it is their space and they teach a variety of material, here it is fragmented and so there is not ownership of the concept and people just work in their own silos and bits of the curriculum without talking to each other.21

Environmental sustainability, pedagogy, curriculum and teaching
The concept of using a building as a teaching aid fits well with the new directions in teaching and learning that emphasise the connectedness of knowledge and interdisciplinarity of concepts. Based on ideas of constructing knowledge and real-world experiences, these buildings provide the perfect test bed for collaborative group work and the exploration of the interconnected aspects and the effect on themselves. There is the opportunity to embed their learning into real-life experience.

At Woodleigh, the building is designed to cool at night using the low and high level windows. Experimenting with the impact of not opening these windows, students could directly experience the next day how much warmer and less comfortable the space was than when it was used correctly. Further, with 20 temperature sensors around the room, they could actually quantify this experience. Intertwined with this could be concepts of thermal mass, the physical properties of air, cross ventilation and stack ventilation.

Teacher 2 highlighted the connectivity of learning, experiencing and creating understanding through his reflection on the students’ conversion of concepts on sustainability into practice:

What was most interesting to see...was the playful exploration that students did. They applied the ideas we covered with them and provided a solution that would never have been reached by the adults involved. When the

students took the straw bales and made their own solutions to what a 'sustainable building' should be, they demonstrated a playfulness and conceptual understanding beyond what had between covered in class. In many respects this understanding seemed more inherent and tacit than they could articulate in word. When asked why they had built the cubby that way their answers were 'it felt right' and 'it seemed to work' rather than 'because hot air rises, this keeps the sun out, lets light in' etc. Their building was very intimate, cave-like and inaccessible to adults. It worked really well thermally and had a small stack to ventilate it. This was all done through planning and negotiation across the four year levels, changing and evolving their ‘design’ together as they went along. The funny thing about this cubby was that it addressed all the aspects of the school policy which is about giving students citizenship and engagement in their environment – they had ownership of the program, how the building met their needs, their learning, the concepts covered and how it all worked together became more than an idea...it invited individual meaning creation...it became part of them.\(^{22}\)

Conclusion
Schools are best understood as complex systems in which the physical environment interacts with pedagogical, curricular, social, cultural, management and economic factors. Rather than thinking of environmental initiatives only in terms of energy benefits, it is useful to also consider how simple green palettes can transform school environments into 3-D textbooks enhancing the school curriculum. The case studies demonstrate that students can interact with buildings and develop better appreciation of issues such as seasonal changes, comfort levels, passive design, material selection and efficiency. Being involved in the design, development and construction of the buildings provided a valuable learning experience. Most importantly, Woodleigh demonstrates that students can take these lessons and apply them within other contexts.

Interestingly the two case studies have shown that there are important teaching opportunities for buildings that are overtly sustainable. This attribute seems to raise curiosity and interest. Those buildings that are not carrying their ‘greenness’ on their sleeves are used without reflection on its performance. Teaching/learning opportunities are lost. These three buildings and the reflections of the teachers demonstrate that using buildings as 3-D textbooks to support the teaching for environmental sustainability is an effective tool: ‘once they have been there and have sat in it, they get it’.  

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