More than a survey: an interdisciplinary post-occupancy tracking of BER schools

Clare Newton*, Sue Wilksa, Dominique Hesb, Ajibade Aibinua, Robert H. Crawforda, Kate Goodwina, Christopher Jensenb, Dianne Chambersb, Toong-Khuan Chana and Lu Ayec

aFaculty of Architecture, Building and Planning, The University of Melbourne, Victoria 3010, Australia; bMelbourne Graduate School of Education, The University of Melbourne, Victoria 3010, Australia; cRenewable Energy and Energy Efficiency Group, Department of Infrastructure Engineering, Melbourne School of Engineering, The University of Melbourne, Victoria 3010, Australia

In February 2009, the Australian Government announced the $16.2b Building the Education Revolution (BER) as part of an economic stimulus package. In the context of a global financial crisis, the Government called for ‘shovel ready’ projects requiring state education departments to develop template designs to speed the delivery process. Three years later, new facilities have been completed in over 1100 government schools in Victoria (DEECD, 2012). This article outlines research by an interdisciplinary team to track the early occupation of a template design used in Victoria. The design template was unusual: it enabled schools to continue using traditional classroom teaching or to slide open walls to form larger neighbourhoods suitable for team teaching. Our research linked different methodological frameworks to undertake post-occupancy evaluation (POE) of the new spaces. POE strategies are often driven by construction and project management perspectives rather than focus on organizational issues and user behaviour.

Keywords: evaluating school designs; multidisciplinary research; pedagogy and space; post-occupancy evaluation; sustainable school design

Introduction

The tight deadlines imposed by the Australian Government when launching the ‘Building the Education Revolution’ (BER) initiative in response to the global financial crisis meant there was no time for clients, users, designers and builders to collaborate on designs for each school. Instead education departments were required to propose template designs for schools to select from. Each state in Australia proposed different templates and procurement methods. The concern at the time, within both the design industry and education sectors, was that the benefits of quick job creation might be at the expense of a missed opportunity to thoughtfully reinvigorate school infrastructure following decades of neglect.

This study focused on the state of Victoria’s template designs. As the new teaching spaces began to be occupied by the staff and students, we observed school communities in different locations and from different learning cultures move into almost identical teaching spaces based on the same building template. What experiences did each school community share and what variations would be revealed? Our multidisciplinary team with experience in education, information and computer technologies (ICT), engineering and architecture visited three schools as they settled into the new spaces. In contrast to many current discipline-specific post-occupancy evaluations (POEs), we drew together a non-cognate research team to research the impact of the BER initiative from different perspectives.

During the second half of 2010, our team studied a small number of schools aiming to track the transition into the first of the newly completed template spaces. With $50,000 funding from the Melbourne Sustainable Society Institute, our team observed and mapped how learning communities occupied the template spaces and measured how environmental performance was affected by the different locations, orientations and detailing.

In this preliminary pilot research project, we were able to observe gaps that occurred in handover communication compromising comfort and usability. We saw how the sustainability credentials of a design could be compromised by budget cutbacks. For example, the high-level louvres for night purging and ventilation were replaced with fixed glass in one school. We also saw the impact of orientation on indoor climate. In terms of pedagogy, we not only found differences in how spaces were occupied between different schools, but also observed different pedagogical cultures between one end of a template space and its other mirrored end.

*Corresponding author. Email: c.newton@unimelb.edu.au
The context of POE

Evaluation should be a normal part of any learning cycle to ensure mistakes are not repeated but effective POE strategies have intrinsic difficulties and are not yet well embedded within the built environment industries. Although there is general agreement that evaluation of past performance will enable better-informed decisions, the best methods to measure performance are contested. Which strategies should be used to measure building performance, user satisfaction and value for money? Who should undertake the POE studies, who pays and how will results be applied to improve new building briefs (Cooper 2001, Vischer 2001)?

Craig Zimring describes POE evolving from an ‘extraordinary confluence of interests among social scientists, designers and planners in the 1960s and 1970s’ (2001, p. 44) with early researchers particularly focused on user experience. In the 1980s, as more formal POE processes were adopted, the focus shifted to building processes and the physical aspects of buildings. More recently, there has been a further shift towards the environmental performance of buildings. Within this changing context, user satisfaction is often based on short surveys and focus group interviews (Bordass and Leaman 2007) rather than the deeper understanding of user behaviours undertaken as critical ethnographies (Denzin and Lincoln 2000). The advantages of survey techniques include broad user sampling, high rates of survey completion, easy analysis and the potential to benchmark internationally; however, subtleties in user experiences are unlikely to be measured compared with multidisciplinary mixed method research.

POE is gradually being redefined as building performance evaluation (BPE) to enable formative impact as well as post-occupancy feedback (Preisar and Nasar 2008). With any new building there are change management difficulties as occupants adapt to new spaces. There is potential to move beyond POE and BPE strategies to action-based research to support better alignment between space, comfort and occupation (Finch 1999).

In July 2011 the BER Taskforce published its government commissioned evaluation of the BER programme (DEEWR 2011). The Taskforce measured the ‘Value for Money’ of the BER initiative in each state and each school sector according to three parameters: quality 30%, time 20% and cost 50%. Quality was defined in terms of meeting required design standards and complying with agreed scope. Missing from the definition were the ways that spaces might contribute to the called-for ‘education revolution’ through the provision of innovative spaces that support 21st century learning. Also missing was a whole-of-life costing.

Buildings are not products that can be easily measured in terms of value for money. Higher quality, same cost and longer construction time may be a better outcome over the life of a building as might lower quality or higher cost if there is a better value per dollar spent. Design quality in the Taskforce measurement included issues such as leaking roofs but it was largely silent on how well the building designs supported teaching and learning activities (Newton and Gan 2012).

Evaluating school design

An innovation in this research undertaking was the drawing together of broad expertise and epistemological viewpoints to study a significant moment for school design in Australia. The template designs were a unique opportunity to better understand how different school communities utilized space for pedagogy. The same template in different locations with different orientations, user groups, details and commissioning strategies provided a useful case study to consider indoor occupant comfort and energy use. For the study, we observed three learning communities as they moved into similar template spaces and, at the same time, measured the qualities of their indoor environment. One different template space was measured to provide contextual data. The resultant qualitative and quantitative information enabled a rich description of the template spaces improving our understanding of how space, pedagogy, sustainability and life-cycle costing interlink. A literature review by Higgins et al. (2005) indicates no robust research base to fully understand more integrated, personalized learning environments. During the last 4 years, some of our team members have been researching relationships between space and pedagogy as part of an Australian Research Council’s funded Linkage Grant called Smart Green Schools. That research had found that the transition into new, more open planned spaces had been difficult even for those teachers, who over many months, had worked closely with the design team (Newton and Fisher 2009). How then would school communities adapt to moving into the template design spaces when they were given little choice in the layout of their new building once the off-the-shelf template had been selected?

In terms of the quality of indoor environments, review of literature on the benefits of environmentally responsible school designs found no well-designed, evidence-based studies concerning the overall effects of green schools on the health or educational development of students and teachers (National Research Council 2006). However, there were many studies (particularly within the USA) that correlated specific factors such as moisture problems with respiratory problems; air quality and lighting with learning and productivity; and reduced noise levels with student achievement (Schneider 2002).

Research design

The overarching project aim was to ascertain whether the BER initiative within Victoria was a model of transformation or a missed opportunity. Our key questions were associated with the issues of pedagogy and space; professional development; user satisfaction; the use of ICT;
indoor environmental qualities; space and sustainability; environmental assessment and life-cycle costing.

We investigated three BER Template J buildings, among the earliest completed in Victorian primary schools. Department of Education and Early Childhood Development (DEECD, 2012) provided a list of possible schools from which the research team selected three, two (School A and School B) located in suburban Melbourne and one in a regional community (School C). The chosen building template illustrated in Figure 1 features a library and learning centre. This was one of the larger templates offered to schools (950 m²) and had the research advantage of being a mirror-image design, that is, one end of the building was a mirror image of the other end. This meant that as well as comparing one school to another we could observe whether there were variations in culture between the classrooms at each end.

Human ethics approval to conduct the research was granted by the DEECD and the University of Melbourne in May 2010. The participants interviewed were the Principals and teaching staff at each school. Staff members were interviewed just before they were about to occupy the new building and then again soon after occupying the new building.

Three research strands were investigated. The pedagogy and space research team focused on understanding the ways in which teachers were occupying the new spaces, and whether the learning spaces supported their desired pedagogical approaches, including the integration of ICT and multimedia technologies and whether new pedagogies were being used. The sustainability research team analysed school environmental performance in terms of energy, water, waste, indoor thermal comfort, acoustics and lighting. The final research team investigated the life-cycle costing implications of the template approach. Aspects of the observation and measurement components of the project were then compared with alternative templates.

Research strand 1 – pedagogy and space

The Principals of the three schools were interviewed about the preparation for the building project and the early occupation of their buildings. Teachers and their classes were observed and the teachers were interviewed about teaching and learning practices in the new spaces. This research strand on the occupation of the new learning spaces comprised:

- observation and mapping of the different modes of occupying similar template spaces (pedagogy/space links);
- reviewing whether/how teachers were trained to use new spaces (professional development);
- gaining feedback from teachers using the new spaces (user satisfaction survey);
- reviewing the use of ICT.

The schools were observed at several stages of occupation to obtain comparative data. For most new school buildings there is a long process of discussion and consultation. We therefore first sought to explore and understand why Template J was chosen and who had been involved in the process of deciding which template was chosen for the new building. At all three schools the Principal (although not necessarily the current Principal) had chosen which template would be built. All the current Principals agreed that teaching and learning beliefs were inherently linked to the choice of template and at School C, the then Principal chose Template J, based partly on which option would best fit the land available.

The first teachers to occupy the spaces were carefully chosen. The School C Principal said, ‘We’ll be looking for teachers to go in there that are keen on team-teaching so they can make best use of those spaces’. In previous spaces the instruction given to everyone was ‘doors open’. That was done without guidance or support about what team
teaching should be. This school was keen to explore the possibilities that a Template J school would offer them – for example ‘classrooms’ with sliding walls that could be opened or closed to suit the teaching needs of the class at different times.

The post-occupation observations and interviews captured the experiences of staff soon after moving into their new spaces. Follow-up observations occurred a few weeks later within Schools A and B. The striking finding was the way both students and staff seemed to ‘relax’ into the spaces during their early weeks of occupation. The pedagogy/space research team spent time tracking the movement of students and mapping these onto plans of spaces and noted a marked increase in the use of the central spaces and the increased freedom students had to choose where they worked. At School A the classroom boundaries became less apparent by the second visit, and staff at School B said they were getting the ‘feel’ of the building. Our observations concurred with what one teacher noted: ‘We’ve become a little more – not so much “my room”. When you’re in a box that’s your only space’. The School A teachers found that the majority of students were well behaved and were choosing to complete application tasks in the open spaces. At first the teachers were working mainly in the ‘classroom’ space: ‘When we first moved into the building, [we were] overwhelmed by it’, but they had quickly moved out into the open spaces and were no longer feeling confined to the classroom. One said: ‘there is so much space. I think we had 3 if not 4 grades doing the same activity in it. You find you just help kids . . . doesn’t matter if they’re your children or not’ (Figures 2 and 3).

In terms of information technology, staff at School A felt information technologies were already a big part of the school. At School B it was felt that the new technologies ‘had supported, but not led’ the pedagogies in the new spaces. Staff had chosen portable, rather than fixed, interactive whiteboards as they could be used in the classrooms or in the space between the classrooms as required. At School C mobile devices (NetBooks, laptops) were placed on benches around the space allowing students to work on them directly outside their ‘classrooms’.

The staff experienced some difficulties as they began to occupy the new spaces. Teachers at School A believed there was not a lot of room for changing furniture around in their new learning spaces due to the big sliding doors and the placement of the fixed interactive whiteboards. The teachers were aware that the furnishings available could dictate the way space was used. They commented that in the open space there was very little furniture, very little storage, just tables that the students had placed in the middle: ‘When we get some more flexible furniture it will be good out there’.

It is important to note that none of the schools believed that the new buildings restricted any activities. School B teachers commented that, ‘It has been much easier to work in this space’. Further, they believed that their teaching style had changed stating that previously they ‘didn’t have the capacity to bring the kids all together, although occasionally [we] tried to squash 72 kids into a regular classroom – but behaviour [management] was difficult’. They found that now when they gathered, the students as a group ‘just sit and listen. Maybe this has to do with the space they have because they are a small group in a big space’. They believed that the students could do more individual work because there was less noise. One commented that when the students were working outside on the grass and steps: ‘It feels less like work to them’. School B also found that ‘Even the two large tables moved in last week already encouraged kids to work together in different ways’. Also, groups of students were working in teams that were not necessarily class based. The teachers located their desks in the best viewing positions so that when the door was open, they had sightlines into the common space.

The teachers at School B believed the spaces offered a great opportunity to all their students who were ‘filtering into different spaces and then coming back’. They believed the noise level was better than in their previous teaching spaces – perhaps because people were more spread out. The teachers were trying to do more hands-on activities – particularly in numeracy. They were used to making their teaching ‘fit wherever you are, but it works better in the new space. Space makes a big difference’. Once they were in the new spaces they learned more about the spaces. However, they believed they were not able to use the new spaces
properly as they did not have furnishings in the central area. They were keen to have furnishings that were easily moved aside to allow them to form a large space.

The School C teachers perceived the students to be more enthusiastic and excited, especially the boys who had found new ‘corners’ to work in. They noted that, when given the opportunity, the students chose to go and work in the bigger space. At first teachers in School C were concerned with students who could not be trusted to work unsupervised; however, they found that they were able to sit in a spot that enabled them to see through the doorway to the open space and thus oversee all students. Interestingly, this meant that teachers’ desks were often found in a location good for observation rather than in the more traditional front of class position. The teachers liked the fact that they could shut the doors if presentations were occurring and other groups were occupying the common area: ‘The doors seem pretty sound proof too; nice to have the choice to team-teach. [In the] old space we talked over top of each other. . . . Space gives choices’.

Teachers had suggestions for how the spaces could be further improved in terms of more notice board space, storage space and toilets (particularly for staff) with indoor/outdoor access.

Research strand 2 – sustainability and comfort

A second strand of seed research focused on the environmental performance of the new BER template spaces. The Indoor Environment Quality (IEQ) impacts learning outcomes and includes views, lighting, thermal comfort and air quality. Research into thermal comfort – air temperature, mean radiant temperature, relative humidity and air velocity – has shown that being comfortable positively affects students’ performance in terms of attention, comprehension and learning levels (Corgnati et al. 2007). Other supporting international research (Pepler and Warner 1968, Seppänen and Fisk 2004, Wargocki and Wyon 2006, 2007) has concluded that students are less distracted by discomfort and also less likely to become ill if the classroom environment stays between the comfort temperature band of 20 and 27°C. Other research has shown that inadequate ventilation can lead to a build-up of CO2 levels in classrooms making students feel lethargic and consequently affecting their performance (Daisey et al. 2003, Shorrock 2006).

The IEQ category within Green Star (Australia’s most common environmental rating system) has a high weighting due to the influence that IEQ has on creating effective, healthy and pleasant indoor learning environments. Within Green Star, IEQ gets over 17.5% of the possible points. A number of design aspects contribute to the IEQ of a building, including building orientation, ventilation systems and daylight controls. Quite often these aspects also have an effect on the energy performance of the building. Thus, temperature, humidity, light levels (including day lighting) and acoustics were the environmental features measured by the researchers.

The main purpose of this study was to determine an acceptable methodology for testing the IEQ of template learning spaces. Two of the J Template schools were considerably different in a number of ways, including orientation, construction quality and omission or inclusion of certain design elements, such as operable louvre windows.

Three different IEQ monitoring devices were installed at each school, and, depending on battery capacity, worked for up to 2 weeks. In future studies the monitoring should ideally be installed concurrently at each school to compare results across the same timeframe. Each of the three schools has some monitoring devices to capture environmental performance information for displaying on LCD screens in real time within the teaching space. Ideally, a further in-depth study of the template schools would have the capacity to compare or validate temporary monitoring against permanent.

The results obtained suggested that the environmental systems installed needed further adjustment to ensure that both temperature and indoor CO2 levels were within acceptable limits. Indoor CO2 concentration levels in two of the three buildings monitored were found to be above an acceptable level for periods during normal occupancy and may have been causing unnecessary tiredness to the staff and students working in these spaces. The measured indoor temperatures were found to be within the set temperature bands for most of the time. The daytime temperature during building occupation (Monday to Friday) was consistently between 18 and 21°C. However, the school where the high-level louvre windows were replaced with fixed glazing experienced a period of temperature above 26°C. As the data were collected during a cooler period of the year, this indicated a potential problem during warmer weather.

The buildings had heating but not cooling, except for fans. The relative humidity inside the three school template buildings was recorded using Q-Track Plus. The results from the monitoring of the buildings showed that humidity consistently remained between 40 and 70% over the monitoring period.

Light levels were measured within the central space of each template building using the Testo 545 Light Meter. The light levels during school hours were generally above the minimum required level of 240Lux for general-purpose classrooms (as defined by AS 1680.2.3 1994).

Differences in the orientation of the buildings, the location of the meter and other environmental factors made comparisons between schools difficult in this short study. All three schools monitored for this short period made the most of natural light — minimising artificial light requirements and energy use. Although the measurement of light levels is fairly straightforward, the use of the Testo 545 Light Meter was problematic due to the lack of battery life and memory storage. At worst, the measurement only lasted 4 days on a 1min measurement interval. At best, 7 days
of measurement occurred. In addition, the measurement of light levels is highly weather dependent and it may be more appropriate to take a long-term average as the primary result with peak high and peak low as a secondary measurement.

Reverberation tests by a partner Acoustics Engineer showed that the measured reverberation times was low (0.3–0.4 s) indicating acoustic treatments had been installed as specified. In the full research project, acoustics will form a key research agenda, with both reverberation and sound levels to be recorded using the methods tested in this pilot project. The acoustics, only tested at one school, backed up what was found by the Strand 1 researchers. One School A teacher, commenting on the sound quality, said: ‘It can’t be the carpet – it’s not as though it’s padded! The students just work well in there. They’re relaxed, they’re proud of their building. The surprise is how well the students have adapted to the environment’.

In summary, the monitoring process could be improved in the following ways:

- longer term meters;
- more meters — in particular locating meters closer to work spaces for staff and students;
- a better understanding of the lighting controls within the built-in system of the building.

**Research strand 3 — life-cycle cost study**

LCC is a technique to estimate the total cost of ownership (SAE 1999). LCC can be applied to quantify the total costs of whole building and building components and can also monitor the costs during the life of a building. At the design stage LCC can estimate the cost of key components of life cycles and compare alternative design solutions, thereby facilitating rational selection of the most cost-effective option. During occupation stage LCC can be used to understand the actual operating costs of a building and can be used to prove the cost effectiveness of the building design (ANAO 2001).

Potentially, LCC for a school building may be used to make a case for increase or decrease in capital expenditure – based on school commitment to a particular initiative. The usefulness is in aiding a school to decide whether to minimize initial capital cost or alternatively minimize maintenance and operational cost.

In this third strand of our research, we conducted a life-cycle cost study of one of the template designs. The objective was to develop an exploratory life-cycle cost model that could inform maintenance and operating cost requirements as well as indicate the cost implications of the design template. The purpose was to determine the pattern of future costs over the life of the building and thereby understand the future resource requirements so that schools can make budgetary provisions for the cost of running and operating the building.

It was envisaged that life-cycle cost studies would indicate cost reduction opportunities, in particular areas in which running costs might be reduced in the future operation and maintenance of the building (either by change in operating practice or maintenance policy or by changing the relevant systems/components). It was also envisaged that the outcome of the life-cycle cost study would be useful when evaluating the building design for possible improvements in the future. LCC estimates could also help improve the specification of future school buildings.

The LCC study was conducted using the following steps: (1) defining the objectives of LCC, (2) identifying the cost drivers and establishing their parameters, (3) choosing the analytical cost model and discount rate, (4) collecting data on cost as well as data relating to the parameters of the model, (5) estimating the cost profile for each year of study by converting the cost for each year into their present values, (6) plotting a chart of the distribution pattern of total life cost by year, (7) plotting a chart of the distribution pattern of life cost by building elements, (8) plotting a chart for total life cost by cost components, (9) conducting sensitivity analysis and (10) interpreting the results.

Some of the data used in the LCC model were those published by the Australian Institute of Quantity Surveyors (AIQS 2002). Water and energy consumption and costs were taken from benchmark data published by the Financial Management Association of Australia (FMA), City West Water and Simply Energy. In the next phase of our research some of the parameters of the LCC model will be revised based on data obtained from actual operation of the building.

Nevertheless, the preliminary exploratory LCC model developed provided a comprehensive framework for the next phase as well as giving useful insight on the pattern of ownership cost of the building. It also indicated the distribution pattern of the maintenance and running costs as well as the significant components of the building life cost.

In the LCC model the life of the building was assumed to be 100 years and was used as the study period. The life of the building refers to the time interval between construction and demolition. A 10% discount rate was used to discount all future and annual costs to their present value. However, sensitivity analysis was conducted based on a discount rate of 5–15%. The initial capital cost was extracted from the building cost plan obtained from the Victorian DEECD. The LCC model was set up in Microsoft Excel workbook and broken down into building elements as reflected in the cost plan. Operating costs, maintenance cost, cleaning costs and alteration/replacement costs were considered and estimated for each element where relevant.

The results show that the life cost for the school building over 100 years, expressed in present value terms current at January 2011 is $3,761,353 (about $3970 per square metres gross floor area). This figure includes all capital, operating, maintenance, cleaning and alteration/replacement costs but excludes financial and occupancy cost. It excludes adjustment for the residual value of the building at
disposal/demolition. Figure 4 shows the distribution of life costs by type of cost component. Capital costs are the most significant (83%) followed by cleaning costs (8%), operating costs – electricity, gas and water (4%), alteration and replacement costs (3%) and maintenance costs (2%). The present value of life cost by year (Figure 5) shows that after around 60 years the life cost becomes negligible. Thus, in the next phase of our research a study of 60 years will be used. Figure 5 is useful as it indicates pictorially the distribution of future resources requirement. More importantly, it shows the dates at which future expenses are significant so that decision makers can proactively make budgetary plans for such expenses. It is important to note that the distribution pattern of the future expenses over 100 years indicates a significant jump every 8 years. This is because major repairs, alterations and replacement of floor tiling and paving as well as plastering and painting on walls occur every 8 years. Figure 6 shows the contribution of building elements/components to the present value of life costs. ‘Paving, tiling and floor finishes’, and ‘electrical services’ are potential areas through which cost savings can be achieved. Since capital costs are already expended, cost savings may be achieved by design modifications that reduce cleaning costs and alteration/replacement costs for ‘paving, tiling and floor finishes’ as well as by design solutions that reduce water and electricity consumption. However, such decisions will depend on the additional capital costs of achieving the design modifications as well as the actual performance of the building when compared with a best-case scenario. A more economical approach might be to reduce life cost through operational practices that reduce the water and energy consumption below the assumptions made in this study.

A sensitivity analysis to examine the relationships between uncertainties in the parameters of the LCC model and the present value of life cost was conducted. The parameters considered were: discount rate (10%), electricity consumption (59 kWh/m²/year), gas consumption (118 MJ/m²/year), water consumption (708 kl/year), electricity unit price ($0.2088 per kWh), gas unit price ($0.01637 per MJ), water unit price ($1.50 per kl), capital cost ($3,147,359), maintenance cost ($69,957), operating cost ($145,307), cleaning cost ($292,943), alteration/replacement cost ($107,787) and number of cleaning days in year (191 days). A −50% to +50% range of variation in each parameter was used for the analysis. The results (Figure 7) suggest that the life cost for the building is most sensitive to discount rates, capital cost, the number of cleaning days and cleaning costs. This provides useful information for the next phase of the research where actual data from the building will be employed. It indicates that
there is a need to pay greater attention to the choice of discount rates as well as measurement and calculation of the number of cleaning days and cleaning costs.

Based on the LCC study we estimated the initial, operational, maintenance and recurrent embodied energy for the building. The results (Figure 8) suggest that operational embodied energy is by far the largest (61%) followed by initial embodied energy (23%), recurrent embodied energy (11%) and maintenance energy (5%). The LCC model as set up in Microsoft Excel workbook demonstrates how LCC can be used to understand the pattern of life cost for a building and particularly for the selected template design.

**Conclusion**

After approximately a month’s occupation all the observed schools, teachers and classes appeared to almost relax into the new spaces. We observed students making appropriate choices about where and how they wanted to do independent or collaborative work with other students. The idea of the classroom having a front had disappeared. The teachers located themselves where they could see into the central spaces.

For many teachers the move into the new spaces meant they would need to function outside their pedagogical and spatial comfort zones. Principals were aware that the full
potential of the spaces would be realized by teachers who wanted to work within teams rather than teachers preferring to work more independently behind the closed doors of the classroom. The researchers observed, at least in early occupation, that the new ‘classroom’ spaces were not configured very differently to the classrooms they had come from in terms of the layout of student tables. In the early days of occupation some teachers chose to revert to quite traditional teaching models to manage the children’s excitement of moving to the new building. Teachers at all three schools believed that the noise level was better than in their previous teaching spaces. They could have doors open and not disrupt one another.

The members of Sustainability Stream 2 were happy with the approach taken in collecting the data for looking at the indoor environmental performance of the BER spaces and the specifics of the equipment. However, battery life was an issue. Within a bigger project a more longitudinal approach would be taken, with data on water and energy use also collected. The main lesson gained was the importance of fine tuning the systems in place, for example, changing some of the set points and ensuring that systems designed to keep indoor CO₂ levels under control, worked. As has been found in a number of previous studies (Wyon et al. 1979, Wyon 1991), the need to avoid extreme temperature conditions and provide as much individual temperature control as possible was strongly supported by the initial findings from this study. It is noted that all three schools had a monitoring system that for the most part was not understood by the school, and in one case switched off. Future projects should look into these systems in more detail to understand how they are working, as they may be able to provide some of the required information on IEQ.

The monitoring of IEQ of the template school buildings links to other team projects looking at space and pedagogy, user comfort and life-cycle cost, and environmental performance within schools. An advantage of this interdisciplinary approach to assessing the performance of the buildings, and ultimately the effect on staff and students work, is that other aspects of the research can be used to explain potential irregularities or issues with the performance of the buildings and the recorded data. For example, there were some IEQ issues that came through in interviews that were conducted with the staff using these buildings. Teachers in two of the three schools struggled to override the automated system that could have given them the flexibility to change the air temperature, turn on the lights out of school hours and turn fans on or off. The other issue that arose was that due to the heating system only being operational from 9 am, teachers using the spaces before this time found the indoor air temperature to be below a comfortable range.

From the LCC study, we developed an exploratory life-cycle cost model for one of the Victorian government school template designs. The model offered some insights into the future cost requirements for the building as well as suggesting areas where cost reduction might be achieved in the future. The model demonstrated how LCC could be used to understand the pattern of life costs. The model would be improved by using actual data from the building. Future research should incorporate a base case LCC model against which any template design can be benchmarked. Schools will be able to make a case for an increase or decrease in initial capital cost – based on commitment to a particular initiative. Schools may choose to minimize initial capital cost or alternatively minimize maintenance and operational cost.

In this preliminary research, we observed gaps that occurred in handover communication, thus compromising comfort and usability. We saw how the sustainability credentials of a design could be compromised by budget cutbacks – where at one school high-level louvres for night purging and ventilation had been replaced with fixed glass. We observed the impact of orientation on indoor climate. In terms of pedagogy, we not only found differences in how spaces were occupied between different schools, but also observed different pedagogical cultures between one end of a template space and its other mirrored end.

From a research point of view, the BER Templates in Victoria are particularly interesting because they were planned to allow teachers to continue working within a ‘closed’ classroom or to open up sliding walls between classrooms and onto a shared activity area. In the second visit some weeks after student and staff moved to the new spaces, we were finding teachers and students more likely to extend their learning environment into the shared spaces and take a more team-teaching approach.

Given that most primary schools within Victoria have access to new spaces as part of the BER initiative, there may be a substantial pedagogical impact as teachers start to observe or experience the potential of team teaching across shared cohorts of teachers. It will be useful to continue observing these spaces over the coming years as they become more embedded within each school culture and
also evaluate the impact of the new BER spaces on teaching and learning that occurs not just within the new spaces themselves, but also within the rest of the school, including outdoors.

The research team tentatively suggests that the Victorian BER Templates will have a reverberating impact across all schools as teachers and students begin to explore the potential of teaching within learning neighbourhoods that are well designed in terms of pedagogy, occupant comfort and layout. Whether the impact will be an ‘education revolution’—only time will tell.

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