Schools as Space - A spatial narrative

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The design and construction of contemporary education buildings is taking place at a time when the nature and process of education is being radically rethought. Current pedagogical discourse is focused on learning and putting students at the centre of the debate and a key driver of educational change in the 21st century is digital technology. Learning environments in their broadest sense need to adapt to this emerging context so that they support collaboration and individual work in the classroom and beyond.

A variety of learning settings can support the different demands of learning. In spatial design there is a trend towards providing environments with greater variation in the types, sizes and shapes of space to accommodate different activities and varied group sizes. However, while education authorities in many countries set space standards that can seem very prescriptive it demonstrates the tension between the constraints of funding and the need to meet increasing education demand.

The design of learning environments are increasingly including spaces that are outside the school boundary placing education at the heart of communities. As the context of education continues to change, so too will the spatial response both at the scale of design of spaces within individual schools, but also the connectivity between spaces across communities, towns and perhaps beyond.

This paper explores the development of school buildings within this context and the characteristics of physical learning environments to support changing education demands.

Introduction

The design and construction of contemporary education buildings is taking place at a time when the nature and process of education is being radically rethought. Increasing globalisation is demanding that people develop new skills that enable them to work in more collaborative and creative ways. Students leaving school today are likely to have several different careers during their working life and quite possibly the job types that young adults will apply for when they leave school will not have existed when they started their education.

This is a world in which traditionally recognised concepts of organisational structure and power no longer always apply. Increasing connectivity between people and the democratisation of knowledge facilitated by rapid developments in mobile technologies, enables networks of citizens to quickly share ideas and information and to challenge the traditional organisational or governmental structures and power whether it is by forcing democratic change, or simply being able to influence them.

Education is not immune from this. These changes are having a profound effect on the nature of education at all levels from early years through to adult learning. Coupled with significant population movements and growth in some countries such as the UK, education authorities are under huge pressure to meet demand very quickly.

Meeting a changing education context

Current pedagogical discourse is focused on learning and putting students at the centre of the debate, and how to make them more adaptive, creative, collaborative, responsive and self-directed to meet the demands of the changing global context. Learning is seen as being at its most powerful when it is learner-centred, structured and well designed, profoundly personalised, inclusive, and social (*OECD, 2011a*).

While globalisation exerts socio-economic pressures and provides opportunities for wider and richer learning, a key driver of educational change in the 21st century is digital technology (*Hannon et al, 2011*). This is not only exerting a pressure for change and demanding new sets of skills, but is providing opportunities for transforming pedagogy. Increasing connectivity means that information is available to students and teachers anywhere and at any time. The role of the teacher being transformed from that of someone who merely disseminates information to that of a facilitator helping students understand how to use it.

Learning environments in their broadest sense, which include the building as well as teaching and the curriculum, need to adapt to this emerging context so that they support collaboration and individual work, are responsive to different needs, and enable both formalized structured learning and informal learning. This marks a shift from a traditional model of schooling characterised by uniformity and conformity, often referred to as the factory model, to a model characterised by individualisation and collaboration. Indeed, similar changes can be seen in the workplace - as people grapple with different forms of interaction- and reflected in its design, offering potential solutions to the design of education buildings, perhaps most obviously to universities and vocational colleges. Three concepts that appear to be important in any discussion on physical learning environments: *connectivity*, *space* and *time* - since learning involves interaction between people, in space over time (*OECD, 2014*).

The social nature of learning implies connectivity between students, teachers and schools and other groups of people not directly connected with the school but who contribute to the learning landscape, for example museums and science centres. Technology such as wi-fi, and 4g mobile services afford greater connectivity between these groups at distance also giving greater and faster access to information. This enables students and teachers to both use spaces on the school campus in new and creative ways, and make greater use of spaces beyond it within the town or their homes.

The type of interaction between people shapes space, and the characteristics of spaces that exist affect the interactions between people. The spaces that are provided for education whether they are within formal or informal learning environments affect the learning activities that can take place within them, whether it is the ability to accommodate large groups, or carry out certain types of activities.

However, space needs to be responsive to changing use through time. Education systems impose a time based order on the use of space in a number of ways for example, semesters, timetables for lessons and other activities, and the hours that the buildings are open and available for use. Space planning needs to enable flexibility of use over these different time frames.

Creating learning settings in space

Space can be defined physically as an enclosure by creating walls or barriers, or it can be more perceptual and indicated by for example, changes in floor finish or the placement of objects or furniture to create perceived boundaries around an area. Space for learning is not confined to being within buildings, it includes external spaces such as the grounds and gardens.

A variety of learning settings can be identified to support the different demands of learning and pedagogical activities to enable interaction (*Fisher, 2005*). In learning environments that promote independence as well as interdependence and self-motivation, the spaces must reflect student needs and enable connectivity beyond the classroom. In such learning environments there will also be peer-to-peer learning, integrated problem solving facilitated by breakout spaces to allow individual student work and furniture needs to be suitable for cooperative learning.

In a learning environment that is supportive and productive where there will be learner centred pedagogies, its design will need to reflect community diversity, respect and value different cultures and enable students to have access to teachers.

The physical environment would also need to include quiet spaces, as well as multi-purpose rooms that enable students to work on different subjects over longer periods of time, and encourage an integrated curriculum. At the same time there should be teacher spaces that encourage cross-disciplinary teams of teachers working with groups of students.

For these reasons contemporary school building design has been moving away from the notion that a school building should be a set of individual classrooms, and other spaces such as halls and libraries, generally arranged either side of a wide

Flexibility, versatility and agility in class spaces is enabled by being able to move furniture about easily and quickly. Northern Beaches Christian High School, New South Wales, Australia.

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corridor, or around a central space. The aim now is to create designs that include a variety of sizes and shapes of room arranged in different ways to meet a range of needs from group size to activity type.

A survey carried out by the OECD for "Designing for Education" (*OECD, 2011b*) showed trends in school building design moving towards providing environments with greater variation in the types, sizes and shapes of space to accommodate different activities and varied group sizes. It also showed the extent to which the buildings are becoming more transparent so that people can see what is happening throughout the building and feel connected with those activities even if they are not always taking an active part in them. The transparency is being facilitated by greater use of glazing or more attention being given to the design of sight lines.

Key to an effective spatial design is the ease with which the user to be able to use it in different ways at different times. Commonly the organisation of spaces within school buildings are fixed to the extent that schools have a variety of spaces that are fixed so that you cannot change their size or shape. Flexibility arises from the ability to be able to change the use of those spaces. The ability to be able to do this relies heavily on being able to move furniture around quickly and easily - in other words spatial agility.

Two examples that explore the flexibility of space are in Senior Albany High School in New Zealand, and Yuille Park P-8 in Victoria, Australia. The former constructed its new school in two stages. First it constructed a temporary building to enable it to explore use of space with different teaching arrangements. It used this experience to inform the construction of the permanent building (*OECD, 2011b*). At Yuille Park the design included separate smaller linked buildings of varying sizes which enabled them to change which year groups would be based in them from one year to the next (*DEECD, 2012*).

In more progressive school designs the space seems more fluid, where the building is not so much a series of rooms but is a series of spaces that may have one or two walls but are open on the other two or three sides. The purpose of such designs is to enable users greater freedom in creating useful learning space with varied learning settings that can be configured in different ways.

Some of these ideas are rooted in the development of school design in the 1960s onwards in the UK and US which saw the evolution of open plan schools. The more traditional blocks of classrooms linked by corridors, was replaced by clustered arrangements where large areas of space could be used for several activities by different classroom groups at the same time. The main criticism of these designs was that the pedagogical narrative described by the architecture did not match teaching practice. These spaces demanded different approaches to teaching which the teaching profession had in general not adopted. For example, team teaching with greater collaboration between teachers on what each would be doing with their respective class groups to avoid conflicts between say the noisy activity of one class and quiet activity of an adjacent class. Keeping each group in an enclosed box was simply easier to manage. One contextual difference between then and now, is the wider recognition of different pedagogical approaches.

The arrangement of this learning space enables different group and individual activities note how the space flows into other learning spaces beyond. Dandenong High School, Victoria, Australia.

Perhaps one key lesson for schools and designers is that however schools are planned, there must be a match between spatial concepts used in the design and how teaching and learning takes place in reality.

Defining standards for spaces

Education authorities in many countries set space standards that can seem very prescriptive. Such guidance generally defines the floor area for certain kinds of spaces for example classrooms, halls and libraries. It may also recommend configurations and how these rooms are arranged in relation to each other. Often these guidelines are used to define the basis against which government funding will be granted while defining what should be an effective learning environment. Whilst funding is always a constraint, it is being exacerbated in countries such as the UK where not only does the government have a tight policy for tackling the country's debt, but also there has been a substantial increase in the demand for school places. This demand has been caused by a rising birth rate due to both immigration and increase in the average age of parents who have delayed raising families.

In England (the constituent countries of the UK have separate education systems) guidance on the design of school buildings has been issued by the education ministry in the form of building bulletins which have defined recommended sizes for different types of space and configurations such as what types of space should be adjacent to other types of space. Although these have often been taken to be minimum standards, they were intended as guidance on what was thought to be appropriate for different levels of education.

In Portugal, the secondary school building modernisation programme (*Blyth et al, 2012*) saw the development of new sets of guidance documents as much aimed at designers to help them with expertise, information and knowledge from the government agency Parque Escolar, which oversaw the programme. As elsewhere the guidance provides information on spatial configuration as well as recommended areas.

Environmental comfort remains important in the design of schools. Spaces should be thermally comfortable, with good

The circulation space provides valuable learning and social areas in a school.

air quality and lighting. The acoustic quality of space is an important constraint on design because of the adjacency of different activities. Indeed one state education authority in Australia has put acoustic considerations at the forefront of its spatial design approach and defined education spaces within what could be loosely called an acoustic landscape by categorising pedagogical activities into three zones: those activities that are reflective and creative; those that are creative and interactive; and those that are interactive (*DEECD, 2008*). In England, although some other standards have been relaxed, acoustic standards remain tight.

However, there is a tension between setting guidelines to meet constraints of government funding and at the same time enable innovative solutions that address a changing learning landscape. In countries where there is growing interest in engaging the private sector in education and the provision of education buildings funding from additional sources may enable schools more flexibility.

While many authorities set out specific standards, some also encourage designers to and schools as clients to begin by examining the needs of learning and the school. In England and Scotland, there is guidance on the briefing process for education buildings. **Table 1** gives an example from the Department of Education and Early Childhood Development, Victoria, Australia which matches the activities within each acoustic zone with spatial principles that define the overall characteristics of the space, and furniture arrangements that define the spatial settings. Rather than initially prescribing a given number of classrooms and other space types with specific dimensions, this authority is encouraging schools and designers to think about the design problem from first principles. At a later stage in the design process a schedule of spaces will be created, but at least this will have been derived from the actual needs of the school.

However, more often a brief consists of a list of spaces with specific sizes that the designer has to configure in the most economical way leaving little option to question whether the types of spaces and configuration are appropriate (*Blyth*

and Worthington, 2010). Control of cost is one reason why this happens. It is easier to calculate how much it will cost to construct a given floor area of building, and using a measure of capacity such as the number of say square metres of area per student define how much a school should cost to build. But also there is an uneasiness about defining spaces that appear to have no specific function other than for general use. Yet it is these sort of spaces that if allowed, can be functionally very useful and which students can make their own especially if they have basic furniture and connectivity both wifi and electrical sockets.

Creating sustainable learning communities

The agenda for education for sustainable development addresses not only the use of resources in the design of buildings, but also the life of the student in general, and the role of education in society and economies.

Education buildings can be seen as examples to the community for how governments envisage the concepts of sustainability being delivered, whether this is through the design of the building and use of on-site power generation technologies, the materials used in its construction, or the didactic use of the building as a teaching tool for students. For example, the installation of meters to measure energy and water consumption, and other technologies or strategies such as waste recycling, or the creation of wildlife habitats on the school campus that enable students to develop environmental literacy.

The OECD PISA survey for 2006, which assessed the knowledge and skills of 400,000 fifteen year olds across 57 countries showed that over 75% of fifteen year olds cite the school, more than any other source, as the place where they learn about environmental issues. Educators and teachers predict a positive influence between the school spaces and environmental knowledge. Repeated exposure to and interaction with the natural environment seems to generate greater comprehension and awareness of the environmental issues that continue to affect the planet. The design of the school to facilitate this is critical (*OECD, 2009*)

In spatial terms a school need not be confined to the school building or campus. There are examples of how schools are reaching beyond their site boundary to use facilities available locally, and which therefore become part of the school resource. For example by using museums and art galleries. Indeed innovations in school learning environments are increasingly including the facilities in the neighbouring community.

In Lund, Sweden, the University of Lund constructed a science centre that students from primary and secondary schools can visit in class groups. Undergraduate science students work with class teachers using interactive equipment. In 2012 over 15,000 school students visited the facility. The building has a small auditorium for about 100 students, science demonstration areas, a small astronomical observatory and workshop spaces.

Another example is in Puebla, Mexico, where the Planetarium offers students interesting activities and introduction courses to foster their scientific and technological skills. Students can participate in a variety of activities regardless of their prior scientific background. In 2012, 22,298 students visited the Planetarium and from April to November 2012, 156 schools, a total of 10,864 students from the city of Puebla and other municipalities visited it. (*OECD, 2013a*).

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	Attributes	Spatial principles/alternatives	Furniture arrangements
Reflective/Creative	• Personal learning spaces • Independent, quiet working areas • Space for reflection • Small groups of 1 - 3 students • Technology access • Located in 'eddy spaces'	• Accommodation for a maximum of 10 individual students • Acoustically and visually separated • Some small, screened meeting spaces or rooms • Provision of work benches	• Lounges • Comfortable seating • Movable tables
Creative/Interactive	• Space for processing/gathering information • Space for learning activities in small groups • Problem, process and inquiry-based learning • Technology access	• Accommodation for a maximum of 25 students in groups • Resource and technology rich • Flexible arrangements • Links to outdoors • Some access to non-specialist wet spaces	• Round tables for 4-6 students • Movable chairs • Storage for student work and resources • Display and projection space
Interactive	• Space for more collaborative, interactive learning • Team teaching • Larger groups • Open space • Technology access	• Accommodation for a maximum of 75 students in groups, e.g. 3X25 students • Movable and flexible furniture • Less acoustic and visual separation • Links to outdoors • Specialist wet spaces/studios shared with other larger groups	• Round tables for 4-6 students or flexible furniture that can be configured in different groupings/arrangements • Views to multiple visual learning screens • Access to multiple display areas

Table 1: Learning zones showing attributes of spaces and respective spatial and furniture principles
Source: DEECD (2008), Victorian School Design, Melbourne

School building projects often form the focus of urban regeneration projects with schools also being seen as vital resources for local communities more than just providing student education. Some schools provide other services such as healthcare consultation for parents, or access to government social services and skills development and training. For many schools, the impact of this is on the management of the spaces that they have rather than the quality of the spaces themselves. The concerns expressed by school managers often being about security or the time and resource needed to clean and prepare the school for the next day after a community event. Whether these strategies work as intended may be open to question and seem to demand more intensive management than may have been assumed at the outset. Different approaches are taken depending on the degree of security and accessibility that the school is able to manage. For example one solution is to create zones within a building that can be independently secured so that only part is used by the community event.

Yuille Park P-8 Community College in Victoria, Australia, is located in an area of high disadvantage and was part of a neighbourhood regeneration project started in 2001. The aim of the project was to increase wellbeing, safety, education, employment, housing and participation of community members. The school was designed to enable multi-use of the spaces, also it was designed with a high degree of transparency within the building giving a sense of visibility and openness, enabling people to feel part of what is going on - this itself is an ongoing trend in school design. (*DEECD, 2012*)

The Community Learning Campus (CLC) in Alberta, Canada, is an innovative approach to high school, post-secondary and community education, sharing resources and working jointly with a variety of community groups and agencies. Community members have access to fine arts and health and wellness facilities, state of the art technology and a variety of learning opportunities. It focuses on bringing together high school and post-secondary education in one place (which may be virtual), seeking to create a seamless transition for students wishing to enter the workforce, apprenticeship, college, or university.

The Liceo Técnico Professional La Florida, Santiago, Chile was the focus of a regeneration project in a disadvantaged part of the city and was built on a disused gas station. The aim was to engage the community in the school and provide a beacon for education in the area. The school provides technical skills training for 14-18 year olds. The design of the building is a series of spaces around a central courtyard. The school is opened up to the community for skills training and other uses including local healthcare services. (*OECD, 2011b*)

In many countries, particularly those affected by natural disasters such as earthquakes, schools are seen as a natural refuge for the local community. This may become more common across most countries as extreme climatically driven events such as flooding becomes more common. From this perspective school buildings need to be large enough to cater for large numbers of people, but be located away from the potential natural event that would affect the area.

Measuring the impact of learning environments

It is a concern that much of what is created for school learning environments lacks any substantial evidenciary basis. In truth we really do not know enough about whether the design strategies employed really do have a positive or negative impact on student outcomes, either cognitive or non-cognitive. To create more effective physical learning environments there needs to be an approach rooted in a research-based approach (*Lippman, 2010*).

There continue to be many attempts to establish the links between the physical environment and student attainment. At its most basic the aim is to try and show that students perform better or worse in a particular building and identify why. The problem has been that overall evidence for this is illusive although some research does show a link between specific aspects of the physical environment and learning such as acoustics, lighting, or air quality and student test scores.

Student learning outcomes are considered as more than just about test scores and include health and wellbeing, affective, social, cognitive and behavioural characteristics of individuals. To add to the complexity these cahraceristics can also be pre-conditions that can impede or enhance learning (*Blackmore et al, 2011*). The physical environment is one of many factors impacting on learning outcomes which still makes identifying specific links very difficult.

However, some studies do suggest that poorly designed and maintained schools (i.e. those with inadequate acoustics, temperature, light and air quality), often found where educational achievement is low, can have a detrimental effect on teacher and student engagement and adversely affect student outcomes and can pose risks to student and staff health and safety (*Blackmore et al, 2011*).

Indeed Peter Barrett (*Barrett et al, 2015*) has shown that in of a study across 153 classrooms 27 primary schools the differences in the physical characteristics of classrooms accounts for 16% of the variation in learning progress over a year. In this study seven design paraemters explain the 16% variation in student performance: light, temperature, air quality, ownership, flexibility, complexity and colour. The approach taken was to

Schools are not confined to using space within their own buildings. A classroom module built as part of a science museum can serve just as well. Plantarium, Puebla, Mexico.

develop a framework that takes a holistic view of the learning environment rather than merely examining simple correlations between two variables and that owes much to neuroscience. It groups these parameters under three headings: Naturalness (light, temperature and air-quality), Stimulation (colour and complexity) and Individualisation (ownership and flexibility). Naturalness contributed 49% to the overall findings, Stimulation contributed 28% and Individualisation 23%. While these seemed to be the most important factors, others such as acoustics have a second order of importance because in the analysis they were competed out by some of the other, but they remain important nonetheless. The value and benefit of this research, other than making the direct connection between the learning environment and student performance, is that it acknowledges the complexity of the interactions, and as such is very persuasive. However, the warning must be that these figures are important in the round, it would be no good merely taking those parameters under the heading of Naturalness and assuming that by addressing just those issues you would automatically achieve an 8% improvement. Sadly the researchers could not include the performance of teachers in the calculations because of data confidentiality, although they would be part of the remaining 84%.

A recent study in the UK (*Williams et al, 2014*) has studied the links between student attainment and schools completed under the Building Schools for the Future programme and found that attainment levels started to rise two years before occupation of the building and this continued until three years after occupation when they fell dramatically. Further study into the contextual factors behind these findings is needed to explain this result. While it does not tell us anything about the reasons for the change in student performnce, it does suggest that simple bivariate analysis may over-simplify complex raltionships possibly distoring the result.

Whether or not there are direct causal links between space and student attainment the design of space for learning remains important, and the impact on other learning outcomes such as well-being and health may be more easily measurable but are also important.

The OECD has launched its Learning Environments Evaluation Programme (LEEP) to look at this question through an international project but also as a means of supporting school improvement (*OECD, 2014*).

The aim of LEEP is to create a better understanding of how the learning environment supports learning and help develop the evidence base for both creating learning environments but also managing and using them effectively. The physical learning environment is the first module being explored in this study.

Health and wellbeing, affective, social, cognitive and behavioural characteristics of individuals are pre-conditions that can impede or enhance learning. They are also desirable learning outcomes (*OECD, 2014*). However, the physical environment is one of many factors that impact on student learning outcomes, although much of the research to date focuses on relatively limited number of outcomes, often cognitive, and not so often on the physical learning environment. This study will draw in both the cognitive and non-cognitive learning outcomes.

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External learning space is important too. Here classrooms open onto external 'class spaces'. Mexico Olimpico, Mexico

Conclusion

The spatial design of learning environments is changing to meet emerging needs of education. Space and teachnology mediates the relationships between people and can enable or constrain people's ability to carry out activities.

New ways of configuring space within schools are being developed with more attention being given to how space supports the needs of education. This may be space within a school building or campus, or a series of spaces connected physically or virtually across the local community. New ways of meeting the needs of learning are being developed through education and design innovation, and it is likely that this will continue as the global context of education continues to change.

As the context of education continues to change, so too will the spatial response both at the scale of design of spaces within individual schools, but also the connectivity between spaces across communities, towns and perhaps beyond. Perhaps it is not to fanciful to imagine a school as being a series of discrete physical environments spread around a city connected by technology but providing places where students can meet each other and their teachers but enable them greater freedom to use the facilities in the city. In this way the spatial narrative that describes learning is continually being developed. However, there is a pressing need more more evidence on what works and a more coherent evidence based approach to design development and use of learning environments.

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